LOWER MID-COLUMBIA MAINSTEM

INCLUDING ROCK CREEK

Subbasin Plan

Prepared for the Northwest Power & Conservation Council

Draft Lower Mid-Columbia Mainstem Subbasin Plan

Includes Rock Creek, Washington

12/08/2004

Prepared for the Northwest Power and Conservation Council

Lower Mid-Columbia Mainstem Subbasin Plan

Table of Contents

List of Tables

List of Figures

Supplemental Errata

The authors have added new material about the Oregon side and the mainstem of the Lower Mid-Columbia Mainstem Subbasin since the May 28, 2004 deadline. The additions, made during the response period in the fall of 2004, are noted by chapter, chapter sections, and page numbers in the table below.

Lower Mid-Columbia Subbasin Plan - Supplemental Errata		
Chapter 1 Contributors		
Section Number	**Page Number**	**Description**
1.1	Page 1	Lead Organizations-Oregon included
1.2	Page 1	Coordinators-Oregon included
1.3.4-1.3.5	Page 1	Contributors-Oregon and mainstem included
1.4	Page 2	Subbasin Plan Approach and Public Involvement-Oregon included
1.4.1	Page 2	Description of Planning Unit-Oregon and mainstem included
Chapter 2 Executive Summary		
2.2	Page 6	Public Involvement-Oregon and mainstem included
2.5	Page 8	Focal Species in Current Planning Area-Oregon and mainstem included
2.6.2	Page 12	Key Findings and Limiting Factors/Oregon Area of the Subbasin
2.6.3	Page 13	Key Findings and Limiting Factors/Mainstem Area of the Subbasin
Chapter 3 Subbasin Overview		
Figure 1	Page 18	New subbasin map
3.1.1	Pages 20-21	Lower Mid-Columbia Mainstem Subbasin Location- changed to reflect the current planning area boundaries
3.2.1	Page 22	General Location-description of subbasin area
3.2.2	Page 22	Topographic/Physio-geographic Environment-Oregon and mainstem included
3.2.3	Page 23	Climate and Weather-Oregon included
3.2.4	Page 23	Land Cover and Vegetation-Oregon included
3.2.5	Page 24	Hydrology and Hydrography-Oregon and mainstem included
3.2.6	Page 30	Jurisdictions and Land Ownership-Oregon and mainstem included
3.2.7	Page 31	Land Use and Demographics-Oregon included
Table 3	Page	Population by Counties-Oregon included
3.2.8	Page 35	Anthroprogenic Disturbances on Aquatic and Terrestrial Environments-Oregon, mainstem, shoreline included
3.2.9	Pages 42-4	Terrestrial/Wildlife Resources-Oregon included
3.2.10	Page 47	Aquatic/Fish Resources-Oregon and mainstem included

Chapter 4 Wildlife Assessment		
4.1.1	Page 56	Introduction-Oregon and mainstem included
4.1.2	Page 56	Wildlife Assessment Methodology-Oregon included
4.1.3	Page 58	Wildlife Habitats and Features in the Lower Mid-Columbia Mainstem Subbasin
Table 7	Page 58-9	Current wildlife habitat types-Oregon differentiated
	Page 58	Rare Plants and Plant Communities-Oregon included
	Page 62	Noxious Weeds-Oregon included
4.1.5	Page 66	Focal Terrestrial/Wildlife Habitats for the Lower Mid-Columbia Mainstem Subbasin-Oregon and mainstem included
4.1.7	Page 68	Focal Wildlife in the Lower Mid-Columbia Mainstem Subbasin
4.3.1	Page 80	Yellow Warbler (Dendroica petechia)-Oregon included
4.3.2	Page 84	American Beaver (Castor canadensis)-Oregon included
4.3.3	Page 89	Lewis' Woodpecker (Melanerpes lewis)-Oregon included
4.3.4	Page 93	Interior Riparian Wetlands and Focal Species Key Findings, Limiting Factors and Working Hypotheses-Oregon included
4.4	Page 96	Shrub Steppe/Interior Grasslands-Oregon included
	Page 97	Grasslands-Oregon included
	Page 99	Description of current shrubsteppe habitat in Oregon
4.4.1	Page 101	Rocky Mountain Mule Deer (Odocoileus hemionus hemionus)/Columbian black-tailed deer (Odocoileus hemionus columbianus)-explains different population(s) in Oregon including the hydrid
4.4.2	Page 114	Grasshopper Sparrow (Ammodramus savannarum)-Oregon included
4.4.3	Page 120	Brewer's Sparrow (Spizella breweri)-Oregon included
4.4.4	Page 125	Shrub Steppe/Interior Grasslands and Focal Species Key Findings, Limiting Factors and Working Hypotheses-Oregon included
4.5	Page 128	Ponderosa Pine (Pinus ponderosa)/Oregon White Oak (Quercus garryanna)-not in this Oregon part of the subbasin, but adjacent locations in Oregon mentioned
4.5.1	Pages137, 139	Western Gray Squirrel (Sciurus griseus)-Oregon's western gray squirrel is not a distinct population segment
4.5.2	Page 141	White-Headed Woodpecker (Picoides albolarvatus) is an Oregon sensitive species (critical)
4.5.3	Page 145	Ponderosa Pine/Oregon White Oak Habitat and Focal Species Key Findings, Limiting Factors and Working Hypotheses-relevant for discussion of white-headed woodpecker
4.6	Pages 146-148	Habitat of Concern: Lower Mid-Columbia Mainstem-new section on mainstem wildlife
4.7	Page 149	Habitat of Concern: Agriculture-Oregon key finding

6.1.2	Page 279	Existing Management Plans-Oregon and mainstem included (new section)
Table 38	Page 286	Existing management programs--Oregon and mainstem
6.1.3	Page 287	Existing Management Programs-Oregon and mainstem included (new section)
6.1.4	Page 299	Projects-Oregon and mainstem included
Chapter 7 Synthesis and Interpretation		
7.1.1	Page 306	Introduction-recommendations on which chapter sections to synthesize and interpret in next iteration; identifies sections that discuss data gaps including for Oregon and the mainstem
Chapter 8 Management Plan		
8	Page 312	Wildlife Introduction-Oregon and mainstem included
8.2	Page 318	Wildlife-Oregon included
8.2.1	Page 319	Interior Riparian Wetlands Objectives and Strategies-Oregon included
8.2.2	Page 322	Interior Riparian Wetlands Focal Species (Yellow Warbler, American Beaver and Lewis' Woodpecker)-Oregon included
8.2.3	Page 326	Shrub Steppe/Interior Grasslands Habitat Objectives and Strategies-Oregon included
8.2.4	Page 329	Shrub Steppe/Interior Grasslands Focal Species (Mule Deer, Grasshopper sparrow, and Brewer's Sparrow)-Oregon included
8.3.1	Page 339	Mainstem Objectives and Strategies: Steelhead, Coho, Fall Chinook-new section
8.3.3	Page 346	Mainstem Objectives and Strategies: Pacific Lamprey-new section
8.3.5	Page 353	Fulton Canyon and Spanish Hollow Objectives and Strategies-new section
Appendices	—	Updated to include Oregon and mainstem information

1 Contributors

1.1 Lead Organizations

The Yakama Nation, Klickitat County, Washington Department of Fish and Wildlife. The lead entities are supported by the Washington Office of the Northwest Power and Conservation Council and its contractors Normandeau Associates, Laura Berg Consulting, Dick Nason Consulting, and Cogan Owens Cogan.

1.2 Coordinators

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Tom Rien, Oregon Department of Fish and Wildlife

1.3 Participants and Contributors

1.3.1 Rock Creek Working Group Participants

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1.3.2 Rock Creek Information Meeting Participants

Larry Jensen, Dave Whitmore, Keith Jensen, Bob Powers, Sandra Powers, Mike Copenhefer, Harry R. (Dick) Wilson, Larry Seaman, Chrystal Seaman, Miland Walling, Ron Juris, Elwood Brown, Bill Mains, Lynn Mains, Fred Wilkins, Don Slater, Virginia Read, Dean Miller, Marie Miller, Earl Lasley, and Linda Lasley, citizens.

1.3.3 Wildlife Participants and Reviewers

Several people participated in reviewing all or sections of the assessment drafts. These individuals, along with the writers, made up the Wildlife Information Group. For a full list of reviewers see Appendix A. This Washington citizens' committee, made up of concerned citizens of the public, also reviewed all or sections of the document drafts.

1.3.4 Oregon Contributors

Brian Stradley, Oregon Association of Conservation Districts; Rod French, ODFW, The Dalles; Russ Morgan, ODFW Heppner Wildlife District Office; Jimmy Kagan, Oregon Natural Heritage Program Information Center; Howard Browers, U.S. Fish and Wildlife; and Tom Rien, ODFW.

1.3.5 Mainstem Contributors

Tom Rien, ODFW; Mike Matylewich, CRITFC; and for GIS products, Van Hare, Pacific States Marine Fisheries Commission/StreamNet

1.3.6 Technical Writers

Laura Berg Consulting, subcontractor to Normandeau Associates and to Cogan Owens Cogan

1.3.7 Reviewer

Dick Nason, Dick Nason Consulting, subcontractor to Normandeau Associates. (Review of the Washington portion of the subbasin.)

1.4 Subbasin Plan Approach and Public Involvement

This Lower Mid-Columbia Mainstem Subbasin Plan, along with the Klickitat and Big White Salmon subbasins, has no single lead entity but was jointly developed by the Yakama Nation, Washington Department of Fish and Wildlife and Klickitat County, with direct support and involvement of the Washington office of the Northwest Power and Conservation Council and its consultants. The Oregon Department of Fish and Wildlife and the Sherman County Soil and Water Conservation District helped with the Oregon portion of the Lower Mid-Columbia Mainstem Subbasin Plan.

Public involvement is discussed in the Executive Summary. Citizens of the subbasin who participated in the public meetings are named in Section 1.3. and other contributors are named in Appendix A.

The management plan was developed in a relatively short time frame and with a limited budget, as the Klickitat, White Salmon and Lower Mid-Columbia Mainstem were among the last subbasins to get started in the NPCC Subbasin Planning Process. Set by the Northwest Power and Conservation Council, the original boundaries of the Lower Middle Mainstem extended upstream to river km 669 at Wanapum Dam and downstream to river km 308 at The Dalles Dam. Priest Rapids, McNary, John Day, and The Dalles dams and reservoirs were included within the subbasin, as was the free-flowing Hanford Reach immediately downstream from Priest Rapids Dam. The current plan, however, was limited in geographic scope to the north side of the Lower Middle Mainstem segment of the Columbia River from the mouth of the Walla Walla River to the mouth of the White Salmon River. During the response period in late 2004, the Oregon side of the subbasin was addressed as was the mainstem portion of this subbasin. Priest Rapids Dam and the Hanford Reach were not included for the following reasons.

- Unknown management strategies for the Hanford Reach Monument, because the U.S. Fish and Wildlife Service process of developing a management plan for the Reach has not progressed sufficiently to provide guidance to the subbasin planners, and
- Uncertainty about the Federal Energy Regulatory Commission determination in response to Grant County PUD's application to relicense the Priest Rapids Hydroelectric Project, which was filed on Oct. 29, 2003.

Many mainstem wildlife and particularly fish issues are not covered in this subbasin plan. For the mainstem Columbia, this plan is limited to mostly habitat issues and only an overview of related issues, such as flows, fish passage, hatchery, and harvest. The complex science and proposals for adaptive management associated with hydrodevelopment are largely outside the scope of this LMM Subbasin Plan and often outside the boundaries of the subbasin itself. Critical topics such as the Mainstem Amendments to the Columbia River Basin Fish and Wildlife Program, the Columbia River Treaty with Canada, the Non-Treaty Storage Agreement, the Pacific Northwest Coordination Agreement, and system flood control and mid-hourly coordination agreements are not addressed here, Even aspects of the ESA Biological Opinions, which are now the frequent subjects of litigation, are not covered within these pages. Similarly harvest issues and their ongoing negotiations and resulting regulations are not included in any depth here as they are subject to the U.S.-Canada Pacific Salmon Treaty and the *U.S. v. Oregon* Columbia River Fish Management Plan. Although many anadromous hatchery fish migrate through the lower mid-Columbia mainstem, no hatcheries in the subbasin's currently active planning area are releasing fish into the subbasin. Thus, the scientific research and debates regarding supplement and genetics are not described in this plan, but can be found in other Columbia Plateau Province subbasin plans.

Because wildlife focal habitats and focal species were initially selected by WDFW, Yakama Nation, and Klickitat County for the Washington side of the subbasin, Oregon and mainstem wildlife species information were added later and in many instances remain incomplete and without the aid of GIS products. These gaps should be addressed in future iterations of this subbasin plan. In the Oregon portion of the subbasin, only two of the three focal habitats are present, Interior Riparian Wetlands and Shrub Steppe/Interior Grasslands. The discussion of lower mid-Columbia mainstem wildlife species and wildlife habitat occurs in 3.2 Subbasin Overview/3.2.8 Terrestrial/Wildlife Resources, 4.1.2 Wildlife in the Lower Mid-Columbia Subbasin, and 4.1.3 Wildlife Habitats and Features in the Lower Mid-Columbia Mainstem, and in the discussion of the relevant individual focal species.

For additional information related to subbasin boundaries and what is included in the Lower Mid-Columbia Mainstem Subbasin Plan, see Sections 2.1 and 3.2.

1.4.1 Description Planning Unit

Lead entities for this subbasin plan are the Yakama Nation, Klickitat County, Washington Department of Fish and Wildlife, and the Oregon Department of Fish and Wildlife. The lead entities are supported by the Northwest Power and Conservation Council.

Infrastructure and Organization

Assessment - The subbasin assessment is a technical analysis to determine the biological potential of the subbasin and the opportunities for restoration. It describes the existing and historic resources, conditions and characteristics within the subbasin. The bulk of the assessment work for Washington focused on Rock and Pine Creeks and was done by the Yakama Indian Nation and WDFW with support and involvement of Klickitat County. The assessment for Oregon was done with the assistance of ODFW. Separate teams of fish and wildlife scientists developed the assessment.

Inventory - The inventory includes information on fish and wildlife protection, restoration and artificial production activities and management plans within the subbasin. The inventory work for Washington focused on Rock and Pine Creeks and was done by the Yakama Indian Nation and WDFW with support and involvement of Klickitat County. The Inventory for Oregon was done with the assistance of ODFW.

Management Plan - The management plan is the heart of the subbasin plan-- it includes a vision for the subbasin, biological objectives, and strategies. The management plan embraces a 10-15 year planning horizon. The Yakama Nation, WDFW, ODFW, Klickitat County and a range of stakeholders were contributors to the management plan.

1.4.2 Vision Statement

We envision healthy self-sustaining populations of fish and wildlife indigenous to the Columbia Basin that support harvest and other purposes. Decisions and recommendations will be made in a community based, open and cooperative process that respects different points of view, and will adhere to all rights and statutory responsibilities. These efforts will contribute to a robust and sustainable economy.

2 Executive Summary

2.1 Purpose and Scope

The Lower Mid-Columbia Mainstem Subbasin management plan (including Rock Creek, Washington)—along with the supporting assessment and inventory —is one of 60 management plans currently being developed throughout the Columbia River Basin for the Northwest Power and Conservation Council (NPCC). This subbasin plan was crafted, in part, by the same team that is currently working on the Klickitat and Big White Salmon subbasins, and thus shares many elements in common with those plans, with the main exception that this subbasin encompasses the lower mid-Columbia mainstem river. The plan will be reviewed and adopted as part of the NPCC's Columbia River Basin Fish and Wildlife Program. The plan will help prioritize the spending of Bonneville Power Administration (BPA) funds for projects that protect, mitigate, and enhance fish and wildlife that have been adversely impacted by the development and operation of the Columbia River hydropower system.

The primary goal of subbasin planning in the Columbia Basin is to respond to the Independent Scientific Group's *Return to the River* report to the NPCC. Notable conclusions from that report were:

> Our review constitutes the first independent scientific review of the Fish and Wildlife Program…
>
> The Program's…lack of a process for prioritization provides little guidance for annual implementation…
>
> We recommend incorporation of an integrated approach based on an overall, scientifically credible conceptual foundation…

The NPCC responded to the ISG by creating the subbasin planning process, within the context of the 2000 Fish and Wildlife program. Subbasin plans provide the first basin-wide approach to developing locally informed fish and wildlife protection and restoration priorities.

An important objective of this subbasin plan is to identify management actions that promote compliance of the federal Endangered Species and the Clean Water acts. None of the recommended management strategies are intended nor envisioned to compromise or violate any federal, state or local laws or regulations. The intent of these management strategies is to provide local solutions that will enhance the intent and benefit of these laws and regulations. The NPCC, BPA, NOAA/Fisheries and the U.S. Fish and Wildlife Service (USFWS) intend to use adopted subbasin plans to help meet requirements of the 2000 Federal Columbia River Power System Biological Opinion. NOAA Fisheries and the USFWS have stated their intent to use subbasin plans as a foundation for recovery planning for threatened and endangered species.

The Lower Mid-Columbia Mainstem management plan's purposes include providing benefits to fish and wildlife where that help is most needed. The broad purposes of the plan and of the NPCC program mesh regarding fish and wildlife species.

From the Columbia River Basin Fish and Wildlife Program (NPPC 1994):

> The development of the hydropower system in the Columbia River Basin has affected many species of wildlife as well as fish. Some floodplain and riparian

> habitats important to wildlife were inundated when reservoirs were filled. In some cases, fluctuating water levels caused by dam operations have created barren vegetation zones, which expose wildlife to increased predation. In addition to these reservoir-related effects, a number of other activities associated with hydroelectric development have altered land and stream areas in ways that affect wildlife. These activities include construction of roads and facilities, draining and filling of wetlands, stream channelization and shoreline riprapping (using large rocks or boulders to reduce erosion along streambanks). In some cases, the construction and maintenance of power transmission corridors altered vegetation, increased access to and harassment of wildlife, and increased erosion and sedimentation in the Columbia River and its tributaries.
>
> The habitat that was lost because of the hydropower system was not just land, it was home to many different, interdependent species. In responding to the system's impacts, we should respect the importance of natural ecosystems and species diversity.
>
> Some species, such as some waterfowl species, have seemed to benefit from reservoirs and other hydropower development effects, but for many species, these initial population increases have not been sustained.

NOAA/ Fisheries and the USFWS have stated their intent to use subbasin plans as a foundation for recovery planning for Endangered Species Act (ESA)-listed species.

The Lower Mid-Columbia Mainstem management plan's purposes include providing benefits to fish and wildlife where that help is most needed. The broad purposes of the plan and of the NPCC program mesh regarding fish and wildlife species.

From the Columbia River Basin Fish and Wildlife Program (NPPC 1994):

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system's impacts, we should respect the importance of natural ecosystems and species diversity.

Some species, such as some waterfowl species, have seemed to benefit from reservoirs and other hydropower development effects, but for many species, these initial population increases have not been sustained.

2.2 Public Involvement

The Lower Mid-Columbia Mainstem Subbasin Plan could potentially have a great effect on fish and wildlife resources in the subbasin. It could have significant economic impacts on the communities within the subbasin as well. For these reasons, public involvement is considered a critical component in the development of the subbasin plans. Considerable time and effort was spent from the earliest meetings to craft a statement or "vision" of what the Washington participants would like to see in their subbasin as the result of efforts to restore, protect and enhance fish and wildlife populations and their habitat. The assessment and planning work for the Oregon side of the subbasin and the mainstem occurred in the fall of 2004—after the initial plan was submitted on May 28, 2004 and after ISPR and the public comment period was concluded. During the fall the technical writer and ODFW staff were not able to meet with local citizens about this Oregon area of the subbasin.

An important goal of the subbasin planning process continues to be to bring people together in a collaborative setting to improve communication, reduce conflicts, address problems and, where ever possible, reach consensus on biological objectives and strategies that will improve coordinated natural resource management on private and public lands.

The plan could potentially have a great effect on fish and wildlife resources in the subbasins, and could also have a significant economic impact on the communities within the subbasins. For these reasons, public involvement is considered a critical component in the development of the subbasin plans.

Public involvement in the subbasin planning processes the Washington side of the Lower Mid-Columbia Mainstem Subbasin (including Rock Creek) involved a public mailing, public meetings held at different locations and times in the subbasin (and towns near the subbasin), regular conference calls, use of a ftp site to store draft documents, posting draft subbasin plans on the NPCC website, and development and use of extensive e-mail lists that were intended to keep members of the public informed regarding the status of the subbasin planning process.

The White Salmon, Klickitat, and Lower Mid-Columbia Mainstem subbasin planning team, as a part of its public outreach effort, developed a brochure for the public mailing. The brochure was sent as bulk mail and delivered to all postal customers residing in the three subbasins.

There were also a total of seven public meetings in Washington held as a part of the subbasin planning effort. These meetings were held on March 9 and May 6 in Goldendale, on March 11 and May 4 in White Salmon, on March 10 and May 5 in Bickleton, and on May 3 in Klickitat, and while meetings focused on a particular subbasin, the meetings were open to citizens of the three closely connected subbasins and questions were taken regarding the three areas. Numerous technical and planning meetings, announced and open to the public, were held in many locations throughout the subbasins to facilitate collaboration, information flow and involvement by as diverse a group as possible. Throughout the subbasin planning process, Washington participants worked on a vision statement that reflects their vision of the subbasin in 10 – 20 years. As previously indicated, given the time line, no public meetings were held in Oregon. The extent of Oregon public involvement has been the cooperation and/or contact with local offices of ODFW, USFWS, conservation districts and the Oregon Natural Heritage Program Information Center.

The participating agencies, the Yakama tribe, the citizens in the Washingon portion of the subbasin and ODFW leadership approved the vision statement for the Lower Mid-Columbia Mainstem Columbia River (including Rock Creek, Washington) The vision statement follows.

2.3 Vision Statement

We envision healthy self-sustaining populations of fish and wildlife indigenous to the Columbia Basin that support harvest and other purposes. Decisions and recommendations will be made in a community based, open and cooperative process that respects different points of view, and will adhere to all rights and statutory responsibilities. These efforts will contribute to a robust and sustainable economy.

2.4 Subbasin Goals

- Protect or enhance the structural attributes, ecological function, and resiliency of habitats needed to support healthy populations of fish and wildlife.
- To restore and maintain sustainable naturally producing populations of chinook, steelhead, coho and white sturgeon that support tribal and non-tribal harvest and cultural and economic practices while protecting the biological integrity and the genetic diversity of the subbasin.

2.5 Focal Species and Habitats in the Current Planning Area

While the Lower Mid-Columbia Mainstem Subbasin as defined by the NPCC includes numerous Columbia River reaches, it is in the watersheds that drain into the Columbia where habitat and other restoration initiatives are most likely to be implemented and achieve benefits for fish and wildlife. But for anadromous fish species, in particular, the success of these initiatives also depends on the mitigation and restoration actions taken in the mid-Columbia mainstem, where three dams (in the current configuration of the subbasin) dominant the river environment.The critical tributaries primarily occur on the Washington portion of the subbasin between the mouth of the Walla Walla River and the town of White Salmon and include Rock, Pine, and Glade creeks. In Oregon, the fish-bearing streams in the current planning area of the subbasin are Spanish Hollow and Frank Fulton Canyon creeks, east of the Deschutes River subbasin and west of the John Day River Subbasin. For terrestrial and wildlife species, important shrubsteppe habitat occurs in the northern halves of Sherman and Gilliam counties, parts of Oregon within the Lower Mid-Columbia Mainstem Subbasin.

The assessment and management plan identify strategies that benefit three focal fish species that utilize the Washington, possibly the Oregon tributaries, and the mainstem Columbia, and one, white sturgeon, that inhabitats the mainstem exclusively. In addition to sturgeon, the focal fish species selected are steelhead, fall chinook, and coho. The Pacific lamprey was chosen as a fish species of special interest.

Because this was initially a Washington-driven subbasin planning effort, three focal habitats were chosen, interior riparian wetlands, shrub stepp/interior grasslands, and ponderosa pine/Oregon white oak. Only the interior riparian wetlands and shrubsteppe grasslands occur in the Oregon portion of the subbasin. Agricultural lands and later the mainstem were selected as terrestrial and/or wildlife habitats of concern. Eight wildlife species from the Rock Creek watershed were chosen as focal species: Western gray squirrel, mule/black-tailed deer, grasshopper sparrow, Brewer's sparrow, white-headed woodpecker, Lewis' woodpecker, American beaver, and the yellow warbler.

The current planning area of the subbasin extends upstream from The Dalles Dam only as far as the Walla Walla River mouth. The portion that includes Hanford Reach and lands to the northeast and northwest are not within current planning boundardies. While there were no management plan strategies developed in this subbasin plan for the Hanford Reach area or its healthy and naturally spawning fall chinook, that population's status is addressed in the assessment section of the Lower Mid-Columbia Mainstem Plan because of its importance to the subbasin and the region. Also, Willow Creek and Juniper Canyon do not appear in this iteration of the Lower Mid-Columbia Subbasin Plan, as they were included in the Umatilla Subbasin Plan. See **Figure 1** for original and current subbasin boundaries.

2.6 Key Findings and Limiting Factors

The management plan and parts of the assessment are presented in tables that describe key findings, working hypotheses, and the objectives and strategies to address the findings. Many of the findings constitute the factors that unless dealt with, limit the ability of the subbasin to sustain the particular focal species and/or habitats.

2.6.1 Washington Area of the Subbasin

The terrestrial and wildlife limiting factors are based on IBIS information, the unpublished Ashley/Stovall Wildife Assessment Report, and the first hand knowledge of the Yakama Nation and its wildlife staff. The fish limiting factors for Rock Creek derives from an EDT (Ecosystem Diagnostic and Treatment) analysis and interpretation. The limiting factors for fish in the other Washington watersheds in the subbasin were taken from the Water Resource Inventory Area 31: Habitat Limiting Factors.

Interior Riparian Wetlands and Associated Focal Species

The major limiting factors for the interior riparian wetland and associated focal species, the yellow warbler, American beaver, and Lewis' woodpecker, are:

1. Reduction in overall habitat, including floodplain acreage

2. Loss of riparian vegetation and habitat and displacement of native riparian vegetation by non-native species

3. Fragmentation of habitat

4. Alterations in upper watershed hydrology

5. Incised stream reaches, loss of stream complexity and riparian function

6. For the the yellow warbler and Lewis' woodpecker, a reduced food base is also a limiting factor

7. Information is lacking to identify and prioritize all key areas for application of the appropriate strategies

Shrubsteppe/Interior Grasslands and Associated Focal Species

The major limiting factors for the shrubsteppe/interior grasslands and associated focal species, the Brewers' sparrow, mule/black-tailed deer, and grasshopper sparrow, are:

1. Loss of quality habitat, including soil damage

2. Loss or reduction in the age class native shrubsteppe vegetation and displacement of native vegetation by non-native species

3. Loss of ephermal wetlands

4. Overall loss and fragmentation of shrubsteppe/grassland habitat

5. For mule deer, additional limiting factors are loss of shrubsteppe habitat in winter range and hunting mortality

6. For the brewer's sparrow and grasshopper sparrow, addititional limiting factors are loss of shrubsteppe habitat within their breeding range

7. Information is lacking to identify and prioritize all key areas for application of the appropriate strategies

Ponderosa Pine/Oregon White Oak Habitat and Associated Focal Species

The major limiting factors for the ponderosa pine/Oregon white oak habitat and associated focal species, western gray squirrel and white-headed woodpecker, are:

1. Loss of large tracts of old growth or late seral forests, which has also resulted in the reduction of large diameter trees and snags

2. Increased stand density and decreased average tree diameter

3. Loss of native understory vegetation and composition

4. For the western gray squirrel, increased competition with introduced, non-native squirrels

5. Information is lacking to identify and prioritize all key areas for application of the appropriate strategies

Rock Creek and Focal Fish Species

The fish assessment and management plan for the Washington portion of the subbasin focus on Rock Creek, where an EDT (Ecosystem Diagnostic and Treatment) analysis was made. The limiting factors for Rock Creek and the associated focal species are steelhead, coho, and fall chinook are:

1. Altered thermal regimes have affected fish life histories such as spawn timing, incubation and rearing, and decreased suitable habitat

2. Juveniles redistribute themselves downstream in the summer and fall after emergence, with highest densities in fall being found well below the major spawning areas

3. Steelhead populations have been dramatically reduced from pre-settlement abundance levels

4. Population levels of Pacific lamprey have been dramatically reduced from pre-settlement levels

5. Tributary summer/early fall habitat availability lower in comparison with pre-settlement environment

6. Loss of habitat diversity and thermal refugia because of off-channel habitat losses

7. Hydrology has been altered to increase peak flows; loss of storage

8. In tributaries, lack of habitat diversity (pools with cover) and lack or decrease of large woody debris

9. Food web in lower river has been altered and/or reduced

10 Predation risk to salmonids from native fish (northern pike minnow), from non-native fish (walleye and smallmouth bass), and from birds is elevated

11. Survival of steelhead kelts (mature spawned out fish with the potential to spawn again) migrating out of the Rock Creek watershed and through the mainstem Columbia to the ocean is believed to be at or near zero

12. Hatchery fish compete with natural-origin fish for space and food resources

13. High temperatures in tributaries have resulted in increased susceptibility of native salmonids to pathogens

14. Loss of habitat diversity and thermal refugia because of off-channel habitat losses

15. Population and ecological effect of beavers have been significantly reduced and altered

16. Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces

Other Washington LMM Watersheds and Focal Fish Species

1. Barrier culverts at SR 14 on Pine Creek preclude access to potential steelhead habitat

2. Low or non-existent flows in all streams during the late summer, fall, and early winter will limit or preclude utilization by fall spawning adults (chinook, coho), and limit mobility of juveniles of all species

3. High stream temperatures in the lower portions of all streams during the summer and early fall limits mobility of juveniles of all salmonid species and can result in mortality due to thermal stress

4. Accelerated channel incision (entrenchment, downcutting) has reduced the quality and amount of available existing or potential fish habitat

5. Channel widening and obliteration of riparian zones

6. Locally poor habitat quality and riparian condition

7. Water quality diminished

8. Removal of or damage to riparian vegetation and compaction and erosion of stream banks and adjacent floodplain areas

9. Low or non-existent flows in all streams during the late summer, fall, and early winter limit or preclude utilization by fall spawning adults (chinook, coho), limit mobility of juveniles of all species, and may be resulting in mortality due to stranding

10. Information available for these findings is limited; additional data is needed on fish utilization and habitat availability and quality; investigation of barriers; more detailed evaluations of the condition of channels, floodplains, wetlands, and riparian areas; identification of sinks and sediments and sediment sources; the causes of high stream temperatures

2.6.2 Oregon Area of the Subbasin

The terrestrial and wildlife key findings and limiting factors are based on information from local ODFW and conservation district sources. Key findings and limiting factors for fish are based on local ODFW sources and the 2004 Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery and Conservation Management Act Essential Fish Habitat Consultation on Resource Management Systems for Dry Cropland and Range and Pastureland in Gilliam, Sherman, and Wasco Counties, Oregon. (Oregon and Washintong's terrestrial and wildlife limiting factors and management objectives and strategies are integrated into the same tables.)

Interior Riparian Wetlands and Associated Focal Species

The major limiting factors for the interior riparian wetland and associated focal species, the yellow warbler, American beaver, and Lewis' woodpecker, are:

1. Reduction in overall habitat, including floodplain acreage

2. Loss of riparian vegetation and habitat and displacement of native riparian vegetation by non-native species

3. Fragmentation of habitat

4. Information is lacking to identify and prioritize key areas for application of the appropriate strategies, in particular, information about losses in and changes to riparian and floodplain areas and function, stream complexity, and food base sources for the yellow warbler and Lewis' woodpecker

Shrubsteppe/Interior Grasslands and Associated Focal Species

The major limiting factors for the shrubsteppe/interior grasslands and associated focal species, the Brewers' sparrow, mule/black-tailed deer, and grasshopper sparrow, are:

1. Fragmentation of shrubsteppe/grassland habitat and wildlife populations

2. Loss of habitat, particularly quality habitat

3. Soil damage

4. Loss or reduction in the age class native shrubsteppe vegetation and displacement of native vegetation by non-native species

5. Information is lacking to identify and prioritize key areas for application of the appropriate strategies, in particular, information about loss of ephermal wetlands and existing habitat for and habitat use by the brewer's sparrow and grasshopper sparrow, including the status of subbasin shrubsteppe habitat within their breeding range

Fulton Canyon and Spanish Hollow Watersheds

1. Watershed hydrology is altered

2. Columbia River dams have reduced potential anadromous fish spawners in these watersheds

3. Summer/early fall habitat availability diminished in comparison with pre-settlement environment

4. Increased fine sediment from background levels in spawning gravels and interstitial spaces

5. Altered riparian and wetland structure

6. Steelhead populations have been dramatically reduced from pre-settlement abundance levels

7. Tributary high temperatures have reduced fish mobility and resulted in increased susceptibility of native salmonids to pathogens

8. Information available for these findings is limited; additional data is needed on fish utilization and habitat availability and quality; investigation of barriers and culverts; more detailed evaluation of the condition of channels, floodplains, wetlands, and riparian areas; identification of sediments and sediment sources; high stream temperature occurrences and causes

2.6.3 Mainstem Area of the Subbasin

The key findings limiting are based on information from ODFW, CRITFC, the 2000 Biological Opinion, the Fish Passage Center, the 2001 LMM Subbasin Summary, the fish agency and tribes' Comments on the "All H Paper," and other professional, agency, and technical sources.

Lower Mid-Columbia Mainstem and Focal Species Steelhead, Fall Chinook, and Coho

1. Hydropower system has altered the historic hydrograph, which has a negative impact on juvenile salmon, including steelhead, coho, and fall chinook

2. Downsteam passage conditions at the hydroelectric dams can result in high mortalities

3. Peak demand flows and fluctuations in flow can have a deleterious effect on juvenile salmon migration

4. Fluctuations in flow can delay adult salmon migration

4. Weir technology is new and has been installed only at Lower Granite Dam. Not all dams and reservoirs have the same passage conditions

5. Prolonged exposure to elevated water temperatures is stressful for upstream migrants and can delay migration

6. When monitored, adult fish passage perfomance criteria are often not in compliance

7. Adult steelhead fallback is occurring at the dams

8. Contaminant input from upstream land-use activities are often trapped in the reservoirs behind dams. Dredging suspends contaminants accumulated in sediments

9. Rapid changes in reservoir levels are occur frequently with harmful results to fish and those who harvest fish

10. Irrigation withdrawals contribute to stranding of rearing juveniles

11. Juveniles can be entrained into irrigation pumps

12. Commercial gillnets used in The Dalles and John Day pools may break free, get lost, and trap fish

13. Juvenile salmon are being harvested by bird and fish predators at higher rates than prior to hydro operations

Lower Mid-Columbia Mainstem and Focal Species White Sturgeon

1. Spawning occurs in the mainstem but can be limited by hydrograph and water temperatures

2. Impounded white sturgeon populations incur periodic year-class failures

3. Egg, larval stage, and YOY white sturgeon are susceptible to predation

4. Impounded white sturgeon populations are less productive than the unimpounded lower Columbia River population

5. The health of white sturgeon populations show up in density, condition factor, reproductive potential, age structure, and fish growth rates

6. Reservoir specific intensive harvest management can influence white sturgeon abundance levels

Lower Mid-Columbia Mainstem and Species of Concern Pacific Lamprey

1. Recent counts of Pacific lamprey at The Dalles, John Day and McNary dams indicate a serious decline in abundance. Low abundances limits lamprey populations in upstream tributaries

2. Adult fishways are difficult for lamprey to negotiate

3. Juvenile lamprey suffer from high impingement rates on bypass screens because they are relatively poor swimmers. John Day Dam, in particular, impinges large numbers of lamprey

4. Contaminants input from upstream land-use activities are often trapped in the reservoirs behind dams. Dredging suspends contaminants accumulated in sediments. Dredging can also lead to direct mortalities

5. Rapid changes in reservoir levels can isolate or dewater rearing areas and lead to juvenile mortalities

Habitats of Concern: Mainstem Wildlife Habitat and Agriculture

The lower mid-Columbia mainstem contains some prime wildlife habitat—islands, embayments, and mudflats, primarily—where a diversity of avian species use the area to stop-over, breed, nest, and winter. This section of the assessment lists nearly 40 important wildlife habitat areas in The Dalles, John Day, and McNary reservoirs, including the Umatilla National Wildife Refuge in the John Day pool. This section discusses the recent invasion of the exotic false indigo that has further degraded riparian areas along the shoreline and on the islands.

Agriculture is briefly discussed as a habitat of important economic significance to the subbasin. This section notes that agriculture is becoming more environmentally friendly. It also mentions that in Oregon's Sherman, Gilliam, and Wasco counties, successful consultation with NOAA/Fisheries has resulted in plans for conservation-oriented Resource Management Systems for dry cropland and range and pastureland as part of helping to protect ESA threatened and endangered salmon species.

2.7 Management Objectives and Strategies

The fish and wildife species addressed in the 8. Management Plan are affected by many of the same limiting factors. Not surprisingly, subbasin planners have identified some of the same or closely related objectives and strategies to eliminate or reduce threats and to maintain and restore species and habitat viability. The strategic themes that bridge both fish and wildlife include an emphasis on restoring and maintaining native species, including vegetation; eliminating or reducing exotic species and the predator threat they pose; restoring and reducing threats to riparian areas, wetlands, and floodplains; reducing exposure to contaminants; reducing anthropogenic disturbance to water, land, plants, and animals; and acquiring the scientific information that is currently lacking.

Primary strategies in both the fish and wildlife portions of this management plans are proposed acations to restore beaver habitat and, where possible, to prepare for reintroduction of a species whose numbers are greatly reduced from historic levels. Restored habitat would benefit beaver, whose activities would in turn benefit the salmon and steelhead that use the watershed for a portion of their life history. Beaver dams result in the creation of off channel habitat and increased channel stability, which would provide a benefit to the fish focal species that utilize the Rock Creek and other tributary watersheds.

Restoring riparian wetland habitat structure and hydrology increases ecological function, bringing benefits to both fish and wildlife. Rehabilation involves increasing native vegetation and creating adequate hydrological conditions, which together help reconnect habitats in tributary and mainstem floodplain areas.

Other objectives and strategies are specific to wildlife or fish, and they are summarized below.

Generally, the areas and actions identified in the primary tier category of the focal fish and wildlife species management plans could be implemented within the next five years and have a high likelihood of achieving the targeted biological objectives. The geographical areas in the primary tier of the fish and wildlife tables are the most appropriate areas for that strategy to be employed.The white sturgeon table is also ordered according to the confidence level associated with particular strategies.

2.7.1 Wildlife

A general wildlife theme identified across the subbasin is stop the reduction in the quantity and quality of all types of terresterial and riverine habitat that the wildlife focal and other species need to flourish.

Reconnecting currently fragmented wildlife habitats types is a common objective of all three focal habitats. The solutions range from changing silvicultural, grazing practices, and other land use practices to purchasing easements and properties with intact habitats.

Among the causes of the diminution and fragmentation of shrub steppe habitat are agriculture and other human development, altered fire frequencies and invasive weed species. Habitat quality can be improved by controlling the frequency and thus the intensity of fire (restoring more natural fire cycles), encouraging appropriate grazing practices, prioritizing weed control areas, and implementing native plant restoration. Restoration and protection of exisiting habitats are key strategies.

Habitat quality and ecological function in ponderosa pine/Oregon white oak habitat has been reduced because of altered forest species composition and age structure. Harvest practices have resulted in removal of late seral stands and large overstory trees across the landscape. Biological objectives and strategies for the ponderosa pine/white oak habitat include retaining any presented late seral stands and large decadent wildlife trees and managing these stands to restore functional habitat. Such strategies include identifying areas where thinning and/or prescribed burning would help achieve habitat objectives and thinning appropriate stands to decrease stand density.

2.7.2 Fish

Many proposed actions focus on restoring riparian function (reconnect side channels, re-establish or enhance native vegetation, increase channel roughness, artificially introduce large woody debris as well implement practices that allow large woody debris to naturally enter and remain in the system). Such actions would contribute beneficially to lowering stream temperatures, increasing wetted perennial areas in the lower watersheds, improving food availability, filtering fine sediment levels, attenuating peak flows and otherwise improve conditions for fish in the subbasin’s tributaries.

There is significant need for ongoing monitoring and evaluation within the Rock Creek watershed. Although there is a high level of certainty with several key findings and strategies, without concerted monitoring and evaluation there is a margin of uncertainty that the best strategies will achieve the most benefit possible. Therefore, along with the actions suggested in the management plan tables, an extensive monitoring and evaluation effort within Rock Creek is considered a high priority.

This plan urges the supplementation of less productive focal fish populations in the subbasin’s Washington tributaries by capturing juveniles below the lower most dam in the system, Bonneville, then transporting and releasing them in upstream reservoirs. The Rock Creek and mainstem Columbia plans call for strategies to improve the survival of steelhead kelts, which are mature, spawned out fish that have the potential to spawn again.

For Spanish Hollow and Fulton Canyon what is particularly needed and called for is the collection and analyses of base line data about the watershed and fish utilization.

Water quality in the lower mid-Columbia mainstem, in Rock Creek, Spanish Hollow and Fulton Canyon and other watersheds are impacted by excessive sedimentation, which can negatively affect steelhead and salmon rearing and egg incubatio. in the mainstem are Strategies identified in the plan include an assessment of the relative contribution of the various sources of that increased sedimentation and implementation of actions to reduce sedimentation. Those actions include improved road and off-road vehicle management and the implementation of upland management practices that mimic natural runoff and sediment production.

In the mainstem, contaminants are suspended in sediments and accumulate in the reservoirs behind the dams. The recommended strategy for the mainstem includes eventually eliminating dredging. Mainstem strategies targeting contaminants call for the full development of TMDLs, including identifying remedial actions.

Many of the mainstem strategies address the critical limiting factor for anadromous fish: up- and downstream passage of salmonids. Because the mainstem plans are not expected to fully plan the restoration and remedial actions that would make the Columbia River habitat more suitable to anadromous fish, this subbasin plan addresses passage and flow issues in a general way. Nonetheless, the mainstem management plan identifies aggressive actions that acknowledge the strategic location of the lower mid-Columbia River and its three hydroelectric dams. Strategies offered in this document's management plan suggest hydrosystem operational shifts that are expected to increase migration survival and spawning success particularly in the Hanford Reach.The plan recommends actions to restore a more natural hydrograph to improve migration conditions; use flow augmention to increase water velocities during fish critical times; use spill to maximize downstream passasge and spread the risk among several strategies for juvenile migration; minimize fluctuations in flows and rapid changes in reservoir levels; and halt additional water withdrawals.

2.8 Adaptive Management of the Subbasin

It is important to recognize that the Lower Mid-Columbia Mainstem Subbasin Plan reflects current understanding of conditions within the subbasin. The strategies recognize uncertainty and lay out a series of processes for improving the scientific understanding of those conditions, as well as implementing actions that the planners feel certain will succeed in meeting plan goals. The purpose of ongoing research and monitoring is to reduce uncertainty regarding subbasin function and to move from uncertainty to action items. As results of research and monitoring become known, or in some cases as projects are further refined, more specific action strategies are expected to be formulated at points in time which do not precisely coincide with updates to the subbasin plan or project review cycles established by the NPCC.

If adaptive management (i.e. a structured process to actively learn from ongoing management as well as research) is to work and improve our decision-making ability over time, research and monitoring programs must be allowed to occur within each planning cycle. Therefore the agencies that use the subbasin plan as a guide for funding decisions are encouraged to recognize that the specific strategies within the plan may soon be out of date, and that newly developed strategies that are derived from and are consistent with biological objectives are intended as components of the subbasin plan.

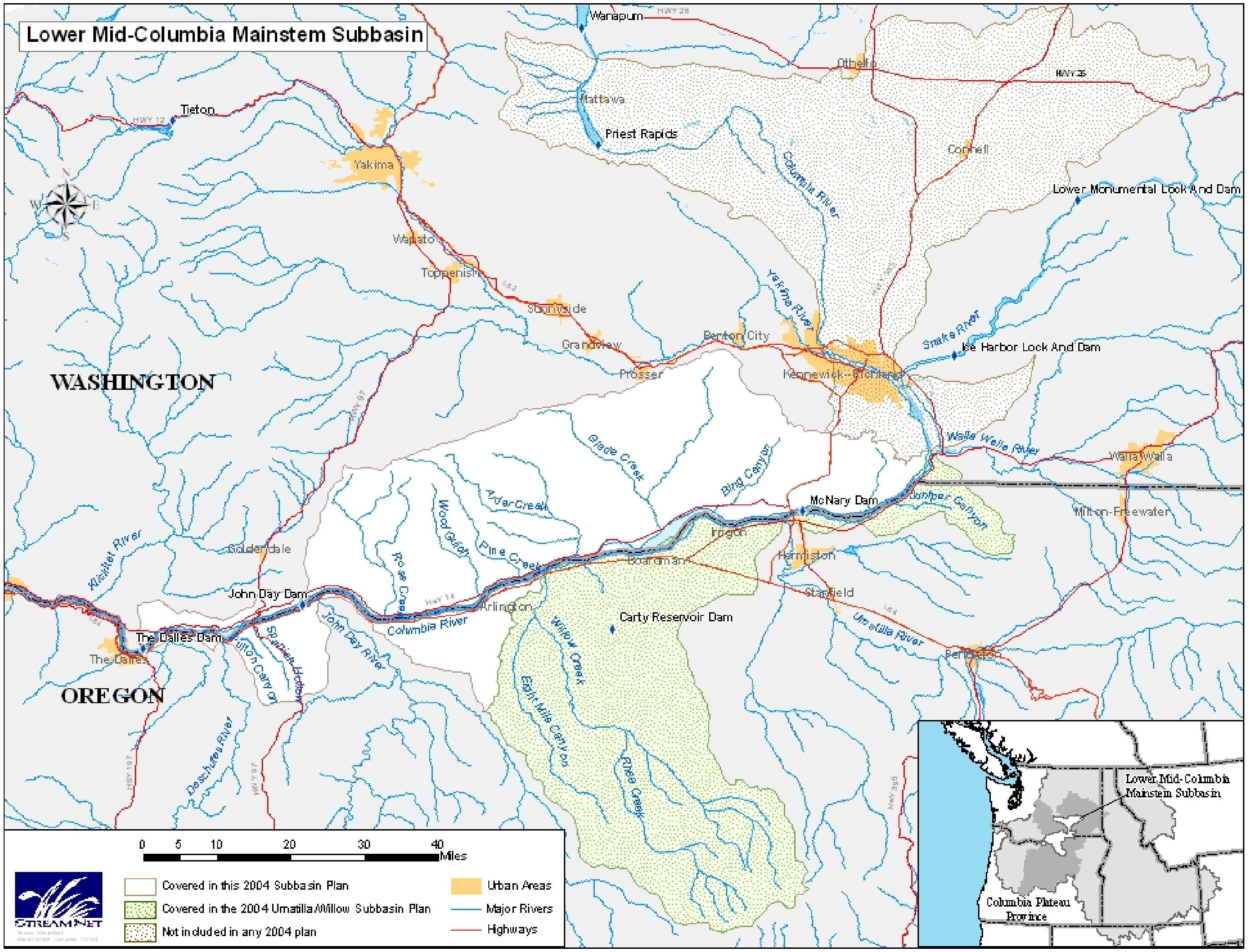


Figure 1 Lower Mid-Columbia Mainstem Subbasin, active planning areas, and location in the Columbia Basin

3 Subbasin Overview

3.1.1 Subbasin in Regional Context

For planning purposes, the Northwest Power and Conservation Council (NPCC) divided the Columbia River Basin south of the Canadian border and its more than 60 subbasins into 11 eco-regions. NPCC is responsible for implementing the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) and the Fish and Wildlife Program mandated by the Act.

The 11 provinces, beginning at the mouth of the Columbia River and moving inland, are: Columbia Estuary; Lower Columbia; Columbia Gorge; Columbia Plateau; Columbia Cascade; Inter-Mountain; Mountain Columbia; Blue Mountain; Mountain Snake; Middle Snake; Upper Snake. These 11 eco-regions include the entire Columbia River basin in the United States, and together cover approximately 25,000 sq. mi. in Washington, Oregon, Idaho and Montana.

Each of the 11 provinces will develop its own vision, biological objectives, and strategies consistent with zthose adopted at the subbasin level. NPCC's intent is to adopt these elements into the 2000 Fish and Wildlife Program during later rulemaking. The biological objectives at the province scale will then guide development of the program at the subbasin scale.

The provinces are made up of adjoining groups of ecologically related subbasins, each province distinguished by similar geology, hydrology, and climate. Because physical patterns relate to biological population patterns, fish and wildlife populations within a province are also likely to share life history and other characteristics (Rawding 2000). The Lower Mid-Columbia Mainstem subbasin is in the Columbia Plateau Province.

Columbia Plateau Province

The Columbia Plateau Province is the largest of the ecological provinces and extends over an area of approximately 45,275 sq. mi. It is defined as the Columbia River and associated watersheds between The Dalles and Wanapum dams on the Columbia River and Ice Harbor on the Snake River. This area includes much of southeast and south-central Washington, northcentral and northeast Oregon, and a small portion of Idaho east of Moscow.

The Cascade Mountains form the western border of the Plateau through Oregon and Washington, while the Palouse region along the Washington/Oregon border and Blue Mountains form the eastern edge. The southern border is marked by the divides that separate the upper Deschutes and John Day drainages from the Oregon High Desert and drainages to the south, while the northern border is formed by the Wenatchee Mountains and the divides that separate Crab Creek and Palouse River from the drainages in the Inter-Mountain Province.

The principal rock of the Columbia Plateau is a series of basalt flows, interspersed with sedimentary layers, called the Columbia River Basalt Group. The hydrology of the Plateau is complex; surface water includes numerous small tributaries draining to mainstem rivers, while underlying the region is the Columbia Plateau aquifer system, localized in some areas by series of groundwater subbasins. Temperatures and precipitation vary widely, usually depending on elevation, with cooler and wetter climates in the mountainous areas at the Plateaus' western, eastern and northern boundaries, and warmer and drier climates in the lower areas that make up most of the province. The mountainous regions are predominantly coniferous forests, while the arid regions are characterized by sagebrush steppe and grassland. Many of the same fish and wildlife species are found in each of the 10 Plateau subbasins.

The native people of the Plateau included the Yakama, Wanapum, Palouse, Cayuse, Umatilla, Walla Walla, Nez Perce, Tenino, John Day (Dock-Spus), and Wyam. Today the Plateau province is home to three tribal confederations and parts of four Indian reservations. Most of the Yakama reservation is located within the southwest portion of the Yakima subbasin, while the Warm Springs and Umatilla reservations of Oregon are located within the Deschutes and Umatilla subbasins, respectively. The northwest tip of the Nez Perce reservation in Idaho is located in the Palouse subbasin.

Significant urban centers within the Province include Tri-Cities (Pasco, Richland, and Kennewick), Walla Walla, Pullman, and Yakima, Washington; Moscow, Idaho; and Bend, Redmond, Pendleton and Umatilla, Oregon.

Columbia Plateau is an important agricultural and grazing area and is a major source of hydroelectric power. Four major hydroelectric dams are located in the Plateau province: McNary and John Day dams downstream of the Snake-Columbia confluence, and Priest Rapids and Wanapum dams upstream of the Yakima-Columbia confluence. Downstream of the province on the mainstem Columbia are two more dams, The Dalles and Bonneville, which must be traversed by anadromous fish migrating to and from the province's 10 subbasins.

The Plateau is divided into 10 subbasins: Deschutes; John Day; Lower Mid-Columbia Mainstem, including Rock Creek; Umatilla; Walla Walla; Tucannon; Snake Lower; Palouse; Crab; and Yakima.

Lower Mid-Columbia Mainstem Subbasin Location

The original boundaries of the Lower Mid-Columbia Mainstem Subbasin, set by the Northwest Power and Conservation Council, extended upstream to river Wanapum Dam and included Priest Rapids, McNary, John Day, and The Dalles dams and reservoirs within the subbasin as well as the free-flowing Hanford Reach immediately downstream from Priest Rapids Dam. Although the Mainstem Columbia River Subbasin Summary, prepared in 2001 for the Council, covered this area in addition to Bonneville Dam and reservoir, the geographic scope of the mainstem Columbia segment of the 2004 Lower Mid-Columbia Mainstem Subbasin Plan is limited to the Columbia River from the mouth of the Walla Walla River to the mouth of the White Salmon River. Section 1.2. Subbasin Approach and Public Involvement gives the reasons for this limited geographic scope.

For the purposes of the 2004 subbasin planning effort the Lower Mid-Columbia Mainstem Subbasin of the Columbia River subbasin of the Columbia Gorge Province is bounded upstream from the mouth of the Walla Walla River, downstream by The Dalles Dam, and on the south by the Columbia River. McNary and John Day hydropower projects and reservoirs and The Dalles reservoirs are include within the subbasin. Lands along the Columbia corridor from the Dalles to the Walla Walla River are also included in the LMM Subbasin Plan.

Certain watersheds adjacent to this segment of the mainstem Columbia are within the subbasin boundaries, including Rock Creek, Pine Creek, and other streams which drain into the Columbia River from Washington upstream of John Day Lock and Dam; Frank Fulton Canyon and Spanish Hollow creeks, which drain into the Columbia from Oregon downstream of John Day Dam; and canyon areas east of Arlington to the John Day River subbasin. While the original NPCC boundaries on the Oregon side also included Juniper Canyon, between McNary Dam and the mouth of the Walla Walla River; Willow Creek and its tributaries, west of the Umatilla River watershed, the Umatilla Subbasin Plan has included them with its active planning area. The Lower Mid-Columbia Subbasin references these watersheds when they relate to terrestrial and aquatic habitats, fish and wildlife populations, or anthropogenic conditions there; in other instances, the reader is directed to the Umatilla or the other adjacent subbasins, the John Day, Deschutes, and Columbia Gorge for further information.

Also, the Rock Creek watershed in Washington—although within the original boundaries of the Lower Mid-Columbia Mainstem—was written as a separate subbasin summary, but is now incorporated in the Lower Mid-Columbia Mainstem Subbasin Plan.

Please see **Figure 1** (and also Section 3.2) for the boundaries and current planning areas of the Lower Mid-Columbia Mainstemn Subbasin.

3.1.2 Aquatic/Terrestrial Relationships

Riparian habitat connects aquatic and terrestrial ecosystems providing an important link between fish, wildlife, and their habitat. Riparian areas perform a number of functions vital to the watershed and water quality. These functions are important to salmon habitat and wildlife that are dependent on salmon for food and nutrients.

Anadromous salmon provide a rich, seasonal food and nutrient resource that directly impacts the ecology of both aquatic and terrestrial consumers and the vegetative landscape. There is also an important indirect effect on the entire food-web linking water and land resources (Cederholm et al. 2000). This food-web has likely always included this co-evolutionary relationship between salmon, wildlife and habitat in the Pacific Northwest.

The life stages of salmon (i.e., eggs, fry, smolts, adults, and carcasses) all provide direct or indirect foraging opportunities for terrestrial, freshwater, and marine wildlife (Cederholm et al. 2000). The relationship between Pacific salmon and wildlife was examined by Johnson et al. (2001). A total of 605 species of terrestrial and marine mammals, birds, reptiles, and amphibians currently or historically common to Washington and Oregon were examined for their relationship to pacific salmon. They found a positive relationship between salmon and 137 species of wildlife. See Appendix C,h.s., table C.6.A,h.s. for a full list of the wildlife species in this subbasin identified as having a relationship with salmon.

There are several predators in the Pacific Northwest ecosystem that benefit from the important ecological contribution that pacific salmon make as prey during their anadromous life history. Pacific salmon contribute nutrients during several stages of their life, regardless of whether particular individual salmon complete all life history stages or not (Cederholm et al. 2000). Six wildlife species present in this subbasin are identified as having a strong, consistent relationship with salmon: common merganser (*Mergus merganser*), harlequin duck (*Histrionicus histrionicus*), osprey (*Pandion haliaethus*), bald eagle (*Haliaeetus leucocephalus*), black bear (*Ursus americanus*) and northern river otter (*Lontra canadensis*).

Fish, and their habitat, also benefit from the presence of particular wildlife species. American beavers (*Castor canadensis*) are extremely important in contributing to large woody debris, which is a critical structural component in Pacific Northwest streams. Large woody debris provides important structural complexity as well as vital nutrients to streams. Large woody debris and beaver dams decreases stream velocity and temperature. It also provides refugia to migrating fish.

There are many human activities that have implications to both terrestrial and aquatic species and habitat. Some examples include timber activities, presence of roads and cattle grazing. Timber activities can fragment and decrease quantity and quality of wildlife habitat. It can also decrease woody debris available to streams and increase sedimentation. High amounts of sediment can increase water temperature, making streams unsuitable for fish, amphibian and aquatic macroinvertebrate species. Roads impact terrestrial wildlife by fragmenting habitat, creating barriers to migrating species. Roads can also reduce vegetation, cause sediment increase and edge degradation, and lead to direct mortality. Grazing degrades vegetation and increases sediment and fecal coliform levels in streams, impacting both wildlife and fish.

Three species of anadromous salmon, fall chinook (*Onchorynchus tschawytscha*), coho (*Onchorynchus kisutch*), and steelhead (*Onchorynchus mykiss*), use streams in the Rock Creek assessment unit. One distinct stock, steelhead, has been identified as indigenous to the subbasin. The remaining anadromous use is believed to be a result of straying of other mid-Columbia stocks, or is incidental use associated with upriver migration of adults or downriver migration of juveniles.

A complete list of the common and scientific names used in this plan can be found in Appendix B.

3.2 Subbasin Description

3.2.1 General Location

The current planning boundaries of the Lower Mid-Columbia Mainstem Subbasin in the Columbia Plateau Province are bounded from east to west by the mouth of the Walla Walla River at river mile RM 315 (km 507) and by The Dalles Dam tailgate at approximately RM 192 (km 309). The subbasin mainstem is 123 river miles (km 198) long. McNary Dam and part of its reservoir and the John Day Dam and its reservoir are within the subbasin. On the Washington side across the Columbia from Walla Walla River mouth, the subbasin extends from south from the crest of the Horse Heaven Hills and west encompassing a series of small canyon creeks including Glade, Sixprong, Pine and Rock creeks then along the Columbia shore following the Columbia Hills to The Dalles Dam. This area includes the Rock Creek watershed, among other smaller streams. South on the Oregon side, the subbasin extends west from mouth of the Walla Walla River along the Columbia shore until reaching Arlington, Oregon, where the subbasin then takes in Alkali, Blalock, Philppi and other small canyons. On the east side of the John Day River, the subbasin includes more canyon areas including Spanish Hollow and Fulton Canyon watersheds. See **Figure 1**. These important tributaries flow into the lower mid-Columbia mainstem: the Walla Walla, Umatilla, Willow, Rock, John Day, and Deschutes. (Each of these tributaries, with the exception of Rock Creek, are described in individual subbasin plans.)

3.2.2 Topographic/Physio-geographic Environment

The geology of the subbasin is dominated by extensive basalt flows up to 2 miles thick. The erosion-resistant nature of these flows resulted in the creation of deep (500 to 800 feet) steep-walled canyons with ragged outcrops and in severely constrained floodplain development along substantial portions of the streams within this subbasin (Lautz 2000).

Along John Day reservoir, canyon walls on the Washington side of the river rise abruptly to as much as 150 meters (500 feet), while elevation at The Dalles Dam is 30 m. Mount-ains adjacent to or near the river have elevations as high as 900 m.

The Oregon shore generally rises gradually along a lower terrace extending up to 1.6 km (1 mile) from the river then abruptly to an elevation of approximately 60-70 m (200 feet), forming a higher terrace. High winds have resulted in the deposition of silt and sand and the creation of dunes along these terraces. The huge scale of geologic events produced a landscape of gently rolling lands, deep soil, and cross-cutting rivers, that through time has evolved to account for such features as steep rugged canyons and many breaks, cliffs, and rims (NOAA/Fisheries 2004).

3.2.3 Climate and Weather

The area within the subbasin generally experiences hot dry summers with temperatures that can reach above 380 C (100.40 F) during the day then cool considerably at night. Winters may be wet and cold with strong winds and blowing snow. Summer temperatures are generally highest in July, with highs averaging 31.10 C at Umatilla and The Dalles Dam. Winter lows in January average –3.3 C (-19.60 F) in Umatilla, and –1.10 C at The Dalles Dam. Total annual precipitation averages only 22.9 cm (9 inches) at Umatilla and 35.5 cm (14 inches) at The Dalles Dam. On the Oregon areas of the subbasin, the range is 20.3 cm-25.4 cm (8-10 inches) annually. In many areas about half the precipitation falls in winter as snow. Less than 10% of the total precipitation occurs during the summer months.

Climate is typical of the continental climate that occurs on the east side of the Cascades. Average daily temperatures range from 70˚ F in the summer with maximums commonly above 90° F and 37° F in the winter (Lautz 2000). Annual precipitation ranges from 35 inches in the headwaters of Rock Creek to less than 10 inches in the southern half of the subbasin (Kresch 1998). Generally, about 75-85% of this precipitation occurs between November and May.

3.2.4 Land Cover and Vegetation

Forestlands comprise about 47% of the subbasin, primarily the headwaters of Rock and Pine creeks, and many have active grazing allotments. Forest communities in Rock Creek watershed are dominated by Oregon white oak and ponderosa pine (WDNR 1998) and are typically found on north-facing slopes and in riparian zones.

Outside of the Rock Creek watershed, the subbasin’s plant community is primarily grasslands without many trees. Over the past 150 years, a significant portion of the former sagebrush steppe, grassland, and riparian communities have been converted to agriculture. About 47% of the land in the subbasin (including lands not in the current planning area) are now in agricultural use including for a variety of dryland grains and irrigated crops (Johnson and O’Neil 2001).

Much of this Columbia Plateau region’s natural vegetation is bunchgrass prairie with areas of bitterbrush steppe and western juniper. Riparian vegetation historically was black cottonwood, willows, chokecherry and aspen with wetlands dotting the plateau (Oregon Progress Board 2000.) See 4.2 Discussion of Focal Habitats and their Representative Focal Species and 5.8 Environmental Conditions for more details.

3.2.5 Hydrology and Hydrography

Columbia River Mainstem

The Columbia River travels through about 123 miles of the subbasin. Major tributaries draining into this subbasin include the Walla Walla in Washington and the Umatilla, John Day, and Deschutes in Oregon. Smaller tributaries flowing into the Columbia River include Glade, Six Prong, Pine, and Rock creeks in Washington, and Willow, Spanish Hollow, and Fulton Canyon creeks in Oregon. Numerous other perennial secondary streams and many intermittent and ephemeral streams provide water to the Columbia River. See **Table 1** for the location and drainage area of Columbia River tributaries within the Lower Mid-Columbia Mainstem subbasin.

Table 1 Tributaries of the Columbia River within the Mainstem Subbasin (Location of confluence is given as Columbia River km)

Tributary	Location of confluence	Drainage area (km2)
Walla Walla River	506 km	2,829
Umatilla River	465 km	3,685
Willow Creek	408 km	2,279
Rock Creek	370 km	--
John Day River	352 km	13,033
Deschutes River	330 km	16,894

Within the LMM Subbasin, three mainstem dams impound this lower, middle section of the Columbia River: McNary Dam, John Day Dam, and The Dalles Dam. The dams separate the river into three impoundments.

At normal pool elevations, 100% of the Columbia River within the subbasin is impounded (**Table 2**). Surface area of the impoundments totals approximately 41,000 ha. Discharges at McNary and John Day dams may range from 14,000 m3/s in spring to 2,000 m3/s in autumn.

Table 2 Characteristics of Columbia River dams and associated reservoirs in the Mainstem Subbasin - U.S. Army Corps of Engineers. Pool measurements are at normal pool

Dam	Operator	Year Completed	River km/ RM	Mean discharge (m^3/s)	Pool length (km)	Average pool width (km)	Pool surface area (ha)
McNary	USACE	1953	470/ 292	5,165	98.1[a]	1.6	15,700
John Day	USACE	1971	347/ 216	5,507	122.9	1.8	21,000
The Dalles	USACE	1957	309/ 192	5,536	38.5	1.4	4,500

The U.S. Army Corps of Engineers (USACE) operates McNary, John Day, and The Dalles dams and reservoirs for hydropower production, recreation, navigation, irrigation, anadromous fish passage, and limited flood control. John Day Reservoir is somewhat unique in that it has substantial flood control capabilities. Mainstem reservoirs in the Columbia Plateau Province have relatively little storage capacity, and discharges through dams are run-of-the-river. (See 5.7 Fish Habitat Conditions.)

Riverine and wetland resources

Riverine and riparian habitat along the mainstem Columbia historically functioned as a travel corridor for both fish and wildlife species. Extensive flatlands that existed along the Columbia prior to inundation have formed shallow wetlands and numerous embayments along the shores of McNary, John Day, and The Dalles reservoirs. These serve as holding or resting areas for migrating adults and juveniles (Lautz 2000).

Flatlands that existed prior to inundation by John Day Dam are now shallow wetlands and embayments along the shore near the mouth of Rock Creek, a condition that occurs elsewhere near several river mouths in the LMM Subbasin. However, spring outflow in the immediate vicinity of fish-bearing waters, such as Rock Creek and other rivers, may provide important cool-water refuges during the summer and early fall.

Riparian habitat along the mainstem Columbia historically provided a critical link between drainages for a number of species (i.e., black-tailed/mule deer, western gray squirrels, neotropical birds). Creation of the John Day pool flooded 1,086 acres of riparian tree habitat, effectively isolating species from rich upland areas. This is evident by species extirpation (yellow-billed cuckoo) and current fragmented populations of threatened, endangered, and sensitive species in watersheds along the Columbia River. Other species such as the bald eagle were undoubtedly common along the riparian sections of the mid-Columbia River.

A reduction in the number of beaver and the inundation of wetlands from hydropower development in the subbasin has resulted in the drying and loss of many wetland and riparian habitats. The creation of the John Day pool resulted in the loss of 511 acres of emergent wetland (Rasmussen and Wright 1989).

Remaining locations of mainstem wetlands, empayments, and riparian areas significant to wildlife and fish are described in 3.2.8 Terrestrial/Wildlife Resources and 5.7.2 Lower Mid-Columbia River Mainstem Assessment Unit.

Hydroelectric development has transformed most fast-moving mainstem riverine habitats into slow-moving reservoir impoundments. Construction of McNary, John Day, and The Dalles dams inundated 200 km of fall chinook salmon spawning habitat in the Mainstem Columbia River (Van Hyning 1973). Today, only the Hanford Reach remains unimpounded and provides the majority of mainstem spawning habitat for fall chinook salmon. It is well established that stream flow quantity and timing are critical components of water supply, water quality, and the ecological integrity of river systems (Poff et al. 1997). Flow regimes, geology of surrounding landscapes, and longitudinal slope are important controlling variables in salmon habitats and operate at both the watershed and reach scale (Imhof et al. 1996). Flow regulation for hydropower, navigation, storage, and flood control also affects connections among groundwater, floodplains, and surface water (Stanford et al. 1996), or convergence zones (hyporheic habitats) where biodiversity and bioproduction are frequently high (Stanford and Ward 1993). The relative magnitude and frequency of high flow events also acts to modify channel form within the constraints of existing geological features.

Water quality

The Columbia River mainstem experiences varied and somewhat unique water quality conditions. Within McNary Reservoir, water quality is strongly influenced by the Snake and Yakima rivers. Flow from the Snake, Yakima, and Columbia rivers are not fully mixed until they reach McNary Dam. Below the confluence with the Snake River, the eastern and southeastern portion of the Columbia River is influenced by the Snake River, whereas the western and northwestern portion is influenced by the Yakima River. The Snake River-influenced portion experiences turbidity ranging from 5-10 NTUs during periods of little or no runoff to 200 NTUs during periods of heavy runoff. This portion of the river also experiences a high nutrient load, particularly nitrates from agriculture. The Yakima River-influenced portion experiences lower turbidity, ranging from 1-4 NTUs during periods of little or no runoff to 100 NTUs during periods of heavy runoff.

Throughout McNary, John Day, and The Dalles reservoirs, pH, mercury, arsenic, fecal coliform, and dioxin meet both Washington and Oregon standards. However, standards for dissolved oxygen, sediment bioassay and water temperatures do not meet state standards; and The Dalles, John Day, and McNary pools are listed as impaired [303(d)] waterways. See 5.8.2 Lower Mid-Columbia River Mainstem Assessment Unit, Aquatic Habitat Conditions, and Water Quality.

Tributaries-Oregon and Washington

Hydrologic data for the streams, particularly those other than Rock Creek are limited. For example, there are no snow data collection stations in the Oregon part of the subbasin. Judging from eight snow stations near the border of the Columbia Ecoregion (the subbasin falls in this region designated by the Watershed Professionals Network), minimal snowpack development was estimated below about 3,000 ft on average during January and February. In watersheds below 3,000 ft in elevation, most peak flows were likely produced by winter rainstorms because of the low elevations and maritime influence of the Columbia River (WPN 2001).

No flow regulation occurs on the tributaries within the subbasin. Some diversions for irrigation and stock watering exist. No water diversions exist on Fulton Canyon or Spanish Hollow and relatively intact habitat exists in the lower reaches of these streams (Mid Columbia Salmon and Steelhead Production 1990). Although the town of Wasco and O'Meara Wells in Sherman Count recent applied to draw .91 CFS of groundwater from the Spanish Hollow Creek basin.

Tributary flows in the subbasin can generally be described as having high peaks during the winter or early spring and often extremely low flows in the summer. Many streams in the subbasin can be characterzied as intermittent. Many lose all surface flow during the summer through parts of their length. Such episodic hydrographs are the result of low precipitation—especially in the Oregon and far eastern Washington portion of the subbasin where little snow accumulation is also the norm—steep-sided canyons that are relatively impervious basalt bedrock, and at lower elevations flat surface relief and sandy soils. Basalt rock and diminished vegetation contribute to rapid runoff and poor groundwater recharge Isolated storm events may cause locally high flows for short periods usually during the winter (Watershed Professionals Network 2001).

The watersheds on the Oregon and Washington side of the lower mid-Columbia mainstem subbasin appear to have similar geomorphic characteristics; most of the descriptive information that follows was generalized from information collected on and observations of the Rock Creek watershed. All of the major drainages originate in the Simcoe Mountains or Horse Heaven Hills (which form the northern boundary of the subbasin), and flow in a southerly to southeasterly direction to Lake Umatilla, the portion of the Columbia River impounded by the John Day Lock and Dam. Elevations range from 200 feet at the confluence of Rock Creek and the Columbia River to over 4000 feet in the Horse Heaven Hills (Lautz 2000).

Headwater tributaries flow out of the mountains, in the case of Rock and Glade creek watersheds, and across the relatively flat basalt plateau. Channels are moderately confined to unconfined (although there may be locally confined reaches caused by channel incision) with gradients generally less than 1% on the plateau. Land cover is primarily coniferous forest; land use is managed forest, grazing, and some rural residential. This area is above known anadromous fish use; available fish habitat is used by rainbow trout and non-salmonids such as dace. Fish habitat quality is generally fair to good; however, there are many areas where habitat has been degraded by grazing, road construction, and riparian harvest (Lautz 2000).

Coming off the plateau, streams enter steep-walled canyons. Channels are highly confined, gradients increase to 2 – 4%, and substrate is characterized by a mix of cobbles and boulders. Land cover is conifer forest or mixed conifer-deciduous forest in the vicinity of streams, transitioning to shrub-steppe in the uplands; land use is primarily grazing, which tends to be limited by steep slopes. Fish habitat quality is generally fair to poor, due mostly or entirely to the higher stream power in these reaches. Little suitable spawning gravel occurs, and rearing areas (pools) are minimal in extent and quality and are limited to protected areas behind boulders and along stream margins. Few macroinvertebrates and juvenile fish were observed in surveys conducted by the Bureau of Land Management (1985, 1986), suggesting that these reaches have relatively low productivity (Lautz 2000).

Below the canyon reaches, streams enter alluvial valleys. Channels are moderately confined to unconfined (although there may be locally confined reaches caused by channel incision), with gradients generally between 1% and 2% near the upper end, diminishing to less than 1% as streams approach the Columbia; substrate is variable, with particle sizes ranging from cobble to silt. Land cover is primarily shrub-steppe in the uplands, with riparian areas transitioning downstream from mixed conifer-deciduous forest to deciduous forest to shrub-grassland; land use is primarily grazing, which tends to be concentrated in the riparian zone. Fish habitat is highly variable, ranging from poor where degraded riparian zones and channel widening and incision occurs, to excellent where complex habitat elements (deep pools, suitable spawning gravels, large woody debris, riparian cover) exist in the vicinity of spring inflow or groundwater upwelling areas (Lautz 2000).

Headwater tributaries flow out of the mountains and across the relatively flat basalt plateau at gradients of generally less than 1%; this area is above known anadromous use. Coming off the plateau, streams enter steep-walled canyons; gradients increase to 2 – 4% or more; fish habitat quality is generally fair to poor, with little suitable spawning and rearing habitat. Below the canyon reaches, streams enter alluvial valleys; gradients range between 1% and 2% near the upper end, diminishing to less than 1% as streams approach the Columbia. Fish habitat in these sections is highly variable, ranging from poor to excellent (Lautz 2000).

Riverine and wetland resources

Flatlands that existed prior to inundation by John Day Dam are now shallow wetlands and embayments along the shore near the mouth of Rock Creek. These wetlands and embayments serve as holding or resting areas for migrating fish and are important habitat for a variety of wildlife (beaver, great blue herons, amphibians, and western pond turtle). Other wetland areas are associated with springs occurring further upstream. Many of the spring areas also serve as cattle watering areas, to the detriment or exclusion of wetland vegetation and water quality. Fish habitat within these spring-related wetland areas is unlikely, owing to their small size.

Riparian areas along the subbasin's tributaries are subject to overgrazing. The major reason for the continued decline in riparian habitat quality in the Rock Creek subbasin is that riparian areas are managed in the same way as upland areas. Because of greater forage production, cover, and water availability relative to surrounding uplands, riparian areas are often subjected to levels of livestock use disproportionately high to their limited area extent (Platts 1990).

Over-grazing has led to loss of vegetative cover, greater summer heating and winter cooling, soil instability, reductions in water quantity and quality, and changes in bank, channel, and instream structure. Additionally, reductions in vegetation across the watershed may also be increasing peak flow discharges, reducing ground water storage, and limiting future recruitment of woody debris to the stream channel.

Floodway and Floodplain Resources

Floodplains in the watershed are relatively narrow along substantial portions of the streams. As such, they limit storage of runoff during the winter for later release in the summer. These factors, combined with the virtual lack of precipitation from July through September, cause some areas to go dry in the summer. At the same time, the lack of storage capacity combined with heavy rains and snowmelt, can result in extremely high stream flows and flooding conditions. The floods of 1996 reduced habitat quality in some areas of the watershed.

Water Quality-Rock Creek Subbasin

All streams in the Rock Creek subbasin are classified as Class A streams, that is, overall excellent water quality for human consumption, but not necessarily for aquatic life. High water temperatures recorded during the summer have been identified as a water quality-limiting factor.

Based on temperature data through 1997, exceedances of the standard at higher elevations (plateau and upper canyon reaches) appear to be relatively minor and of short duration. Some thermal stressing of juvenile salmonids may occur, but may be avoided if there is access to cool water refuges (areas of spring outflow or groundwater upwelling). In lower canyon and alluvial reaches, exceedances extend well into the sub-lethal or lethal ranges for salmonids and are of long duration. It is unknown to what extent cool water refuges exist in these reaches.

Rock Creek became a candidate for the state 303(d) (water quality impaired) list for temperature based on multiple excursions of the standard (18°C/64.4°F) measured in 1990 and 1991 (WDE, 1998). Further monitoring and stream survey work by Ehinger in 1996 concluded that Rock Creek showed "impacts from past grazing activity and episodic flood events, including lack of riparian cover and a shallow, braided stream channel." He also suggested that high stream temperatures observed in upper Rock Creek "may be natural for a small creek in a hot, sunny summer climate," while temperatures in lower Rock Creek were "affected by the exposed rocky substrate (channel bed) and lack of riparian cover."

Based on this assessment, a Memorandum of Agreement between the Washington State Department of Ecology and Eastern Klickitat Conservation District regarding the delisting of Rock Creek from Section 303(d) of the Clean Water Act was signed on July 9, 1996.

The exclusion of Rock Creek from the 303(d) list was subject to a number of conditions to be implemented jointly by the two agencies in cooperation with landowners.

- Identify riparian zones that can be successfully revegetated. Assist landowners to implement Best Management Practices that would enhance canopy cover and encourage channel rehabilitation.
- Monitor grazing and forestry practices.
- Advise landowners in the upper watershed of Best Management Practices for road stability and riparian corridor harvesting.
- Continue water quality monitoring to obtain data for long range planning and for landowners participation with Best Management Practices.
- Seek funds to assist with monitoring and rehabilitation efforts.
- Submit a yearly progress report. Implementation of this agreement is ongoing and will continue at least through 2001.

The MOA expired in 2001 and has not been renewed.

Water Quality-Oregon Tributaries

Neither ODFW or Sherman county Conservation District have habitat surveys of Spanish Hollow and Fulton Canyon Creek watersheds and they do not know of any that have been conducted. In general, habitat conditions in both streams are confined by roads and are affected by sedimentation likely from agricultural practices and, in some places, from livestock grazing (French, pers. comm., 2004; Stradley, pers. comm. 2004).

3.2.6 Jurisdictions and Land Ownership

The Confederated Tribes of the Warm Springs Reservation of Oregon ceded the Oregon portion of the subbasin that is in the current planning area in the June 25, 1855 treaty with the United States. The Warm Springs tribe reserved fishing, hunting and gathering rights among other rights and responsibilities there. In the lower and eastern portions of the Rock Creek watershed, the Yakama Nation and its members own about 749 acres in trust allotments. The Yakama Nation ceded the Rock Creek area in the June 9, 1855 treaty with the United States, reserving fishing, hunting and gathering rights among other rights and responsibilities.

The Warm Springs and Yakama tribes along with the Umatilla and Nez Perce tribes have reserved fishing rights along the mainstem Columbia, including in this subbasin. The largest indigenous fishing place in North America, Celilo Falls, was inundated by The Dalles Dam. For additional information on jurisdictional authority, regulations, plans and projects, see 6. Inventory.

Today over 90% of land base is privately owned (Lautz 2000; Oregon Atlas 2001). Public lands in the Lower Mid-Columbia Mainstem Subbasin make up a small but significant portion of the remaining natural and semi-natural habitats in the subbasin. Most of these lands are held by the U.S. Department of Defense (DoD), U. S. Fish and Wildlife Service (USFWS), with smaller areas managed by the State of Oregon, State of Washington, and U. S. Bureau of Land Management (BLM).

A portion of the Columbia River Gorge National Scenic Area is within subbasin: from the subbasin’s western boundary at the Dalles Dam to the Deschutes River mouth on the Oregon side and to Maryhill Museum on the Washington side.

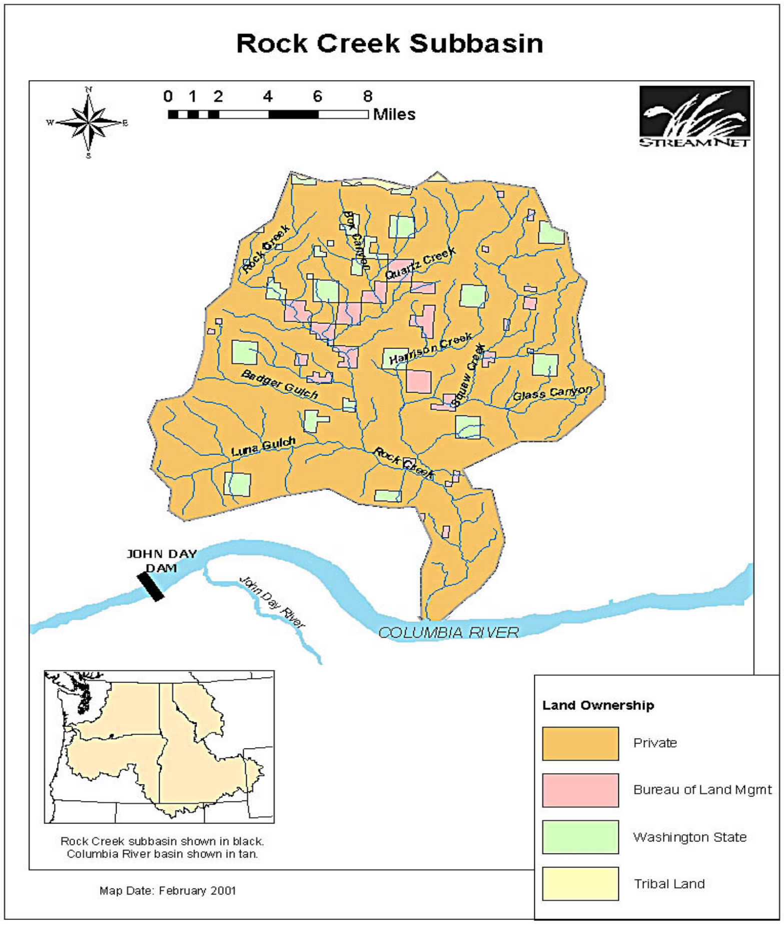


Figure 2 Land ownership in the Rock Creek portion of the Lower Mid-Columbia Mainstem Subbasin

3.2.7 Land Use and Demographics

Land use and ownership in the subbasin have changed dramatically since the arrival of European settlers. Most lands in the Lower Mid-Columbia Mainstem Subbasin are privately owned. About half of the land is used for agriculture. Agriculture and related enterprises are the most important economic activities in the subbasin. High-technology pivot and other irrigation methods are utilized in the subbasin, particularly in Washington and in the northern Oregon portions of the subbasin. In southern Benton County, wheat, grapes, and corn are important crops, and beef and dairy cattle are make an economic contribution. Only 4% of the agricultural land in Rock Creek, which is in Klickitat County, is currently used as cropland. Non-forested rangeland is found in the canyons and other areas unsuitable for agriculture. The rangeland is used for livestock grazing. Wheat, barley, alfalfa, oats, potatoes, poplars, cattle and sheep production, dairies, and food processing (especially potatoes) are important agricultural businesses in this region of Oregon.

The Umatilla National Wildlife Refuge occupies approximately 12,000 ha of marshes, sloughs, open water, cropland, and sagebrush uplands along both sides of John Day Reservoir near Irrigon, Oregon, and Paterson, Washington. The nearby Irrigon Wildlife Area is owned by the USACE and managed under agreement for wildlife habitat and wildlife oriented recreation by the Oregon Department of Fish and Wildlife (ODFW). It includes approximately 380 ha and is immediately adjacent to the Columbia River.

Lands along John Day Reservoir in Oregon include a number of important holdings. The approximately 96,000 (19,000-ha) Boardman Bombing Range is a training facility near Boardman along 12 miles of the Columbia River, bounded on the east and west by irrigated farmland. The Department of Navy owns the eastern half and operates it as an active bombing range or special use airspace (SUA) where jets can frequently be heard overhead. The Army Corps of Engineers owns 13.88 acres located in the northern section. The Morrow Country Port Authority maintains the former airstrip and owns property along the northern boundary.

The State of Oregon owns the western half, which was leased to Boeing in 1963. In the 1970s and 80s, Boeing acquired nine water right permits to irrigate 63,000 acres of the site. In May 2002, the Boeing Agri-Industrial Company sold its lease to agri-business Threemile Canyon Farms. The farm lies just west of the Boardman Bombing Range and is a 225-square-mile mega-dairy, where 6,000 cows are milked to make tons of Tillamook cheese; cow manure is turned into electric power; and enough potatoes are grown to feed 7 million people French fries and hash browns for a year (GlobalSecurity October 2004)

In 2002, the Farm through its wholly owned subsidiary Boeing Agri-Industrial Company purchased the property from the State of Oregon (Federal Register August 27, 2003 [Volume 68, Number 166] wais.access.gpo.gov] [DOCID:fr27auo3-97]). The Portland General Electric Company is a property owner, controlling 3,520 acres within the farm. The Boeing Company leases 2,000 acres as a radar range (Federal Register August 27, 2003 [Volume 68, Number 166]), apparently to support on-going activities such as testing its remote antenna technology (Global Security). Since 1974 most of the property has been used for agricultural purposes. Threemile is developing 10,000 acres of dry land as a wind power site. The farm's remaining 19,000 acres will remain fallow, accommodating Portland General Electric Co.'s coal-fired electric plant, Boeing's radar trial site, and the beef feedlots of Northwest Beef and J.R. Simplot (Global Security). The leased lands contain a small (about 23,000 acres/nearly 10,000 ha) but very high quality remnant of bitterbrush habitat.

After six years of litigation over water withdrawals from the Columbia, water rights, and species conservation, Threemile Canyon Farms agreed to turn over to the Nature Conservancy management of 23,000 acres of farm wetlands as cover for the endangered Washington Ground Squirrel, birds and plants, and to allow public access along the Columbia River. In 2001 the Oregon Department of Fish and Wildlife Commission had listed the Washington ground squirrel, now only inhabiting the Boardman Bombing Range and former leased lands, as an endangered species under Oregon’s Endangered Species Act and applied for federal designation.TNC has begun developing long-term management and restoration plans for the property, which had been proposed for agricultural development. R.D. Offutt Co., the Fargo, N.D. agricultural development giant and world's largest potato producer owns Threemile Canyon Farms (Spokesman Review 04/25/2004).

The Umatilla Army Depot was established in 1941 and occupies approximately 20,000 acres (8,000 ha) in Morrow and Umatilla counties of which 2,600 acres have restrictive easements in place. The depot serves as a storage facility for conventional munitions and chemical warfare agents. Department of Defense contractors expect the stockpile of chemical weapons is to be destroyed by 2012.

While these lands occupied by the Umatilla Army Depot, the Boardman Bombing Range, and its lessees are not wholly within the Lower Mid-Columbia Subbasin, their northern portions are along the subbasin's mainstem Columbia River. Their proximity to the rest of the subbasin warrants consideration in the assessment of environment conditions and the formulation of fish and wildlife management plans and projects in the subbasin. (The Umatilla/Willow Creek Subbasin's Management Plan includes references to the significant and relatively rare shrub-steppe plant and wildlife habitat communities on these lands and offers management strategies for these resources).

In Arlington, Oregon, across the river in near Roosevelt, Washington, and at several other locations in Klickitat County are large landfill operations that take garbage, including hazardous wastes, mainly from the Portland, Seattle, and Spokane urban areas. The waste is transported by railroad cars and trucks; much of the route is along the Columbia River. The Environmental Protection Agency (EPA) has fined Waste Management Inc., one of the Arlington operators, for not following the regulations for proper handling of hazardous wastes. About 17 miles south of town Bickelton, in Klickitat County, is the country's 4th largest landfill, which is owned by Allied Waste Industries.

Energy production, a significant feature of the subbasin since hydroelectric dams were built there, has recently begun to diversify. Some five wind projects are operating or under development in the subbasin's current planning area: Klondike Wind Project (25 MW) and Klondike Phase 2 in Sherman County, Oregon; Arlington Columbia Energy Partners (200 MW), Arlington Pacific Power Marketing (200 MW), and Mar-Lu (projected 104 MW) west of Arlington in Gilliam County, Oregon. Two gas-fired projects, Coyote Springs Units 1 and 2 are operating near Boardman, Oregon. A bio-mass project, the H.W. Hill Landfill Gas Project, is operating near Roosevelt Landfill in Klickitat, Washington and Allied Waste Industries' landfill near Bickleton using decomposing waste to create gas used to generate over 8 megawatts of electrical power. A natural gas, combined cycle generation facility (307 MW) is being developed two miles west of Plymouth, Washington. Numerous other gas-fired generating facilities are producing electricity along the Columbia River corridor, of which this subbasin is a part.

Other nearby projects (bordering the inactive planning area of the subbasin) include both phases of the Stateline Wind Projects (300 MV), located near Wallula Junction on both sides of the Oregon and Washington border. Other wind projects are operating or pending in the nearby John Day and Umatilla subbasins. Most of the new energy projects—operating, under construction, or planned—have or will require new transmission interconnections to deliver power from the new generation facilities to the electric transmission grid. Additions and upgrades to the current transmission infrastructure are planned or have recently been completed in the subbasin. The Celilo converter station at the northern end of the direct-curent Intertie to Los Angeles is being retooled increase transmission capacity for future Northwest surpluses. Near Bickleton, Washington, BPA is completing the replacement of 20 steel lattice towers and all wood pole structures and upgrading transmission lines in a larger area of the region. BPA has proposed a new transmission line between McNary and John Day dams that would be about 79 miles long and add about 1250 MW capacity to help integrate new gas and wind energy generated in the area. In recent years, new natural gas pipelines have been constructed in the subbasin and adjacent areas.

The Columbia Aluminum Company, which has been idle since 2001, sits along Columbia near Washington Highway 14 east of the junction with U.S. Highway 97; Boise Cascade Pulp and Paper Mill in Wallula, Washington, operates along the Columbia in the NcNary reservoir area; and numerous other industrial plants upstream of the subbasin use manufacturing processes that depend on a variety of hazardous chemicals.

Roads and railroads now occupy extensive reaches of land bordering the mainstem. The riprap revetments protecting these areas form significant portions of reservoir shorelines. In the subbasin, Interstate 84 and U.S. Highway 730 run along the southern shore of the Columbia. Union Pacific Railroad operates along most of the south shore of the Columbia River runs extending to Wallula Junction. The Union Pacific also operates a line from Arlington to Gilliam, a major waste dump. On the Washington side of the subbasin, Burlington Northern and Washington Highway 14 run along the Columbia shore. On the mainstem itself, barge traffic hauls petroleum, wood, and agriculture products usually bound for the Port of Portland and beyond. Other water traffic consists of small fishing and recreational boats, law enforcement and Coast Guard craft, several small cruise ships, and fish barges transporting juvenile salmon for release below Bonneville Dam.

The human population of the Lower Mid-Columbia Mainstem subbasin is small and growing slowly (**Table 3**). (The area of Benton County where the population has increased significantly is in the Tri-City area, which is not within the current planning boundaries of the subbasin.) The ethnic backround of the subbasin's residents are predominantly European-American, Hispanic, and Native American. In Oregon, the incorporated towns are Arlington, Condon in Gilliam County; Boardman, Irrigon in Morrow; Grass Valley, Moro, Rufus, Wasco and unincorporated Biggs in Sherman County; and Umatilla in Umatilla County. In Washington the towns in the subbasin are unincorporated and include Paterson and Plymouth in Benton County and Wishram, Bickelton, and Roosevelt in Klickitat County.

The Celilo Village, about 10 miles east of The Dalles, Oregon, was relocated (after being flooded by construction of The Dalles Dam) not far from the original site and continues today as small Indian fishing community.

Table 3 Population of major Lower Mid-Columbia Mainstem subbasin counties and percent change, 1990-2000 (Current planning areas are predominately within the shaded counties)

County/State	1990 Population	2000 Population	% Change 1990 - 2000	Area (sq. mi.)	People/sq. mi. of land area in 2000	Population Change 2000 - 2003
Benton/WA.	112,560	142,475	26.6%	1,703	83.7	7.9%
Klickitat/WA.	16,616	19,161	15.3%	1,872	10.2	2.0%
Umatilla/OR	59,249	70,548	19.1%	3,215	21.9	2.1%
Morrow/OR	7,625	10,995	44.2%	2,032	5.4	5.7%
Gilliam/OR	1,717	1,915	11.5%	1,204	1.6	(7.2%)
Sherman/OR	1,918	1,934	0.8%	823	2.3	(9.3%)

U.S. Census Bureau, 1990, 2000

Significant environment pressures directly from population increases are not anticipated; however, the intensification of economic activities in the region, as briefly indicated above and in the following sections, is likely to add to concerns about fish and wildlife and their habitats.

3.2.8 Anthroprogenic Disturbances on Aquatic and Terrestrial Environments

Over the past 150 years, the Lower-Mid Columbia Mainstem Subbasin has been one of the most transformed regions in Oregon and Washington (Johnson and O'Neil 2001; NOAA/Fisheries 2004). While the economic and human activities described here are important to the citizens of the region, the focus of this section is to discuss how these activities effect aquatic and terrestrial habitats and the fish and wildlife that also use the land, water, and air in this subbasin.

Agriculture

About half of the land in the subbasin is used for agriculture, which has significantly altered the subbasin. Agricultural activities, such as water withdrawals for irrigation, stream channelization, loss of riparian vegetation and wildlife habitat, increased sediment input, and changes in hydrology associated with land conversion and water uses, have affected fish and wildlife resources.

High-technology pivot and other irrigation methods are utilized in the subbasin, particularly in Washington and in the northern Oregon portions of the subbasin. Most water is being withdrawn from the John Day reservoir into canals on the Washington side, although demand for irrigation water from the Columbia continues to increase in both states. In 2003 the Oregon legislature proposed a bill to lift the virtual moratorium on new water rights on the Columbia River. The Capital Press in Salem, Oregon, reported that, as of 2003, Oregon diverts about 0.3% of the average annual flow of the river, while Idaho diverts 2.7% and Washington, 4%.

Irrigation withdrawals can have extensive effects on instream flows, which can result in fewer pools, stream losses, fewer pools, dewatering and fragmented habitat as well as higher water temperatures. Streams are often channelized in agricultural fields to prevent flooding of fields and natural channel movement into fields (is this happening here? Citation/personal communication). Physical blockages caused by irrigation diversions, push up dams, and warm water can limit access to spawning habitat. All factors decreasing habitat suitability for aquatic species.

Dryland farming has its own set of problems, particularly erosion that stems from traditional winter wheat/summer fallow monoculture cropping. Such agricultural practices, which cause run-off and erosion, result in increased stream sediment loads.

In general, land development for agricultural uses, roads, and other activities that occur near and on low gradient streams and rivers (including the mainstem Columbia) has impacted the productive potential of historic salmon spawning, incubation, and freshwater rearing areas.

The conversion of large areas of native vegetation to croplands and grazing lands has resulted in significant loss of wildlife habitat in the basin. Shrubsteppe and grasslands habitats have been the most heavily affected (Johnson and O'Neill 2001; Kagan et al., 2004).

This conversion has also contributed to alterations in the subbasin's hydrology. For example, with large tracts of land in winter wheat and summer fallow, the result has been slower infiltration of precipitation into the ground and greater runoff into streams (Umatilla/Willow Subbasin Plan 2004).

Farm pesticides, herbicides, fertilizers, and other chemicals often find their way into the food chain and ecosystem more broadly; some with known deleterious effects on aquatic and terrestrial resources. Elevated levels of nitrates have been detected in wells in the area that includes the northern portions of Umatilla, Morrow, and Gilliam counties. Potential sources of the contamination is irrigated agriculture and confined animal feeding operations (DEQ 2003).

Land and water use in this subbasin have caused widespread changes in vegetative cover, soil quality, and hydrologic systems. Agricultural practices, including grazing, have contributed to significant soil loss, gully development, stream channel instability, soil fertility and organic matter, which adversely effect agriculture and fish and wildlife productivity alike (Oregon Progress Board. 2000; NMFS. 2000. Biological Opinion on Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including the Juvenile Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin).

Artificial and Natural Fish Production

Two hatcheries are located on Lower Mid-Columbia River in the current planning area. The Irrigon and Umatilla hatcheries are located on the Columbia River near Irrigon, Oregon, and are operated by ODFW. Neither release fish directly into the Columbia River. The Irrigon Hatchery is funded by the Lower Snake River Compensation Program, and serves as an egg incubation and rearing facility for summer steelhead destined for the Grande Ronde and Imnaha River systems. The hatchery is also used as a final rearing site for legal-sized rainbow trout destined for northeast Oregon waters. The Umatilla Hatchery is funded by BPA, and is used for egg incubation and rearing of spring chinook salmon, fall chinook salmon, and summer steelhead for release into the Umatilla River.

Other upstream artificial production facilities and natural spawning areas on the mainstem Columbia and Snake rivers and on the John Day, Umatilla, Yakima, Wenatchee, Clearwater, Salmon and others contribute to the mix of anadromous fish stocks migrating through this section of the Columbia River. About 80% of the spring chinook and steelhead migrating through the lower mid-Columbia subbasin are hatchery produced, while 20% are wild or naturally spawning. For fall chinook in this subbasin, about 25% are hatchery, while 75% are wild or naturally spawning. For coho in the subbasin, roughly 90% are hatchery and 10% are wild, although it currently remains unknown the extent to which coho supplementation is re-establishing naturally spawning runs (Matylewich, pers. comm. 2004).

Dams

In the Lower Mid-Columbia Mainstem Subbasin, the construction of The Dalles, John Day, and McNary dams and resulting impoundments of the Columbia River have inundated mainstem spawning and rearing areas in the mainstem as well as in the lower reaches of tributaries in this subbasin. The reservoir behind McNary Dam is referred to as Lake Wallula or McNary pool (or reservoir) and extends upstream to about RM 345; however, for this current planning effort, the subbasin boundary terminates at RM 315 where the Walla Walla River enters the Columbia. The reservoir behind John Day Dam, which extends upstream to McNary Dam at RM 292, is referred to as Lake Umatilla or John Day pool (or reservoir). The reservoir behind The Dalles Dam (RM 192), which extends upstream to John Day Dam at RM 216, is referred to as Lake Celilo or The Dalles pool (or reservoir). The three dams are equipped with navigational locks.

Built for hydroelectric power, and variously for navigation, flood control, irrigation and storage, dams (including those constructed upstream of this subbasin) and the resulting impoundments alter water flows. Physical blockages and flow fluctuations caused by large and small dams, tidegates, and warm water can limit access to spawning habitat. Dams and impoundments have scoured vegetation and flooded riparian and flatland areas. The river now exhibits steepshore lines and sparse riparian plant communities.

Fish Passage

Because the hydroelectric dams on the Columbia and Snake rivers block the natural flow of the river and thus the natural migration of anadromous fish, the Federal Columbia River Power System uses several methods to mitigate for the loss of this natural system. The three dams in this subbasin provide upstream and downstream fish passage by various means. Downstream passage is accommodated by fishways, which are discussed in the 5. Fish Assessment section.

Juvenile passage is facilitated by barging or transport, spill, flow augmentation, bypass systems including mechnical screens systems that pass fish away from the generating turbines.

This descrption is taken from BPA Fish, Wildlife, and Environment website:

> McNary Dam in this subbasin and three Snake River dams have fish barging or transport facilities. At these four dams, juvenile fish that go through the bypass systems can be routed either directly back into the river below the dam, or to holding and loading facilities for loading into barges or trucks for transport. The transport barges and trucks carry the fish past the remaining projects for release below Bonneville dam. River water circulates through the barges allowing the fish to imprint the chemicals and smells of the water during the trip downriver. The barges have a closed-circuit recirculation system which can shut off water intake in case of contamination in the river. They also have pumping systems which can help de-gas the water in areas where gas supersaturation is a problem.
>
> The Corps runs the Juvenile Fish Transportation Program in cooperation with National Marine Fisheries Service, and in accordance with the National Marine Fisheries Service hydropower Biological Opinion for salmon. Fifteen to 20 million salmon and steelhead have typically been transported each year over the past several years. The program has come under criticism in recent years from state and tribal fishery agencies and environmental groups, who believe that rather than putting fish in barges, efforts should concentrate on improving in-river migration conditions.

The fish agencies, tribes, and environmental groups generally prefer spill and increased flow to other means of juvenile passage. Based on the preponderance of scientific opinion, increased flow during migration increases survival of juvenile salmonids by decreasing travel times, and mortality over spillways is lower than mortalities through other routes at dams. A spill program during juvenile salmonid migration operates at Columbia and Snake River dams. The timing and amount of spill provided by dam operators and mandated by the federal ESA driven Biological

Opinon continues to change. Spill is a relatively safe route to pass dams and in studies is generally shown to provide increased survival over fish transportation and barging options, except for wild chinook during low flow years (Kiefer 2004). Spill, however, is water not used to generate electricy, which means that hydroelectric dam operators and managers generally prefer other alternatives.

Temperatures

The maximum water temperature established by Washington and Oregon for the Columbia River downstream from Priest Rapids Dam is 20°C (68°F), which is often exceeded during the warmest parts of the summer. Considering the life history of fall chinook, coho, and lamprey and the environmental conditions that exist during their freshwater life cycle, high water temperatures may limit this population by reducing fish performance and long-term survival. Steelhead are known to seek colder water refuges at river mouths and may generally have a tolerance for slightly warm water.

Fish passage

Juvenile and adult fish passage structures operate at McNary and The Dalles Dams. McNary Dam has one of the Columbia River’s major fish bypass and collection facilities, which are used in barging and transporting juvenile salmon where they are released downstream of Bonneville Dam. Spill is also used at these dams to facilitate the upstream migration of juvenile salmon.

Predation

Primary predators of juvenile salmonids in the lower mid-Columbia River include northern pikeminnow, smallmouth bass, and walleye. Predator-prey relations have been altered by development of the hydropower system in many ways. Although northern pikeminnow are a native species and have always preyed on juvenile salmonids, development of the hydropower system has increased the level of predation.

Bird predation on juvenile salmonids at the lower mid-Columbia dams may also be a problem. Although estimates for bird predation have been 2% or less of salmonids passing a single dam, the cumulative effect is probably significant. Avian predators include Caspian terns, various gull species, double-crested cormorants, American white pelicans among others. While bird predation on juvenile fish is natural part of the food web, dams have made it easier for the birds to select their prey, e.g., by concentrating juvenile salmon at the dams.

Other ecosystem changes

The transformation of the mainstem Columbia River into a series of reservoirs has altered the food webs that support juvenile salmonids and resident fish. Continued decline in populations of salmon and other fish species results in loss of overall biomass being contributed to the subbasin. This reduction has negative effects on wildlife and fish abundance.

Dairy and Food Processing

Waste water disposal is one of the most significant environmental issues, especially for large scale food processing and manufacturing. Food processing wastewaters are high in organic matter (measured as biochemical oxgen demand) typically contained with high levels of suspended solids, ammonia and protein compounds. Effective ways of eliminating this problem are still in the experimental phases. (Food Manufacturing Coalition for Innovation and Technology Transfer 1997, Great Falls, VA).

Potential sources of the nitrate groundwater contamination in northern Oregon areas of the subbasin include land application of food processing water as well as irrigated agriculture and confined animal feeding operations (DEQ 2003).

Solid waste from thousands of cows is another source pollution. Threemile Canyon attempts to address this by using solid and liquid water from cows to produce methane gas that generates enough electricity to run the farm and some to sell. Leftover manure is is used as crop fertilizer. Potato skins and other crop waste are fed to the cows.

Currently, there is debate about whether Threemile Canyon Farm is a sustainable agricultural enterprise that protects land and water resources or a giant factory farm with confined animal production and industrialized potato production that damages the land it occupies and nearby ecosystems.

Energy

While the development of sources of energy production such as gas-fired, wind, bio-mass generation offer alternatives that have the potential to reduce dependence on the river's hydrosystem, they come with their own potential threats to fish and wildlife and their habitats. Gas-fired generation emits carbon dioxide, a major source of global warming, and other questionable emissions; this technology also requires large quantities of water for cooling. Global warming has long-term implications for the future of viable fish and wildlife resources. More immediate air quality issues are of concern to terrestrial and avian species. Wind power is known to be a more benign source of electric generation. Recent improvements in turbine blade design seem to be less harmful to birds and other avian species (BPA 2002 Avian and Bat study).

Yet even the cleaner wind and, arguably, cleaner bio-mass energy production along with gas-fired electricity have environmental costs. There are construction issues, including access roads, culverts, tree removal, soil damage, and construction debris, and siting concerns when habitats selected for development also have play an important role in the life cycle of wildlife or fish. But possibly more problematic are the need for most new generation facilities to connect to the electric transmission system, which can cause problems in addition to those previously described. Because the access lines are high voltage and may extend for some distance and require additional steel lattice towers, they may have a deleterious effect on habitat generally and on the migratory patterns of large and small animals as well as birds and bats. Transmission system upgrades require extensive infrastructure investments and careful management of hazardous waste disposal from mercury converters and pentachlorophenol- and creosote-treated utility poles.

On the positive side of alternative energy development, these other generation sources could be used to reduce the power system's dependence on hydropower to meet peak demand. Hydropower has been used to serve peak loads because dams can react by quickly putting more water through generating turbines. However, running more water through generating turbines to meet peak demand kills millions of juvenile salmon every year as they are forced through the generators and their turbine blades. During certain times of the year, drawing down so much water has also uncovered (dewatered) salmon redds, killing the salmon eggs (Foley and Lothrop 2003).

Fish and Wildlife Harvest

Tribal ceremonial, subsistence, and commercial fishing, primarily for salmon, occur in the mainstem Columbia portion of the subbasin; tribal commercial fishing usually occurs as far upstream as McNary Dam. Sport fishing and waterfowl hunting occur in the subbasin, particularly on the Columbia River. Tribal and non-tribal hunters also harvest deer and elk in the subbasin.

Forest practices

Forestlands comprise about 47% of the Rock Creek watershed, primarily in the headwaters of Rock and Pine creeks. Most of these lands are in private ownership and many have active grazing allotments (see “Livestock Grazing” below). (Have these lands been logged? Upland land uses such as forestry and grazing can contribute to the sedimentation of spawning gravels in low gradient reaches.

Livestock grazing

Improper livestock grazing practices have reduced the total amount of native vegetation and replaced native plants with others of low forage value and/or non-native and invasive species. The result has been the reduction of surface cover, resulting in increased water amd and wind erosion, which can negatively impact both aquatic and terrestrial wildlife species. Cattle, sheep, and horses can also destroy riparian vegetation and destablilize streambanks when they are allowed to forage in riparian zones (Waters 1995) Waters, T.F. (1995) Sediment in Streams: Sources, Biological Effects and Control. American Fisheries Society Monograph 7. American Fisheries Society, Bethesda, Maryland.).

Non-native, invasive plants are widespread and troublesome in this subbasin as elsewhere in the region and in United States. Whether spread by livestock movement, human travel, or introduction of non-native ornamentals, non-native invasive species are replacing native plants to the detriment of the subbasin’s riparian areas, terrestrial wildlife, and ecological processes (e.g. fire regimes, particularly in shrub-steppe habitats).

Military

Although the effects of the Navy’s use of the Boardman facility as a bombing range is unknown to the authors of this subbasin report, the one beneficial aspect of the Navy’s presence there is that part of the land has been spared some of the development the rest of the basin has experienced. The area, including the portion owned and leased out by the state near Boardman along 12 miles of the Columbia River includes habitat for a number of native declining bird species and is a stronghold for the Washington ground squirrel, *Spermophilus washingtoni*. The Washington ground squirrel was listed in 2001 in Oregon as an Endangered Species and petitioned for listing to the USFWS for federal ESA protection.

The largest remaining habitats of sage brush and bitterbrush shrub-steppe in the subbasin are found on the northern part of the Umatilla Army Depot and the Boeing lease lands, both of which face significant threats (Kagan et al. 2000). The bitterbrush habitat may be the best example of this type of shrub steppe habitat in the world (Umatilla/Willow Subbasin Plan 2004).

The site also provides a connection between large blocks of habitat at the Boardman Bombing Range and habitat to the west.

After some legal challenges to water permits for Boeing leased lands, including a finding of jeopardy to listed salmon stocks under the Endangered Species Act, an agreement was reached to protect important fish and wildlife resources while maintaining the potential to develop additional acres. The Nature Conservancy manages 4,750 acres, the on the Boardman Bombing Range, Boardman Research Natural Area (in the lower Umatilla basin).

Then in 2001, The Nature Conservancy took over management of 22,642 acres of the former Boeing lease lands and has begun developing long-term management and restoration plans for the property.

Recreation

A variety of recreation activities take place in subbasin including angling, windsurfing, boating, water skiing, waterfowl hunting, sightseeing, and birdwatching.

Rural residential

The current planning area of the subbasin is sparsely populated, with small towns and no cities. Small-scale residential developments, primarily in the downstream areas, however, impact fish, wildlife, and their habitats to some degree.

The release of effluents from wastewater, septic tanks, and other wastewater systems can affect water quality by increasing or decreasing temperatures and elevating concentrations of ammonia and chlorine in streams and rivers.

Levees, dikes, and rip-rapped banks constructed to protect roads, rail beds, homes, and farm buildings on floodplains have confined stream channels and reduced riparian vegetation in parts of the subbasin including the mainstem, leading to a decline in available fish and wildlife habitat (Johnson and O'Neill 2001; USGS, unpublished data.)

Transportation

Roads and railroads now occupy extensive reaches of land bordering the mainstem. The riprap revetments protecting these areas form significant portions of reservoir shorelines, but resulting in a pervasive loss of riparian vegetation.

Roads are a primary contributor of fine sediment and a number of roads in the headwaters are built primarily of native material with a high fine sediment component. Some of these roads parallel or are in close proximity to streams and many have had infrequent maintenance. In-channel fine sediment is a problem in some areas of the subbasin, particularly in the headwaters and lower alluvial reaches. Being impervious to water, many transportation surfaces increase surface run-off, making streams more likely to flood and washing oil and other chemicals into streams.

Both paved and gravel roads are often constructed along waterways in the subbasin. Transportation corridors can significantly impact hydrology and ecology by increasing the loss of riparian vegetation, stream water temperatures, surface water run-off into stream channels, and flashiness in stream flow.

Chemical contaminants enter the river from spills along the rail and road transportation corridors and at the locks (and other dam locations). Hydraulic connections beneath portions of the transportation corridor between embayments, mouths of streams, and mainstem is accomplished through bridges, culverts, and trestles, sometimes limiting access to spawning habitat or other tributary habitats or hatchery weirs.

Waste disposal

Several dangers to environment are presented by the transport and disposal of large quanities of waste, including hazardous wastes, in the subbasin. The entire stretch of highway and Trucks and railroads transporting the waste along this subbasin's major waterway, the Columbia River, are subject to accidents and spills. Although new liner technology is used to contain the garbage during disposal, the danger of ground water contamination from improper practices or faulty equipment is real. The Environmental Protection Agency (EPA) has fined at least one of the Arlington operators, Waste Management Inc., for not following regulations for the proper handling of hazardous wastes.

Water withdrawals

Flow objectives of NOAA/Fisheries' Biological Opinions for the mainstem Columbia River are rarely met during the summer, especially in moderate to low water years. The summer is a critcal time for migrating salmon, for steelhead and especially fall chinook. Diversion of water for agricultural production, also at its peak during the summer, contributes significantly to this shortage. Low flows, resulting in part from water withdrawals contribute to higher water temperatures and delays in salmon migration, both harmful to fish.

As of 2003, only two new Oregon water rights were issued since 1994 for Columbia River withdrawals for irrigation (Lies 2003). In 2004 the National Academy of Sciences, working on behalf of the State of Washington, released a report recommending no additional permits be issued for water withdrawals on the Columbia River during the samon critical months of July and August (2004).

3.2.9 Terrestrial/Wildlife Resources

Vegetation

The region's extremes in temperature and low level of precipitation result in sharp contrasts between riparian and upland vegetation. Riparian vegetation generally consists of a variety of deciduous trees, shrubs, grasses, and forbs that grow along the shoreline of rivers and streams. In John Day Reservoir, riparian habitats have been broken into three categories (Rasmussen and Wright 1990, ODFW 1993): trees, shrub, and herb. In the hardwood community, black cottonwood *Populus trichocarpa* is the dominant species, with willow *Salix* sp., white alder *Alnus rhombifolia*, Russian olive *Elaegonus angustifolia*, Russian mulberry *Morus alba,* black hawthorn *Crataegus douglasii,* northwestern paper birch *Betula papyrifera* and hackberry *Celtis reticulata* comprising a smaller component. Locations inhabited by people may also include Lombardy poplar *Populus nigra*, black locust *Robina pseudoacacia,* and Siberian Elm *Ulmus sinuate,* while Russian Olive is found around the reservoirs and the Columbia River. Shrub habitat includes willows, young hardwoods, false indigo *Amorpha* spp., chokecherry prunus virginiana, Saskatoon serviceberry *Amelanchier alnifolia*, rose *Rosa spp.*, and other shrubs. Herb communities are generally found on sand, mud, or gravel bars. They are typically dominated by non-native mustard Brassicaceae, dock *Rumex* spp., pigweed *Chenopodium* spp., and Russian thistle *Salsola tragus*..

Most natural vegetation in upland areas of the subbasin is classified as steppe or shrub-steppe. The steppe, or grasslands, can be broken into three climatic, climax vegetation zones: *Artemisia-Agropyron*, *Agropyron-Poa,* and the *Festuca-Koeleria* zone (Poulton 1955). The *Artemisia-Agropyron* zone occupies the driest lower reaches of the subbasin and is dominated by big sagebrush *Artemisia tridentata*, bluebunch wheatgrass *Pseudoregnia spicatum*, and bluegrass *Poa secunda*. Epigeous cryptogams made up 13% of the groundcover in this association, the second highest percentage after bluebunch wheatgrass. The combined stress of grazing and fire have allowed rabbitbrush *Chrysothamnus nauseosus* and cheatgrass *Bromus tectorum* to invade and dominate this association, rapidly reducing the cryptogam crust.

The Agropyron-*Poa* zone is slightly wetter than the *Artemisia-Agropyron* zone (Poulton 1955). Bluebunch wheatgrass, bluegrass, and rabbitbrush dominate the *Agropyron-Poa* zone with an epigeal layer of mosses and lichens. This zone receives an average annual precipitation of approximately 37 cm, approximately 15 cm more than the *Artemisia-Agropyron* zone. Disturbance leads to increased rabbitbush and cheatgrass through the *Agropyron-Poa* zone. Agriculture is prevalent in this zone, marking the driest site in the annual cropping area of the Columbia basin (Poulton 1955).

The *Festuca*-Koeleria zone is wetter still, with prairie junegrass *Koeleria cristata*, Idaho fescue *Festuca idahoensis*, and bluebunch wheatgrass dominating the grassland areas (Poulton 1955). Black hawthorn *Crataegus douglasii* and common snowberry *Symphoricarpos albus* occur along streams and in concave areas on north-facing slopes. Cryptograms comprise 28% of the groundcover in this zone. Grazing disturbance results in an increase in Kentucky bluegrass *Poa pratensis*, brome *Bromus commutatus and B. brizaeformis*, mule's ear *Wyethia amplexicaulis*, and St. John's wort *Hypericum perforatum*.

The Rock Creek subbasin lies within a vegetation zone in transition from arid shrub-steppe to the south and forest vegetation to the north. Within the zone, there is a mosaic of meadow-steppe communities and forest communities dominated by Oregon white oak and ponderosa pine (WDNR 1998). The forest communities are generally found on north-facing slopes and in riparian zones, while the steppe communities populate drier areas. The meadow steppe communities also occupy drier areas in the subbasin. Bluebunch wheatgrass (*Agropyron spicatum*) and Sandberg's bluegrass (*Poa suandbergii*) generally dominate this plant community type (WDNR 1998). Also present are a variety of forbs indicative of lithic soils. In the south central Klickitat area, heavily grazed stands are dominated by cheatgrass (*Bromus tectorum*), gray rabbitbrush (*Chrysothamnus nauseosus*), broom snakeweed (*Gutierrezia sarothrae*), and/or lupines (*Lupinus* sp.). In headwaters, land cover is primarily coniferous forest; this area is mostly above known anadromous fish use, although rainbow trout and non-salmonids such as dace use available fish habitat. Coming off the plateau, land cover is conifer forest or mixed conifer-deciduous forest in the vicinity of streams, transitioning to shrub-steppe in the uplands. Below the canyon reaches, land cover is primarily shrub-steppe in the uplands, with riparian areas transitioning downstream from mixed conifer-deciduous forest to deciduous forest to shrub-grassland. The riparian zones are made up of primarily the white alder plant community. The subbasin contains some of the few known high-quality occurrences of the white alder community type within Washington, where it is limited to riparian zones in the eastern portion of the state.

Most of the riparian zone community has an overstory of Oregon white oak (*Quercus garryana*), bigleaf maple (*Acer macrophyllum*), white alder (*Alnus rhombifolia*), black cottonwood (*Populus trichocarpa*), and water birch (*Betula occidentalis*), while shrubs are dense in places and include mock orange (*Philadelphus lewisii*), ocean spray (*Holodiscus discolor*), currant (*Ribes aureum*), and occasionally willow (*Salix* sp.) (WDNR 1998).

The Oregon side of the subbasin originally supported vast natural grasslands broken by brushy draws and tree and rimrock-bordered streams. Wheat fields and various irrigated crops, such as alfalfa, pasture grasses, and mint, have since replaced the grasslands. Corn, melons, peas, and a variety of other crops, are grown near the Columbia River. The area remains largely treeless, aside from riparian sites, farmsteads, and towns.

This area of Oregon is one of the most heavily modified by human activities. Only remnanats of the original grass steppe remain, and some of these are dominated by exotic species. The original grass steppe was dominated by bluebunch wheatgrass, Idaho fescue and Sandberg's bluegrass. There are some areas near the Columbia River, and along the western edge of the province, that are dominated by bitterbrush, but they are now smaller, isolated, and fragmented patches.

A list of of the rare plants and plant communities found in this subbasin are included in Appendix D.

Wildlife

The Lower Mid-Columbia Mainstem subbasin supports 435 species of wildlife, 35 which are federal and state listed species (IBIS 2003). Riparian and wetland habitats directly influenced by the Columbia River and upland habitats along the river are important to many species of wildlife. Species assemblages vary among habitats, which include open water, wetland, riparian, and upland. Assemblages also differ among reaches of the Columbia River.

In ODFW's Wildlife Diversity Plan (1993), Oregon is divided into 10 physiographic provinces based on geologic and vegetative patterns. The Oregon side of the Lower Mid-Columbia Mainstem subbasin is located within the western half of the Columbia Plateau Province, which lies immediately south of the Columbia River between the Cascade Range to the west and the Blue Mountains to the east.. According to the Plan, this province is below average in vertebrate diversity in all taxonomic groups because of the absence of true coniferous forest types.

A number of mammals, birds, reptiles and amphibians known to occur in the subbasin are state or federally listed as threatened or endangered. Numerous additional species are candidates for listing, or are considered sensitive or species of concern. See Appendix C, Table C.2. for a list of federal and state listed species of the Lower Mid-Columbia Mainstem subbasin.

Birds

This subbasin supports 280 species of birds. Asherin and Claar (1976) found 114 species of birds associated with McNary Reservoir. Tabor (1976) found 145 species of birds associated with John Day Resevoir and 79 species associated with The Dalles Reservoir. Avian species such as the bald and golden eagles were historically more common along the riparian sections of the Columbia River. Although numbers of bald eagles have increased in the Columbia River Gorge in the past 10 years, current numbers are considered a small remnant of past population levels.

Peregrine falcons have recently been seen at the mouth of Rock Creek during the breeding season but no nest sites have been located to date.

Agricultural production of cereal grains, as well as the increase in open water since development of the hydropower system have contributed to a significant increase in breeding and migrant/wintering waterfowl numbers. All reservoirs in the subbasin support colonies of colonial nesting birds, such as herons and gulls, that are primarily dependent on fish. This subbasin also supports one of the largest Northwest concentrations of wintering waterfowl, particularly Canada geese *Branta canadensis* and mallards *Anas platyrhynchos* (ODFW 1993).

The Northwest Area Committee, a multi-agency spill response planning group, identified a number of areas in Columbia River mainstem, including the Dalles, John Day, and McNary pools, where habitat resources and concentrations of waterfowl and shorebirds nest, breed, and winter. Within the Dalles Pool these areas include: 1) mouth of Deschutes River; 2) between Maryhill, WA and Rufus, OR; 3) mouth of Spanish Hollow Creek at Biggs Junction OR; 4) NE of Miller Island in the Columbia River Mainstem - sensitive nesting species, gull and tern nesting area; and 5) islands south and southeast of Brown's Island (includes concentration of diving ducks) (Northwest Area Committee 2004a).

The John Day pool includes the following waterfowl and shorebird habitats: 1) NE of I-82 bridge, near Plymouth WA; 2) second inlet west of Plymouth; 3) island between Irrigon and Umatilla, east and north entrances; 4) shallow water area, WA side, north of Irrigon, OR; 5) Paterson Slough; 6) WA side, east end of abandoned railroad tracks; 7) Big Blalock Island and two islands sw of Big Blalock; 8) Glade, Willow, and Alder creeks; 9) first set of small islands east of Long Walk Island, south end and se point of island, and area between Sand Island and island to the west; inlet east of Messner; 10) northeast corner and west end of Whitcomb Island; 11) Crow Butte Island; 12) inlet entrances to Threemile Canyon; 13) shallow water habitat, RM 255.8; 14) Jones Canyon and Sundale; 15) John Day River mouth and inlet just northwest of John Day Dam (Northwest Area Committee 2004b).

McNary Pool also has many habitat areas that attract large numbers of waterfowl and shorebirds: 1) Strawberry Island - Canada goose nesting habitat and wildlife refuge; 2) Sacajawea State Park shores; 3) inlet west of Highway 410 and inlet just east of Snake River railroad trestle (south end) - sensitive marsh habitat, Hood and Sacajawea Park; 4) inlet just west of Snake River railroad trestle, and inlet mouths south of Snake River railroad trestle (south end); 5) entrance to Villard Pond; 6) point south of and east end of Columbia River railroad trestle; 7) Foundation Island – geese, cormorants, shorebirds, herons; 8) entrance to Casey Pond; 9) south tip of Corps of Engineers habitat management area; 10)Badger Island; 11) mouth of Walla Walla River (various wildlife resources); 12) Juniper Canyon – marsh, Corps of Engineers habitat management area, shallow water habitat; 13) point on south shore opporsite Spukshowski Canyon; 14) point northeast of Cold Spring Juntion; 15) first island north of Cold Springs Junction; (16) northeast point of peninsula jutting out, north of Cold Springs Junction; 17) two largest islands east of Hat Rock State Park and passageways between the two islands (Northwest Area Committee 2004c).

Riparian forest and cliffs provide nesting opportunities for several species of raptors (e.g. red-tailed hawks *Buteo jamaicensis*, Swainson's hawks *B. swainsoni*, prairie falcons *Falco mexicanus,* and American kestrels *Falco sparverius)* and are used by other species (sharp-shinned hawks *Accipiter striatus* and Cooper's hawks *A. cooperii)* during migration. Owls, game-birds, passerines, and shorebirds also inhabit the subbasin. A significant population of curlew breed in the Umatilla-Boardman area, including the Boardman Bombing Range and the Umatilla Army Depot. Long-eared owls nest in junipers on the Boardman Bombing Range and burrowing owls many reach the peak of their state abundance in grasslands associated with the bombing range (ODFW 1993).

Riparian areas of the province, while heavily disturbed by livestock, still support numerous songbirds. This province may have more bank swallows than any other. This sensitive species nests in scattered colonies, using burrows in vertical sand banks. Native grassland communities in the Boardman area of Morrow county support sparse populations of grasshopper sparrows (ODFW 1993).

Mammals

IBIS lists 108 species of mammals in this subbasin, including aquatic and terrestrial furbearers, small mammals, and big game. Blalock and Philippi Canyons, just east of the John Day River in the northwest corner of Gilliam County, support a resident herd of California bighorn sheep numbering approximately 70 animals (Russ Morgan, pers. comm., 2004). Historically, California bighorns were the most abundant wild, native sheep in Oregon (Toweill and Geist 1999). They were found throughout the steeper terrain of southeast Oregon, and the non-timbered portions of the Deschutes and John Day River drainages. California bighorns were extirpated from Oregon by 1915 because of indiscriminate hunting, unregulated grazing by domestic livestock, and parasites and diseases carried by domestic livestock. Between 1954 and 1985, efforts were made to restore California bighorn sheep to Oregon with transplants from British Columbia and other states as animals and funding ware available. Oregon now supports 3,700 California bighorn in 32 herds (ODFW 2003b).

Overall, most established California bighorn herds are stable to increasing in number, although it will take a few years to evaluate the success of recent transplants. The annual rate of increase in all populations tends to decrease as total population size increases. The exact cause for this drop in productivity or survival is not yet known. Biologists think that as bighorn density increases, parasite levels and possibly stress have a depressing effect on overall herd productivity and survival (ODFW 2004g).

Numerous species of small rodents are also present, including the Washington ground squirrel (recently listed as endangered in Oregon, and has been petitioned for federal listing across its entire range), which is associated with native shrub-steppe and grassland habitats. It has a very limited distribution and occurs only in portions of the Columbia basin, including the BAIC tract and Boardman Bombing Range (TNC 1999).

Reptiles and Amphibians

Twenty-three species of amphibians and 24 species of reptiles are known to inhabit this subbasin. Amphibians and reptiles often reveal important information about the ecological condition of an area because, they are predators, often rely on specific habitats, and are sensitive to environmental degradation. Furthermore, there is global concern that amphibians are declining as the result of climate change and habitat alteration (Wake and Morowitz 1991; Stebbins and Cohen 1995).

Before inundation by hydroelectric dams, the natural hydrological flooding and seasonal drying of lowland backwater areas along the Columbia created environments that would have been especially rich in amphibian species, such as spotted frog *Rana sp*. and western toad *Bufo boreas*. Now these species are primarily missing from the Columbia River lowlands. The western painted turtle *Chrysemys picta belli* is abundant in the Irrigon Wildlife Management Area, supported by the complex of emergent marsh and open water.

3.2.10 Aquatic/Fish Resources

At least 51 species of fish from 14 families have been reported from the mainstem Columbia River between Wanapum and The Dalles dams (Appendix C, Table C.8). Thirty of these species are native. Thirty-three species were found just in backwaters between McNary and Bonneville dams (USFWS 1980). Most of the species observed remain in the subbasin throughout their life naturally or because they are largely constrained within the barriers presented by the dams (e.g., white sturgeon). See **Table 4.**

Anadromous Fish

At least five anadromous fish species are found in the Lower Mid-Columbia Mainstem Subbasin, including spring, summer/fall chinook (*Oncorhynchus tshawytscha*), summer steelhead (*O. mykiss*), sockeye salmon *(O. nerka*), coho salmon (*O. kisutch),* and Pacific lamprey (*Lampetra tridentata*). Counts of adult salmonids passing The Dalles Dam have averaged nearly a half million fish in recent years.

Areas of the lower mid-Columbia River historically served as spawning grounds for fall chinook and steelhead. Today the lower mid-Columbia is mostly a migration corridor to and from the Pacific Ocean for adult and juvenile salmonids. Although Pacific lamprey, American shad, bull trout, ocean-type Chinook salmon, coho salmon, and rainbow trout (steelhead) may use the subbasin for significant portions of their life history. Salmon spawning has been observed in limited areas in the Columbia River. Most fish species spawn and rear in tributary streams away from the Columbia River. Anadromous fish that primarily use the subbasin as a migration corridor include stream-type chinook and sockeye salmon. In the mainstem Columbia River, salmonid concentrations and habitat are found in shallow water, inlet, and island locations. See 5.7.2 Lower Mid-Columbia Mainstem Assessment Unit.

Seven watersheds in the subbasin are known to have anadromous fish use, five on the Washington side: Rock Creek, Pine Creek, Wood Gulch, Alder Creek, and Grade Creek; and two on the Oregon side, Frank Fulton Canyon and Spanish Hollow. Three species of anadromous salmon, fall chinook, coho (*Onchorynchus kisutch*), and steelhead (*Onchorynchus mykiss*), use streams in the Rock Creek assessment unit. Steelhead have been identified as indigenous to the subbasin. The remaining anadromous use is believed to be a result of straying of other mid-Columbia stocks, or is incidental use associated with upriver migration of adults or downriver migration of juveniles. Pacific lamprey have also been observed in Rock Creek (Jim Matthews, YN, pers. communication 2001).

Historically summer steelhead used Spanish Hollow and Fulton Canyon. Currently, they use Fulton Canyon when water conditions permit, but there is some uncertainly as to the exent to which summer steelhead to use Spanish Hollow, including for spawning (French, pers. comm., 2004).

Chum salmon are reported to have once migrated up the Columbia River as far as the Walla Walla River, a distance over 300 miles from the ocean (Nehlsen et al. 1991) and were productive in many lower Columbia River tributaries. Runs of nearly 1.4 million fish are believed to have returned annually to the Columbia River. After Bonneville Dam was completed, passage counts were variable ranging from over 5,000 adults in 1941 to less than 100 by 1968. Since 1970, counts have been as low as one.

Historical distribution of chum upstream of Bonneville Dam is not well known. Few fish were observed passing The Dalles Dam upon its completion and since adult passage counts began in 1957. Recent production is generally limited to areas downstream of Bonneville Dam although adults continue to be observed ascending Bonneville Dam. All naturally produced chum salmon populations in the Columbia River Basin were listed as threatened under federal ESA August, 1999.

Hanford Reach

This subbasin plan covers only a portion of the Lower Mid-Columbia Mainstem subbasin and its management plan does not include strategies for the Hanford Reach. However, WDFW biologists thought the Hanford Reach's naturally spawning fall chinook population to be important enough to deserve mention in the Lower Mid-Columbia Mainstem subbasin document.

Gray and Dauble (1977) list 43 fish species (i.e. anadromous and resident) in just the Hanford Reach. Beach seine catches from April-June in the Hanford Reach are dominated by subyearling fall chinook salmon (U.S. Geological Survey, USGS, unpublished data).

Hanford Bright Fall Chinook

Most of the salmon migrating through the Lower Mid-Columbia Mainstem Columbia River are from the Hanford Reach, which remains the most important natural spawning area for fall chinook salmon in the mainstem Columbia River. The salmon in the Hanford Reach area are classified as the upriver bright stock of fall chinook. These bright fall chinook migrate upstream to spawning areas in the Hanford Reach from mid-August through October, dig redds and deposit eggs from late October to late November. The Hanford Reach is a 50-mile segment of the Columbia River extending from the upper end of McNary Dam Reservoir (near the downstream border of the Hanford Nuclear Reservation) to Priest Rapids Dam.

The number of fall chinook salmon redds observed in the Hanford Reach increased through the decades of the 1960s, 1970s and 1980s until reaching a high in 1989 of nearly 9,000 (see**Figure 30**). In the early 1990s, redd counts declined to approximately one-third, but rebounded in the late 1990s. Redd survey data generally agree well with adult escapement figures obtained by counting migrating adult fish at fish ladders on the Columbia River.

The Priest Rapids Hatchery contributes significantly to the Hanford bright fall chinook run. In 2003 nearly 100,000 fall chinook salmon returned to the Hanford Reach to spawn, and recent years have seen some of the highest returns in over 40 years of record-keeping. A recent CRITFC study (Hatch and Talbot 2002) found that the proportion of Priest Rapids Hatchery fish returning to the natural production areas in the Hanford Reach to spawn ranged from 4.64%to 60.57%—an average of 29.83%—between 1979 and 2000. The proportion of Hanford Reach returns attributable to Priest Rapids Hatchery ranged from 1.33%to 33.0 %, with an average of 8.63%.

Resident Fish

Whitefish, sturgeon, trout, and char were the dominant resident species in the mid-Columbia before reservoir inundation. Hydropower development and production in the mid-Columbia created a subsequent shift in resident species composition. Today, bull trout, rainbow, whitefish and white sturgeon are present in the reservoirs along with numerous non-native (e.g. American shad, bass, bulleye, carp, crappie, perch, walleye) and cool water, non-game species (e.g. northern pikeminnow, shiners, and suckers). Burbot, chiselmouth, dace, peamouth, sculpin, and three-spine stickleback are also found in this subbasin.

A number of areas in the Dalles, John Day, and McNary pools are identifed where habitat resources (includes warm water nurseries) and concentrations of resident fish species exist. See 5.7.2 Lower Mid-Columbia Mainstem Assessment Unit.

Rainbow trout are currently present in the mid-Columbia reservoirs, however they are likely the result of hatchery steelhead and resident rainbow trout production programs in nearby tributaries. Resident rainbow trout do not appear to be self-sustaining in the reservoirs, though self-sustaining populations of rainbow, cutthroat, and brook trout are maintained in the tributaries (Chelan County PUD 1998; Zook 1983). Resident rainbow trout have been found in many of the streams in the Rock Creek subbasin, particularly in the headwaters. They have also been observed in upper Rock Creek, Quartz Creek, Squaw Creek and Box Canyon. Suckers (*Catostomus spp*), dace (*Rhinicchthys spp*) and other non-game fish species have also been observed in Rock Creek (Jim Matthews, YN, pers. communication 2001).

In Spanish Hollow and Fulton Canyon, redband trout, longnose dace, reside shiner, and largescale sucker were historically and are currently present. However, redband trout in Spanish Hollow have not been recently observed (Rod French, pers. comm., 2004).

Smallmouth bass are abundant in the Hanford Reach and mountain whitefish are common and support a recreational fishery. Beach seine catches at Hanford from April-June were dominated by redside shiners, carp, largescale suckers, northern pikeminnow, and peamouth (U.S. Geological Survey, USGS, unpublished data). Tench, threespine sticklebacks, and mountain whitefish are rarely captured in Hanford beach seining activities.

Bull trout are rarely observed in the Columbia River; however, Gray and Dauble (1977) reported collecting bull trout at two sites within the Hanford Reach. In recent years very few bull trout have been collected during sampling in McNary Reservoir (ODFW, unpublished data). Extensive multi-gear, multi-season sampling (beach-seining, electrofishing, gill-netting, and minnow trapping) in the Priest Rapids and Wanapum tailraces, reservoirs, and forebays during 1999 resulted in the capture of only 2 bull trout (Pfeifer et al. 2000). A bull trout was observed in the Smolt Monitoring Program collection facility at John Day Dam, 5/18/2002 (Martinson et al. 2003).

Resident Predators

Primary predators of juvenile salmonids in the Columbia River include northern pikeminnow, smallmouth bass, and walleye. Northern pikeminnow are a native cyprinid that is widely distributed throughout the Columbia River Basin. They are the subject of an extensive predator control effort. Smallmouth bass and walleye support popular recreational fisheries and walleye are also harvested in commercial fisheries.

Beamesderfer and Rieman (1991) estimated abundance in John Day Reservoir to be approximately 85,000 northern pikeminnow and 15,000 walleye longer than 250 mm fork length, and 35,000 smallmouth bass longer than 200 mm fork length. Ward et al. (1995) estimated abundance of northern pikeminnow relative to that in John Day Reservoir to be approximately 138% in The Dalles Reservoir and 68% in McNary Reservoir (excluding the Hanford Reach). Zimmerman and Parker (1995) estimated abundance of smallmouth bass relative to that in John Day Reservoir to be approximately 10% in The Dalles Reservoir and 45% in McNary Reservoir.

Petersen (1994) estimated the annual loss of juvenile salmonids to predation by northern pikeminnow in John Day Reservoir to be 1.4 million, approximately 7.3% of all juvenile salmonids entering the reservoir. Rieman et al. (1991) determined that northern pikeminnow accounted for 78% of the loss of juvenile salmonids to fish predators. Ward et al. (1995) estimated predation on juvenile salmonids by northern pikeminnow relative to that in John Day Reservoir to be approximately 190% in The Dalles Reservoir and 50% in McNary Reservoir.

Predation on juvenile salmonids by northern pikeminnow has decreased since implementation of the Northern Pikeminnow Management Program in 1990 (Beamesderfer et al. 1996; Friesen and Ward 1999). From 1992 through 1999, annual exploitation rate of northern pikeminnow longer than 250 mm fork length has averaged approximately 11.4% in The Dalles Reservoir, 5.2% in John Day Reservoir, and 15.3% in McNary Reservoir and the Hanford Reach combined. Annual exploitation rate throughout the lower Columbia River Basin has averaged about 12%, resulting in an estimated 25% reduction in predation on juvenile salmonids (Friesen and Ward 1999).

Smallmouth bass are introduced and are also widely distributed throughout the Columbia River basin. Crayfish and fish each constitute nearly 50% of the diet (by weight) of smallmouth bass in lower Columbia River reservoirs (Zimmerman 1999). Sculpins are the primary fish prey, with salmonids comprising about 10-25% of the fish consumed by weight, and about 14% by number. Individually, smallmouth bass consume fewer juvenile salmonids than northern pikeminnow[TR1]. But in areas where smallmouth bass are more abundant than northern pikeminnow, they likely consume more salmonids. Density of smallmouth bass is generally higher in upstream reservoirs and abundance of smallmouth bass is especially high in John Day Reservoir (Zimmerman and Parker 1995).

Introduced walleye are generally less abundant in lower Columbia Reservoirs than either northern pikeminnow or smallmouth bass, although fluctuations in walleye abundance are common (Tinus and Beamesderfer 1994; Friesen and Ward 2000). Walleye year-class strengths are highly variable, with occasional dominant years (Rieman and Beamesderfer 1990; Friesen and Ward 2000). Walleye may consume as many salmonids per individual as northern pikeminnow (Vigg et al. 1991), but low predator numbers usually preclude extensive losses of juvenile salmonids. Fish comprise almost 100% of the diet in lower Columbia River reservoirs, with salmonids constituting about 14% of the fish by number (Zimmerman 1999). Predation may be much higher in spring, when salmonids constitute almost 60% of the fish by weight.

Table 4 Fish species reported from the Columbia River between Wanapum and The Dalles dams

Tolerance refers to physiological resistance to organic pollution, warm water, sedimentation, and low dissolved oxygen (Zaroban et al. 1999). Status refers to listing as threatened or endangered: FE = federal endangered, FT = federal threatened, FSC = federal species of concern, OT = Oregon threatened, WC = Washington candidate.

Family, species	Origin	Tolerance	Status
Petromyzontidae			
Western brook lamprey Lampetra richardsoni	Native	Intermediate	--
River lamprey L. ayresi	Native	Intermediate	FSC
Pacific lamprey L. tridentata	Native	Intermediate	FSC
Acipenseridae			
White sturgeon Acipenser transmontanus	Native	Intermediate	--
Clupeidae			
American shad Alosa sapidissima	Exotic	Intermediate	--
Salmonidae			
Rainbow trout/steelhead Oncorhynchus mykiss	Native	Sensitive	FE, FTa,WC
Cutthroat trout O. clarki	Native	Sensitive	--
Chinook salmon O. tshawytscha	Native	Sensitive	FE, FTb, OT, WC
Coho salmon O. kisutch	Native	Sensitive	--
Sockeye salmon O. nerka	Native	Sensitive	FEc, WC
Bull trout Salvelinus confluentus	Native	Sensitive	FT, WC
Brown trout Salmo trutta	Exotic	Intermediate	--
Mountain whitefish Prosopium williamsoni	Native	Intermediate	--
Lake whitefish Coregonus clupeaformis	Exotic	Intermediate	--
Cyprinidae			
Carp Cyprinus carpio	Exotic	Tolerant	--
Grass carp Ctenopharyngodon idella	Exotic	Tolerant	--
Goldfish Carrassius auratus	Exotic	Tolerant	--
Chiselmouth Acrocheilus alutaceus	Native	Intermediate	--

Family, species	Origin	Tolerance	Status
Redside shiner Richardsonius balteatus	Native	Intermediate	--
Northern pikeminnow Ptychocheilus oregonensis	Native	Intermediate	--
Peamouth Mylocheilus caurinus	Native	Intermediate	--
Longnose dace Rhinichthys cataractae	Native	Intermediate	--
Leopard dace R. falcatus	Native	Intermediate	WC
Speckled dace R. osculus	Native	Intermediate	--
Tench Tinca tinca	Exotic	Intermediate	--
Catostomidae			
Largescale sucker Catostomus macrocheilus	Native	Tolerant	--
Bridgelip sucker C. columbianus	Native	Tolerant	--
Mountain sucker C. platyrhynchus	Native	Intermediate	WC
Longnose sucker C. catostomus	Native	Intermediate	--
Ictaluridae			
Channel catfish Ictalurus punctatus	Exotic	Tolerant	--
Black bullhead Ameiurus melas	Exotic	Tolerant	--
Brown bullhead A. nebulosas	Exotic	Tolerant	--
Yellow bullhead A. natalis	Exotic	Tolerant	--
Poeciliidae			
Mosquitofish Gambusia affinis	Exotic	Tolerant	--
Gadidae			
Burbot Lota lota	Native	Intermediate	--
Gasterosteidae			
Three-spine stickleback Gasterosteus aculeatus	Native	Tolerant	--
Percopsidae			
Sandroller Percopsis transmontana	Native	Intermediate	--
Centrarchidae			
Largemouth bass Micropterus salmoides	Exotic	Tolerant	--

Family, species	Origin	Tolerance	Status
Smallmouth bass M. dolomieui	Exotic	Intermediate	--
Black crappie Pomoxis nigromaculatus	Exotic	Tolerant	--
White crappie P. annularis	Exotic	Tolerant	--
Warmouth Lepomis gulosis	Exotic	Tolerant	--
Bluegill L. macrochirus	Exotic	Tolerant	--
Pumpkinseed L. gibbosus	Exotic	Tolerant	--
Percidae			
Walleye Stizostedion vitreum	Exotic	Intermediate	--
Yellow perch Perca flavescens	Exotic	Intermediate	--
Cottidae			
Paiute sculpin Cottus beldingi	Native	Intermediate	--
Torrent sculpin C. rhotheus	Native	Intermediate	--
Prickly sculpin C. asper	Native	Intermediate	--
Reticulate sculpin C. perplexus	Native	Intermediate	--
Mottled sculpin C. bairdi	Native	Intermediate	--

a Middle Columbia River and Snake Basin Steelhead ESUs listed as threatened; Upper Columbia River ESU listed as endangered. b Snake River Chinook Salmon ESUs listed as threatened; Upper Columbia River Spring-run ESU listed as endangered. c Only the Snake River ESU is federally listed (endangered)

4 Wildlife Assessment

4.1.1 Introduction

The subbasin wildlife assessment is a technical analysis to determine the biological potential of the subbasin and the opportunities for restoration. It describes the existing and historic resources, conditions and characteristics within the subbasin. Separate teams of wildlife scientists developed the assessment. The bulk of the Washington assessment work was done by the Yakama Nation and WDFW with support and involvement of Klickitat County. ODFW guided the Oregon assessment draft and, under the circumstances of time, agreed to the focal habitats and species.

The initial subbasin planners from Washington chose a set of focal wildife species, and habitats, on which to focus their assessment. A focal species has special ecological, cultural, or legal status and is used to evaluate the health of the ecosystem and the effectiveness of management actions. Criteria used in selecting the focal species include a) designation as federal endangered or threatened species, b) cultural significance, c) local significance and d) ecological significance, or ability to serve as indicators of environmental health for other species. Each of the focal wildlife species for the Lower Mid-Columbia Mainstem Subbasin is described below.

Focal Wildlife Species and Representative Habitats

Wildlife

Eight wildlife species found in the Lower Mid-Columbia Mainstem Subbasin have been chosen as focal species for this planning effort: Western gray squirrel, mule/black-tailed deer, grasshopper sparrow (*Ammodramus savannarum*), Brewer's sparrow (*Spizella breweri*), white-headed woodpecker, Lewis' woodpecker (*Melanerpes lewis*), American beaver (*Castor canadensis*), and the yellow warbler (*Dendroica petechia*).

Table 5 Wildlife focal species and their distribution within the Lower Mid-Columbia Mainstem subbasin

Wildlife Focal Species	Habitat Represented
Western Gray Squirrel	Ponderosa Pine/Oregon White Oak
Mule/Black-Tailed Deer	Shrub Steppe/Interior Grasslands
Grasshopper Sparrow	Shrub Steppe/Interior Grasslands
Brewer's Sparrow	Shrub Steppe/Interior Grasslands
White-Headed Woodpecker	Ponderosa Pine/Oregon White Oak
Lewis' Woodpecker	Interior Riparian Wetlands
American Beaver	Interior Riparian Wetlands
Yellow Warbler	Interior Riparian Wetlands

4.1.2 Wildlife Assessment Methodology

This section briefly describes the framework used to develop the subbasin wildlife assessment for the Lower Mid-Columbia Mainstem subbasin plan. A number of state and local wildlife /land management agencies provided data and information to complete the subbasin plan: The Yakama

Nation Wildlife Department, WDFW, ODFW, Klickitat County, Washington, and Sherman and Gilliam counties, Oregon. The Yakama Nation Wildlife Department is the lead wildlife agency in the Lower Mid-Columbia Mainstem subbasin compiling wildlife assessment, inventory, and management information for the subbasin.

The wildlife assessment was developed from a variety of "tools" including the Mainstem Columbia Subbasin Summary (Ward 2001), Rock Creek Subbasin Summary (NPPC 2001), Umatilla and John Day Subbasin Plans (i.e. some watersheds within the Oregon portion of the subbasin, border the Umatilla and John Day subbasins and were included in these plans), the Interactive Biodiversity Information System (IBIS), the WDFW Priority Habitats and Species (PHS) database, the ODFW Sensitive Species List and Oregon Administrative Rules, the Washington Gap Analysis Project (GAP) database, Partners in Flight (PIF) information, National Wetland Inventory maps, and input from local, state, federal, and tribal wildlife managers.

Although IBIS is a useful assessment tool, it should be noted that IBIS-generated historic habitat maps have a minimum polygon size of 1 km^2 while current IBIS habitat type maps have a minimum polygon size of 100 ha or 250 acres (O'Neil, pers. comm., 2003). In either case, linear aquatic, riparian, wetland, subalpine, and alpine habitats are under represented, as are small patchy habitats that occur at or near the canopy edge of forested habitats. It is also likely that microhabitats located in small patches or narrow corridors were not mapped at all. Another limitation of IBIS data is that they do not specifically rate habitat quality nor do they associate key ecological correlates (KEC) with specific areas. As a result, a given habitat type may be accurately depicted on IBIS maps, but may be lacking in functionality and quality. For example, IBIS data do not distinguish between shrub steppe habitat dominated by introduced weed species and pristine shrub steppe habitat.

Washington State GAP data was also used extensively throughout the wildlife assessment. The GAP generated acreage figures may differ from IBIS acreage figures as an artifact of using two different data sources. The differences, however, are relatively small (less than 5%) and will not impact planning and/or management decisions.

The WDFW has created the Priority Habitats and Species (PHS) List, which is a catalog of species and habitat types that were identified as priorities for management and preservation. For many of these species and habitat types, documents have been created that include, in the case of species, habitat need and use descriptions, basic life history information, population status and trends, and in the case of both species and habitats, provide factors limiting presence and make management recommendations. Available documents were used for species and habitat write-ups as well as for the creation of key findings, limiting factors and working hypotheses to be used in the creation of a management plan.

Wildlife in the Lower Mid-Columbia Mainstem Subbasin

Using IBIS (2003), 435 wildlife species have been identified to currently occur within the Lower Mid-Columbia Mainstem subbasin. For a full list of species and breeding status in this subbasin, see Appendix C, table C.1.

Species richness for the Lower Mid-Columbia Mainstem subbasin is given in **Table 6**. Differences in species richness between subbasins can partially be explained as variation in biological potential and quality of habitats, amount/type and juxtaposition of remaining habitats, and robustness of databases used to establish the species lists.

Table 6 Species richness of the Lower Mid-Columbia Mainstem subbasin, Washington and Oregon (IBIS 2003)

Class	Number
Amphibians	23
Birds	280
Mammals	108
Reptiles	24
Total	435

Many of the wildlife species found in this subbasin can be listed in several different categories. These categories include: federal and state listed species, game species, Washington state Partners In Flight species, species used in the Habitat Evaluation Procedure (HEP), and species that have documented relationships with salmon. These groups were compiled by IBIS (2003) and are discussed next. These categories were some of the criteria used in choosing focal species later.

Federal and State Listed Species

Of the 435 wildlife species listed above, 54 are either federally (threatened, candidate, or concern) or state (endangered, threatened, sensitive, or candidate) listed. See Appendix C., table C.2.A for a full list, and table C.2.B for definitions of listings.

Game Species

Of the 435 wildlife species identified in the subbasin, 65 species are listed in IBIS (2003) as game animals. Of these, 1 is an amphibian, 41 are birds and 23 are mammals. For a detailed list of game species in the subbasin, see Appendix C, table C.3.

Oregon and Washington Partners in Flight

The goal of Partners in Flight (PIF) is to focus resources on the improvement of monitoring and inventory, research, management, and education programs involving birds and their habitats. The PIF strategy is to stimulate cooperative public and private sector efforts in North America and the Neotropics to meet these goals. Of the 435 wildlife species in the subbasin, there are 280 bird species. Of these, 111 are listed in Partners in Flight for this subbasin. See Appendix C, table C.4 for a full list of species.

Habitat Evaluation Procedure

The wildlife species listed under the Habitat Evaluation Procedure (HEP) are used to assess habitat losses associated with federal hydroelectric facilities on the Lower Snake and Columbia Rivers. Of the 435 wildlife species in the subbasin, 26 are used under HEP, 20 birds and 6 mammals (IBIS 2003). See Appendix C table C.5 for a full list.

Salmonid Associations

Anadramous salmon provide a rich, seasonal food resource that directly affects the ecology of both aquatic and terrestrial consumers, and indirectly affects the entire food web that knits the water and land together. Wildlife species and salmon have likely had a very long, and co-evolutionary relationship with salmon in the Pacific Northwest. Of the 435 species in the subbasin, 92 are classified as having a routine relationship with salmon (combination of species with Strong and Consistent, Recurrent, Indirect and Rare relationships, see Appendix C, table C.6.B for definitions). See Appendix C., table C.6.A for entire list (IBIS 2003).

Priority Habitat and Species (PHS)

The PHS list is a catalog of habitats and species considered to be priorities for conservation and management. Priority species may warrant management measures for their perpetuation at target population levels due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance. Priority species include State Endangered, Threatened, Sensitive, and Candidate species; animal aggregations considered vulnerable; and those species of recreational, commercial, or tribal importance that are vulnerable.

In this subbasin there are 77 wildlife species listed on the PHS list for Washington State. Internet access to the PHS List is available via the World Wide Web at: http://www.wa.gov/wdfw/hab/phslist.htm.

4.1.3 Wildlife Habitats and Features in the Lower Mid-Columbia Mainstem Subbasin

Wildlife Habitats

The Lower Mid-Columbia Mainstem subbasin consists of 12 wildlife habitat types as identified by IBIS (2003). These are briefly described in **Table 7**. Historic and current wildlife habitat distribution is illustrated in **Figure 3** and **Figure 4**. However, not all areas shown on the maps or all current habitat types occur in the present planning area of the subbasin.

Table 7 Current wildlife habitat types within the Lower Mid-Columbia Mainstem subbasin, Washington (IBIS 2003); only shaded areas occur in Oregon part of the subbasin

Habitat Type	Brief Description
Montane Mixed Conifer Forest	Coniferous forest of mid-to upper montane sites with persistent snowpack; several species of conifer; understory typically shrub-dominated
Interior Mixed Conifer Forest	Coniferous forests and woodlands; Douglas-fir commonly present, up to eight other conifer species present; understory shrub and grass/forb layers typical; mid-montane.
Ponderosa Pine & Interior White Oak Forest and Woodlands	Ponderosa pine dominated woodland or savannah, often with Douglas-fir; shrub, forb, or grass understory; lower elevation forest above steppe, shrubsteppe.
Western Juniper and Mountain Mahogany Woodlands	Not found in Rock Creek
Interior Canyon Shrublands	Chokecherry, oceanspray, and Rocky Mtn. maple with shrubs and grasses dominated the understory.
Interior Grasslands	Dominated by short to medium height native bunchgrass with forbs, cryptogam crust.

Habitat Type	Brief Description
Shrub steppe	Sagebrush and/or bitterbrush dominated; bunchgrass understory with forbs, cryptogam crust.
Agriculture, Pastures, and Mixed Environs	Cropland, orchards, vineyards, nurseries, pastures, and grasslands modified by heavy grazing; associated structures.
Urban and Mixed Environs	High, medium, and low (10-29% impervious ground) density development.
Open Water - Lakes, Rivers, and Streams	Lakes, are typically adjacent to Herbaceous Wetlands, while rivers and streams typically adjoin Eastside Riparian Wetlands and Herbaceous Wetlands
Herbaceous Wetlands	Generally a mix of emergent herbaceous plants with a grass-like life form (graminoids). Various grasses or grass-like plants dominate or co-dominate these habitats.
Interior Riparian-Wetlands	Shrublands, woodlands and forest, less commonly grasslands; often multilayered canopy with shrubs, graminoids, forbs below.

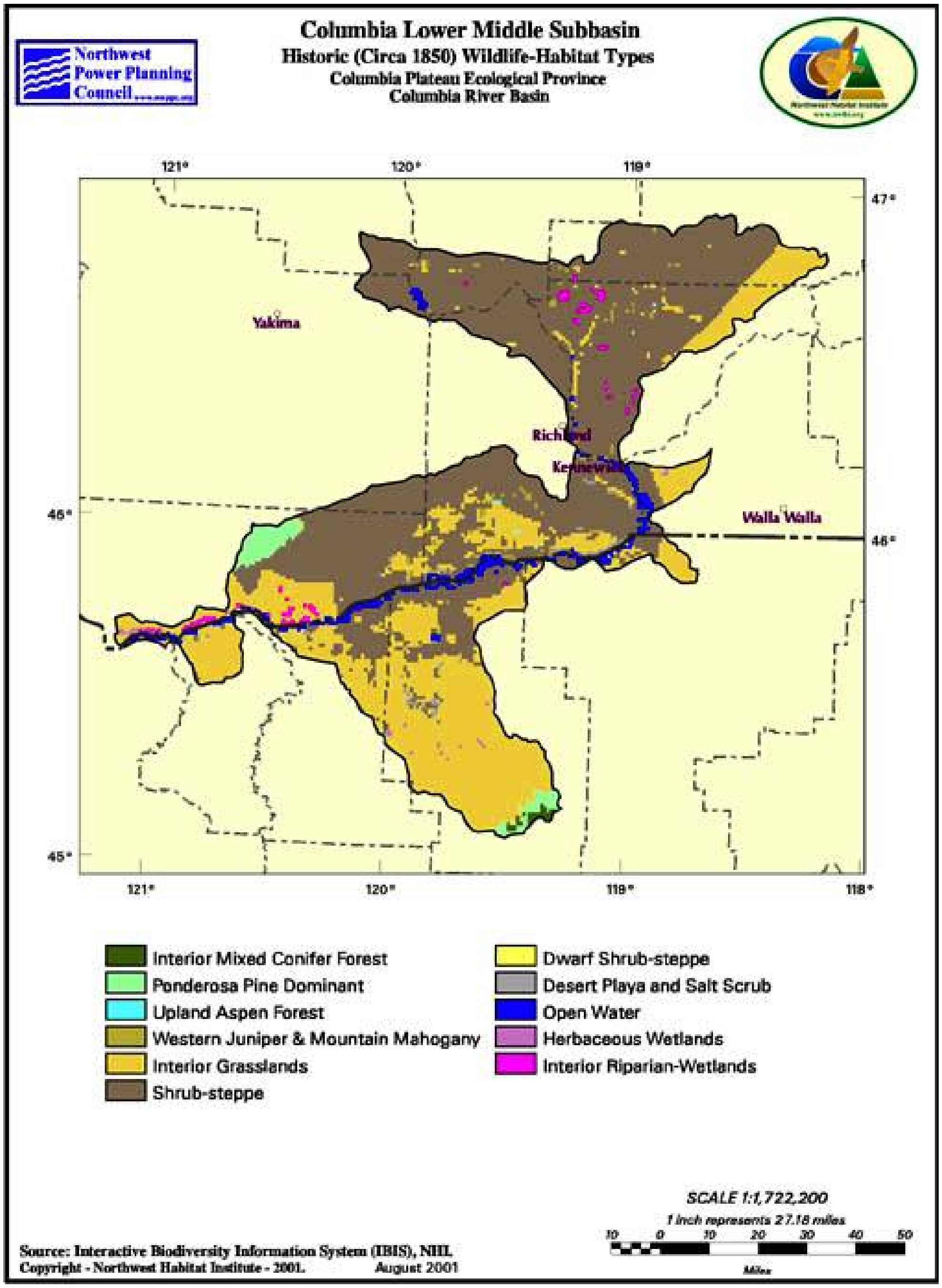


Figure 3 Historic wildlife habitat types of the Lower Mid-Columbia Mainstem Subbasin (IBIS 2003)

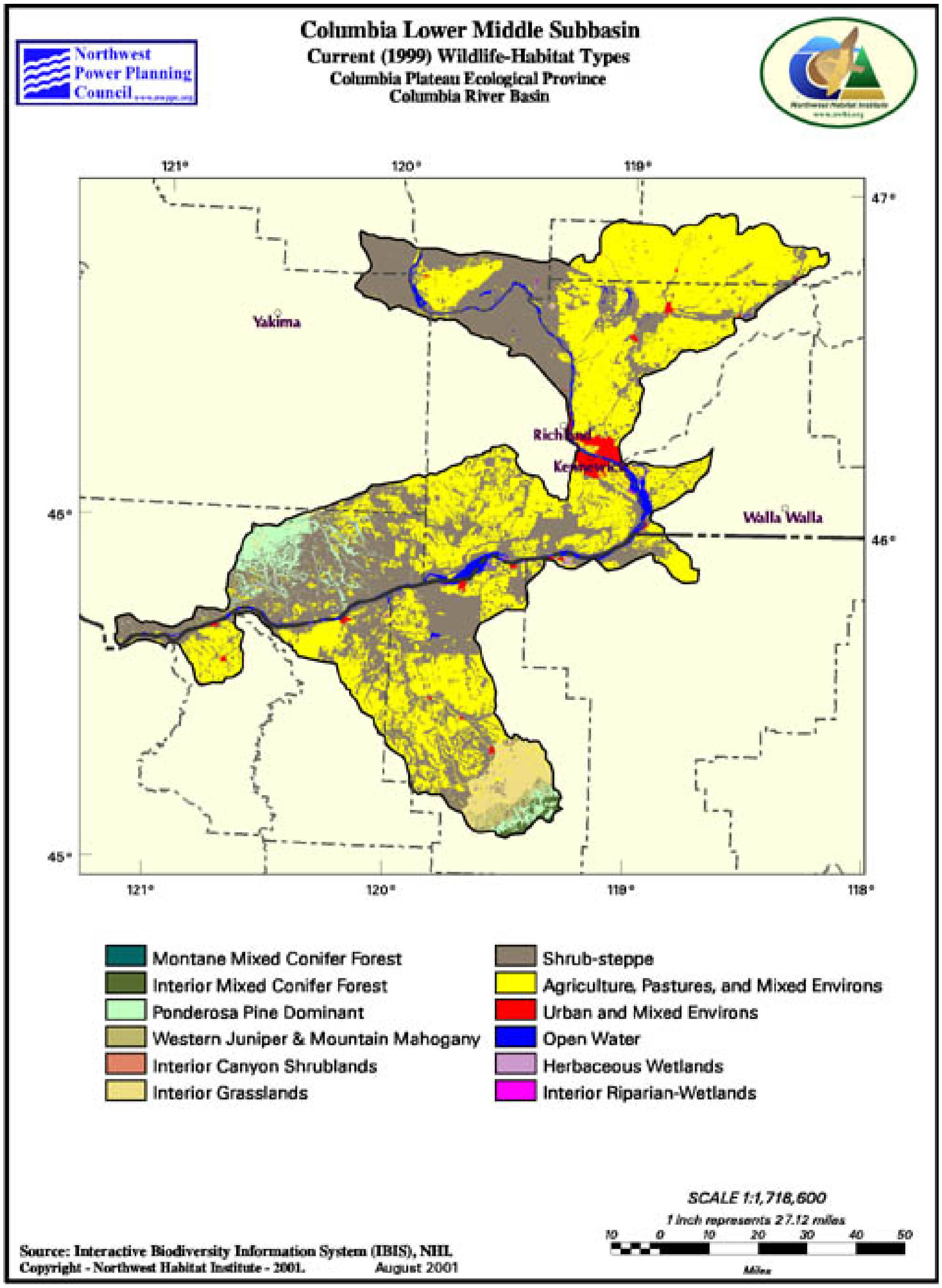


Figure 4 Current wildlife habitat types of the Lower Mid-Columbia Mainstem Subbasin (IBIS 2003)

Rare Plants and Plant Communities

The Washington and Oregon Natural Heritage Programs (2003, 2004) list 76 rare, endangered, and threatened plants in Klickitat County, Washington, and Sherman, Gilliam, and Morrow counties, Oregon (part of which make up the Lower Mid-Columbia Mainstem subbasin). The Oregon Natural Heritage Program (2004) does not track plant communities, but Klickitat County has 23 rare or high-quality plant communities (WNHP 2004). Complete listings are in Appendix D, tables D.1.A and D.2

Priority Habitat and Species (PHS)

The PHS list is a catalog of habitats and species considered to be priorities for conservation and management. Priority habitats are those habitat types or elements with unique or significant value to a diverse assemblage of species. A Priority habitat may consist of a unique vegetation type or dominant plant species, a described successional stage, or a specific structural element.

In this subbasin there are 17 habitats or habitat elements listed within the PHS list for southwest Washington (Region 5) (see Appendix D, table D.3). Internet access to the PHS List is available via the World Wide Web at: http://www.wa.gov/wdfw/hab/phslist.htm.

Plant Species of Importance to the people of the Yakama Nation

There are many species of native plants that have traditional and modern cultural importance to the Yakama Nation. When looking for focal habitats, habitats that supported culturally important, and often imperiled, plants were considered. For a short list of some of these plant species that have already been published in other literature, refer to Appendix D, table D.5

Noxious Weeds

To help protect the state's resources, the Washington State Noxious Weed Control Board (WD NWCB) adopts a State Noxious Weed List each year (WS NWCB 2004). This list categorizes weeds into three major classes – A, B & C - according to the seriousness of the threat they pose to the state or a region of the state. The Rock Creek watershed has 22 classified weed species. One is Class A, 19 are Class B, and two are Class C.

The governing agency in Oregon is the Oregon Department of Agriculture's Plant Division. The classification system for their Noxious Weed Control Program categorizes weeds into three major classes – A, B, & T - according to the seriousness of the threat they pose to the state, or a region of the state, and the quantity of the invasive plant. Gilliam County renews their noxious weed list once a year. It was last renewed in July 2004 and has 39 classified weed species: Class A = 17, Class B = 15 and Class T = 7 (Farrar, pers. comm., 2004). Sherman County also classifies invasive weeds based on the seriousness of threat and quantity, but they use an A, B, & C system. They review their weed list annually, and currently have 48 weed species: Class A= 20, Class B=11, Class C=17 (Asher, pers. comm.,2004).

Noxious weeds have one of the most degrading impacts on our native wetland and terrestrial habitats. They often out-compete native plant species and degrade wildlife habitat. They can also decrease the recreational and economic value of land. The focal habitats chosen all have noxious weeds that have already degraded or currently threaten what remains of these habitats. See Appendix D, table D.4.A and D.4.B C, D, E, & F for a complete list of weeds and class definitions for the Rock Creek watershed (WA.) and Sherman and Gilliam counties (OR.).

4.1.4 Focal Terrestrial/Wildlife Habitat Selection and Rationale

Subbasin wildlife planners emphasize an ecosystem approach to management through use of focal habitat types while including components of single-species, guild, or indicator species assemblages. This approach is based on the following assumption: a conservation strategy that emphasizes focal habitats at the subbasin scale is more desirable than one that emphasizes individual species.

By combining the “course filter” (focal habitats) with the “fine filter” (focal wildlife species assemblage) approach, subbasin planners believe there is a much greater likelihood of maintaining, protecting and/or enhancing key focal habitat attributes and providing functioning ecosystems for wildlife. This approach not only identifies focal habitats, but also describes the most important habitat conditions and attributes needed to sustain obligate wildlife populations within these focal habitats. Although conservation and management is directed towards focal species, establishment of conditions favorable to focal species also will benefit a wider group of species with similar habitat requirements.

To ensure that species dependent on given habitats remain viable, Haufler (2002) advocated comparing the current availability of the habitat against its historic availability (see**Table 8**). According to Haufler, this “coarse filter” habitat assessment can be used to quickly evaluate the relative status of a given habitat and its suite of obligate species. To ensure that “nothing drops through the cracks,” Haufler also advocated combining the coarse filter habitat analysis with a single species or “fine filter” analysis of one or more obligate species to further ensure that species viability for the suite of species is maintained.

The following rationale was used to guide selection of focal habitats (see **Figure 5** for an illustration of the focal habitat/species selection process):

- Identification of habitats that can be used to evaluate ecosystem health and establish management priorities at the subbasin level (course filter);
- Habitats that have experienced a dramatic reduction in acreage or quality within the subbasin (**Table 8** and **Table 9**).
- Habitats that are naturally sensitive and have likely undergone reduction in quantity and quality, although historical records may be lacking (riparian habitats).
- Other considerations included cultural, economical, ecological and special factors.

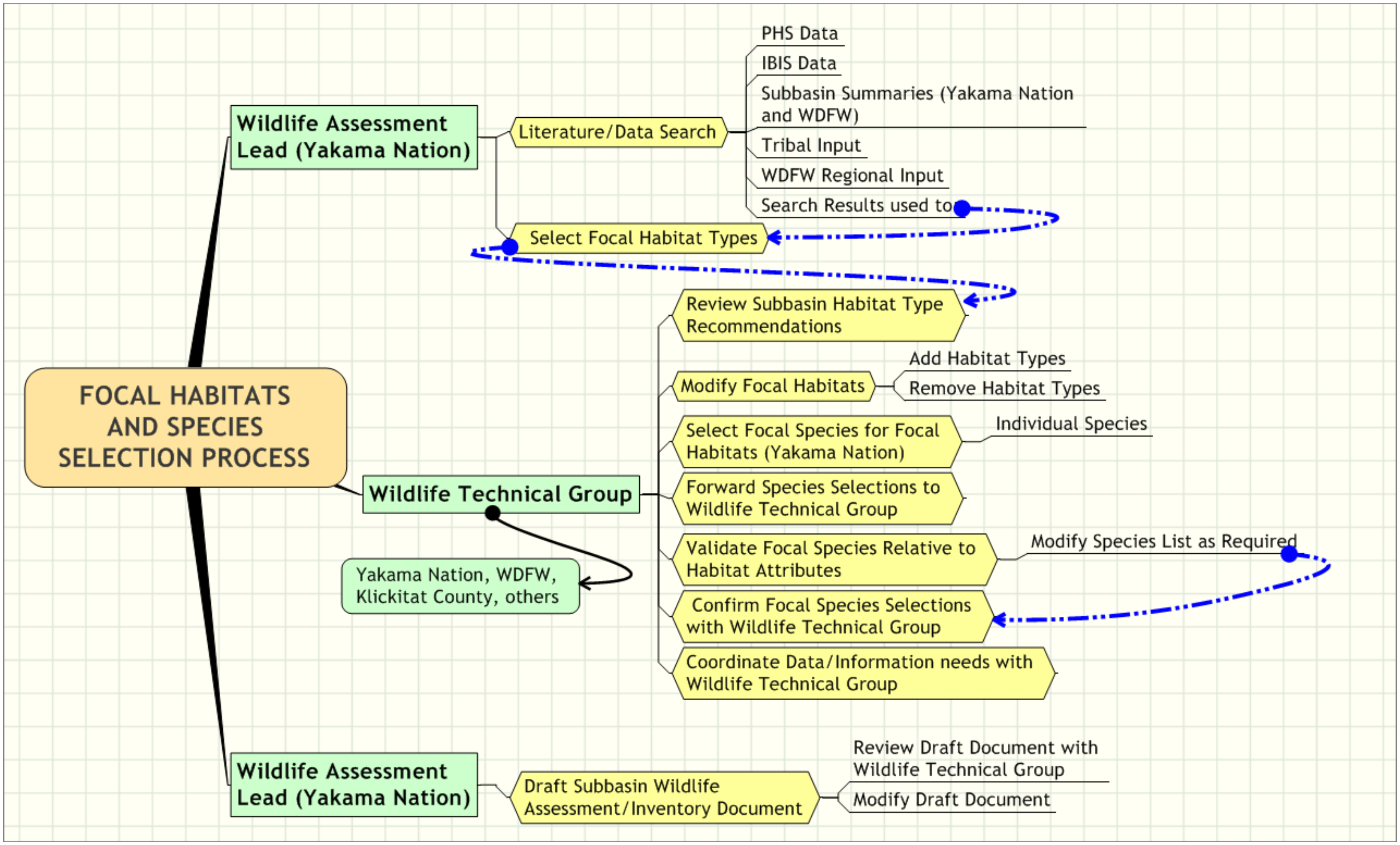


Figure 5 Washington and Yakama Nation focal habitat and species selection process summary (prepared by Paul Ashley, 2004)

Table 8 Changes in wildlife habitat types in the Lower Mid-Columbia Mainstem Subbasin from circa 1850 (historic) to 1999 (current) (IBIS 2003)

	STATUS (Acres)			
HABITAT TYPE	**Historic**	**Current**	**Change**	**Change (%)**
Montane Mixed Conifer Forest	unknown	5	N/A	N/A
Interior Mixed Conifer Forest	9,349	20,034	-10,685	114
Upland Aspen Forest	1,236	unknown	N/A	NA
Ponderosa Pine & Oregon White Oak Forest and Woodlands	67,856	120,017	+52,161	77
Western Juniper and Mountain Mahogany Woodlands	31,290	25,670	-5,620	18
Interior Canyon Shrublands	Unknown	437	N/A	N/A
Interior Grasslands	1,238,342	103,136	-1,135,206	92
Shrub Steppe	2,162,965	1,518,558	-644,407	30
Dwarf Shrub Steppe	741	unknown	N/A	N/A
Desert Playa and Salt Scrub Shrublands	17,795	unknown	N/A	N/A
Agriculture, Pastures	unknown	1,697,796	N/A	N/A
Urban	0	46,551	+46,551	999
Open Water - Lakes, Rivers, and Streams	94,005	112,125	+18,120	19
Herbaceous Wetlands	6,838	6,771	-67	1
Interior Riparian Wetlands	22,733	2,021	-20,712	91
Totals	3,653,150	3,653,121		

Note: A percent change value of 999 indicates a positive change from a historic value of 0 (habitat not believed to be present historically); N/A indicates change is unknown due to lack of historical data.

The IBIS riparian habitat data are incomplete. Therefore, riparian floodplain habitats are not well represented on IBIS maps (accurate habitat type maps, especially those detailing riparian wetland habitats, are needed to improve assessment quality and support management strategies/actions).

4.1.5 Focal Terrestrial/Wildlife Habitats for the Lower Mid-Columbia Mainstem Subbasin

Subbasin planners selected three focal wildlife habitat types from the 12 identified by Interactive Biodiversity Information System (IBIS) in for the subbasin. Subbasin focal habitats include: Interior Riparian Wetlands, Shrub Steppe/Interior Grasslands and Ponderosa Pine/Oregon White Oak. In the Oregon portion of the subbasin, only two habitat types are represented in the plan: Interior Riparian Wetlands and Shrub Steppe/Interior Grasslands. See **Figure 4** for an alternative GAP habitat map of the focal habitats. As with IBIS, riparian habitat is not mapped well.

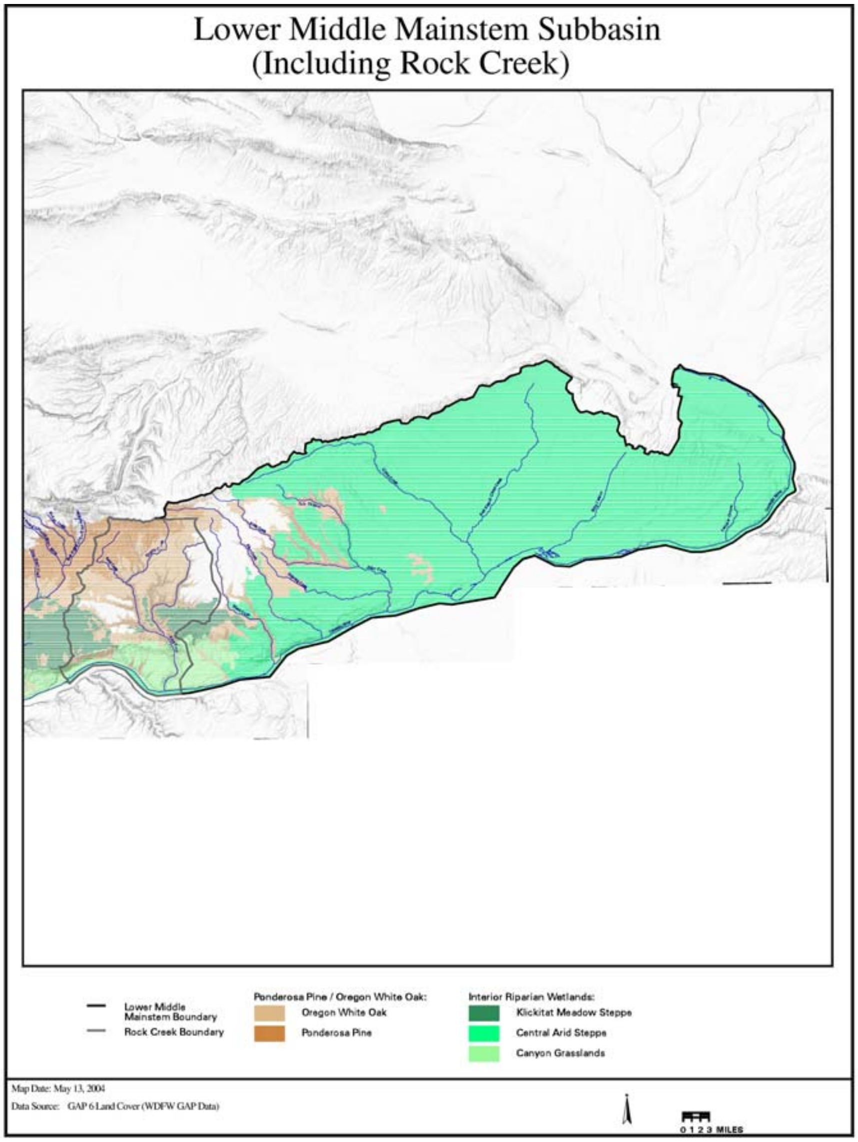


Figure 6 Range of two focal habitats (Ponderosa Pine/Oregon White Oak and Shrub Steppe/Interior Grasslands) in the Washington portion of lower mid-Columbia mainstem subbasin (Cassidy 1997)

Table 9 Focal habitat selection matrix for the Lower Mid-Columbia Mainstem subbasin

Habitat Type	Criteria						
	PHS Data	ECA Data	IBIS Data	Considerable loss in quantity	Considerable loss in quality	Listed in subbasin summary	Historically present in macro quantities[1]
Interior Riparian Wetlands	Yes	Yes	Yes	Likely, not mapped well	Yes	Yes	No
Shrub Steppe/Interior Grasslands	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ponderosa Pine/Oregon White Oak	No	No	Yes	Yes	Yes	Yes	No
Agriculture[2]	No	No	Yes	-	-	Yes	No

[1] Habitat types historically comprising more than 5% of the subbasin land base. This does not diminish the importance of various micro habitats.

[2] Agriculture is not a focal habitat; it is a habitat of concern. Focal species were not selected to represent this habitat type.

4.1.6 Focal Wildlife Species Selection and Rationale

The term focal species was defined by Lambeck (1997) as a suite of species whose requirements for persistence define the habitat attributes that must be present if a landscape is to meet the requirements for all species that occur there. The key characteristic of a focal species is that its status and trend provide insights to the integrity of the larger ecological system to which it belongs (USDA Forest Service 2000).

Subbasin planners refer to these species as "focal species" because they are the focus for describing desired habitat conditions, attributes and needed management strategies and/or actions. The rationale for using focal species is to draw immediate attention to habitat features and conditions most in need of conservation or most important in a functioning ecosystem. The corollary is those factors, which affect habitat quality and integrity within the subbasin, also impact the species, hence, the decision to focus on habitat with focal species in a supporting role.

Subbasin planners consider focal species' life requirements representative of wildlife habitat conditions or features that are important within a properly functioning focal habitat type.

Subbasin planners selected focal species using a combination of several factors including:

- Primary association with riparian or wildlife habitats for breeding;
- Specialist species that are obligate or highly associated with key habitat elements/conditions important in functioning ecosystems;
- Declining population trends or reduction in their historic breeding range (may include extirpated species);

- Cultural significance of the species, from a tribal and non-tribal perspective;
- Special management concern or conservation status such as threatened, endangered, species of concern, management indicator species, etc.; and
- Professional knowledge on species of local interest.

Subbasin planners identified a focal species assemblage and combined life requisite habitat attributes for each species assemblage to form a recommended “range of management conditions.” Fisheries and wildlife habitat managers will use the recommended range of riparian and wildlife habitat conditions to identify and prioritize future habitat restoration and protection strategies and to develop specific habitat management actions/measures for focal habitats.

Focal species can also serve as performance measures to evaluate ecological sustainability and processes, species/ecosystem diversity, and results of management actions (USDA Forest Service 2000). Monitoring of habitat attributes and focal species will provide a means of tracking progress towards conservation. Monitoring will provide essential feedback for demonstrating adequacy of conservation efforts on the ground, and guide the adaptive management component that is inherent in this approach.

4.1.7 Focal Wildlife in the Lower Mid-Columbia Mainstem Subbasin

A total of five bird species and three mammalian species were chosen as focal or indicator species to represent three priority habitats in the Lower Mid-Columbia Mainstem Subbasin (table 7). See Appendix C, table C.7 for an entire list of species associated with the focal habitats. Focal species selection rationale and important habitat attributes for each species are described in further detail in **Table 11**.

A number of watersheds on the Oregon side of the Lower Mid-Columbia Mainstem Subbasin border the John Day (Rock Creek) and Umatilla (Willow Creek, Eightmile Canyon, Six-mile Canyon, Juniper Grove, and their tributaries) subbasins and were included in these subbasin plans. Although some general information on focal wildlife habitats and species in Oregon were taken from the John Day and Umatilla subbasin plans, detailed information is included in these plans and is not replicated here.

It is important to note some differences in the selection of wildlife focal species for this plan and those selected for the Umatilla and John Day subbasin. Both the John Day and Umatilla plans include the sage sparrow and great blue heron as focal species to represent shrub-steppe and interior riparian wetlands, respectively. Although they were not selected as focal species for the Lower Mid-Columbia Mainstem Subbasin, they do occur here and detailed information on their life-history, distribution, status, and trends within the Columbia Plateau can be found in the John Day and Umatilla subbasin plans.

Table 10 Focal species selection matrix for the Lower Mid-Columbia Mainstem subbasin, Washington and Oregon

Focal Species (Common Name)	Focal Habitat	Priority Habitat Species	Partners in Flight Species	Game Species	Status[1]	
					Federal	State
Yellow Warbler	Interior Riparian Wetland	No	No	No	-	-
Lewis' Woodpecker		Yes	Yes	No	-	WC, OS
American Beaver		No	No	Yes	-	-
Mule/Black-Tailed Deer	Shrub Steppe/Interior Grassland	Yes	No	Yes	-	-
Grasshopper Sparrow		Yes	Yes	No	-	-
Brewer's Sparrow		No	Yes	No	-	-
White-Headed Woodpecker	Ponderosa Pine/Oregon White Oak	Yes	Yes	No	-	WC, OS
Western Gray Squirrel		Yes	No	No	-	WT, OE

[1]FC = Federal Candidate; WE = Washington Endangered; WT = Washington Threatened; WC = Washington Candidate; OE = Oregon Endangered; OT = Oregon Threatened; and OS = Oregon Sensitive,

Table 11 Focal species selection rationale and habitat attributes for the Lower Mid-Columbia Mainstem subbasin, Washington and Oregon

Focal Species	Focal Habitat	Life/Habitat Requisite	Conservation Focus	Habitat Attribute (Vegetative Structure)	Comments	Habitat Criteria for Selection
Yellow Warbler	Interior Riparian Wetlands	Reproduction	Subcanopy foliage, riparian habitat	> 70% cover in shrub and subcanopy w/ subcanopy > 40% of that, > 70% cover native species	Highly vulnerable to cowbird parasitism; grazing reduces understory structure	Riparian obligate, reproduces in riparian shrub habitat and makes extensive use of adjacent wetlands
Lewis' Woodpecker		Reproduction	Large cottonwood trees/snags	> .8 trees/acre > 21” dbh, canopy closure ≤ 30%, shrub cover ≥50%	Dependent on insect food supply, mast; competition from E. starlings detrimental	Dependent on insect food supply, mast
American Beaver		Food	Canopy closure	40-60% tree/shrub canopy closure trees, < 6” dbh; shrub height 6.6 ft.	Wetland and riparian shrub/forest habitat	Indicator of healthy regenerating cottonwood stands; important habitat manipulator
		Water (cover for food and reproductive requirements)	Permanent water	Stream channel gradient 6% with little to no fluctuation	Keystone species creating pools and standing water used by many species	
		Food	Shoreline development	Woody vegetation 328 ft. from water	Important tool in watershed and wetland restoration	
Brewer’s Sparrow	Shrub Steppe /Interior Grasslands	Breeding	Sagebrush cover, low exotic plant presence	Sagebrush cover 10-30%, sagebrush height > 64 cm, herbaceous cover > 10%, bare ground > 20%, non-native herbaceous cover < 10%	More abundant in areas of loamy soil than areas of sandy or shallow soil	Indicator of healthy sagebrush dominated shrub steppe w/ native cover, PIF species
Mule/Black-Tailed Deer		Winter forage	Ceanothus, Big sagebrush, antelope bitterbrush	30-60% canopy cover of preferred shrubs < 5 ft., number of preferred shrub species > 3, mean height of shrubs > 3 ft., 30-70% canopy cover of all shrubs < 5 ft.	Deer are important food source for predators and scavengers, agric. important suppl. food source	South facing slopes important in winter
Grasshopper Sparrow		Breeding	Vegetative complexity, large unbroken patches	Bunchgrass cover > 15% and > 25 cm tall, > 60% total grass cover and shrub cover < 10%	Vegetation type not as important as percent cover, require some bare ground	Indicator of healthy, native grasslands, Washington state candidate

Focal Species	Focal Habitat	Life/Habitat Requisite	Conservation Focus	Habitat Attribute (Vegetative Structure)	Comments	Habitat Criteria for Selection
White-Headed woodpecker	Ponderosa Pine/Oak Woodlands (Not present in Oregon part of subbasin)	All life stages, non migratory	Large patches of late seral forest with large trees and snags	> 10 trees/ac, > 21” dbh w/ > 2 trees > 31” dbh, 10-40% canopy closure, > 1.4 snags/ac > 8” dbh w/ > 50% > 25”, 250-500 acres suitable, unfragmented habitat	Weak primary excavator, needs well decayed snags for nesting. Needs open stand, canopy closure 30-50%	Obligate for large patches of healthy late seral ponderosa pine forest
Western Gray Squirrel		All life stages, non migratory	Oak and ponderosa pine forests	Acorns and other mast producing plants, important in winter, pine cones and seeds in summer	The core population of the western gray squirrel is currently found in the lower Klickitat drainage	Obligate for oak pine woodlands habitat. Mixed stands of oak and ponderosa pine preferred for nesting

4.2 Discussion of Focal Habitats and their Representative Focal Species

4.3 Interior Riparian Wetlands

Rationale For Selection

The Interior Riparian Wetlands wildlife habitat type was selected as a focal habitat because its protection, compared to other habitat types, may yield the greatest gains for fish and wildlife while involving the least amount of area (Knutson and Naef 1997). Riparian habitat covers a relatively small area yet it supports a higher diversity and abundance of fish and wildlife than any other habitat: it provides important fish and wildlife breeding habitat, seasonal ranges, and movement corridors; it is highly vulnerable to alteration; it has important social values, including water purification, flood control, recreation, and aesthetics; and, many species that primarily dwell in other habitat types, such as shrub steppe, depend on riparian areas during key portions of their life history. Interior Riparian Wetlands have suffered degradation and losses to hydrological function as well as fragmentation of habitat, which also fragments movement corridors for wildlife.

Description of Habitat

Historic

Since the arrival of settlers in the early 1800s, 50 to 90% of riparian wetland habitat in Washington State has been lost or extensively modified (Buss 1965). Prior to 1850, riparian habitats were found at all elevations and on all stream gradients; they were the lifeblood for most wildlife species with up to 80%of all wildlife species dependent upon these areas at some time in their lifecycle (Thomas 1979a).

These habitats are strongly influenced by stream dynamics and hydrology. Riparian forests require various flooding regimes and specific substrate conditions for reestablishment. Annual flood cycles occurred in most riparian wetland areas, although flood regimes varied among stream types. Hyporheic hydrology supported riparian wetland conditions considerable distances from perennial creek and river channels. Upwelling and downwelling groundwater dynamics created thermal conditions in wetland and spring brook areas conducive to wildlife use throughout the seasons. Fire typically influenced habitat structure in most areas, but was nearly absent in colder regions or on topographically protected streams. River meander patterns, ice and log jams, sediment dynamics and flood debris deposits provided spatial and temporal changes in habitat condition. Abundant beaver activity cropped younger cottonwoods (Black cottonwood, Populus balsamifera ssp. trichocarpa) and willows (Salix spp.), damming side channels. This activity influenced the vegetative, sediment, hyporheic and surface water dynamics creating diverse and complex habitat interactions.

In this subbasin, the density and diversity of wildlife in riparian wetland areas is also high relative to other habitat types. Riparian forest habitats are critical to the structure and function of rivers and to the fish and wildlife populations dependent upon them (Rood and Mahoney 1990). Healthy forested riparian wetland habitat has an abundance of snags and downed logs that are critical to many cavity nesting birds, mammals, reptiles and amphibians. Cottonwood, alder (Alnus spp.) and willow are commonly dominant tree species in riparian wetland areas from the

Cascades down through the valley portion of the sub basin. This habitat is often characterized by relatively dense understory and overstory vegetation. Riparian wetland habitats also function as travel corridors between, and provide connectivity to, other essential habitats (e.g., breeding, feeding, seasonal ranges).

Though riparian wetland habitats are often forested, they also contain important sub-components such as marshes and ponds that provide critical habitat for a number of wildlife species. Broad floodplain mosaics consisting of cottonwood gallery forests, shrub lands, marshes, side channels, and upland grass areas contain diverse wildlife assemblages. The importance of riparian wetland habitats is increased when adjacent habitats are of sufficient quality and quantity to provide cover for nesting, roosting, and foraging.

Riparian vegetation was restricted in the arid Intermountain West, but was nonetheless diverse. It was characterized by a mosaic of plant communities occurring at irregular intervals along streams and dominated singularly or in some combination by marshes, side channels, grass-forb associations, shrub thickets, and mature forests with tall deciduous trees. Common shrubs and trees in riparian zones included several species of willows, red-osier dogwood (*Cornus stolonifera*), alder, Wood's rose (*Rosa woodsii*), snowberry (*Symphoricarpos* spp.), currant (*Ribes* spp.), black cottonwood, water birch (*Betula occidentalis*), trembling aspen (*Populus tremuloides*), and peach-leaf willow (*Salix amygdaloides*). Herbaceous understories were very diverse, but typically included several species of sedges (*Carex* spp.) along with many dicot species. Marsh habitats contained tule (*Scirpus* spp.), common cattail (*Typha latifolia*), narrow-leaved bur-reed (*Sparganium angustifolium*), wapato (*Sagittaria latifolia*), water-plantain (*Alisma plantago-aquatica*), many species of submersed macrophytes (including sago pondweed (*Stuckenia pectinatus*), common hornwort (*Ceratophyllum demersum*), and greater bladderwort (*Utricularia vulgaris*), yellow waterlily (*Nuphar polysepalum*), and common watercress (Nasturtium officinale). Lower elevation wet meadows contained much of the vegetation found in their montane counterparts; including sedges, smartweeds (*Polygonum* spp.), spike rushes (*Scirpus* sp.), common camas (*Camassia quamash*), and wild onion (*Allium* spp.). Floodplain grasslands were dominated by great basin wild rye (*Elymus cinereus*), greasewood (*Sarcobatus vermiculatus*), and dogbane (*Apocnum* spp.).

Riparian areas have been extensively impacted within the Columbia Basin such that undisturbed riparian systems are rare (Knutson and Naef 1997). Losses in lower elevations include large areas once dominated by cottonwoods that contributed considerable structure to riparian habitats. In higher elevations, stream degradation occurred with the trapping of beaver in the early 1800s, which began the gradual unraveling of stream function that was greatly accelerated with the introduction of livestock grazing. Woody vegetation has been extensively suppressed by grazing in some areas, many of which continue to be grazed. The implications of riparian area degradation and alteration are wide ranging for bird populations, which utilize these habitats for nesting, foraging and resting. Secondary effects that have affected insect fauna have reduced or altered potential foods for birds as well.

Historic wetland acreage in this subbasin is difficult to measure. The IBIS riparian habitat data are incomplete; therefore riparian floodplain habitats are not well represented on IBIS maps. Landscape information such as that contained in floodplain maps can be consulted but was not done so for this assessment due to time constraints.

Current

Quigley and Arbelbide (1997) concluded that the cottonwood-willow cover type covers significantly less in area now than before 1900 in the Inland Pacific Northwest. The authors concluded that although riparian shrub land occupied only 2%of the landscape, they estimated it to have declined to 0.5%of the landscape. Approximately 40%of riparian shrublands occurred above 3,280 ft. in elevation pre-1900; now nearly 80%is found above that elevation.

Riparian and wetland conditions in this subbasin range from severely degraded to high quality. Roadway and development projects have constricted floodplains in some areas of the subbasin and reduced riparian wetland habitats. Riparian habitats are degraded in some places because of historical timber practices, removal of beaver, road construction, and inappropriate livestock grazing. Within the past 100 years, a large amount of this subbasin riparian wetland habitat has been altered, degraded, or destroyed. As in other areas of the Columbia Basin, impacts have been greatest at low elevations and in valleys where, agricultural conversion, road development, altered stream channel morphology, and water withdrawal have played significant roles in changing the character of streams and associated riparian areas.

Stresses

Natural systems evolve and become adapted to a particular rate of natural disturbances over long periods. Land uses alter stream channel processes and disturbance regimes that affect aquatic and riparian habitat (Montgomery and Buffington 1993). Anthropogenic-induced disturbances are often of greater magnitude and/or frequency compared to natural disturbances. These higher rates may reduce the ability of riparian and stream systems and the fish and wildlife populations to sustain themselves at the same productive level as in areas with natural rates of disturbance.

Other characteristics also make riparian wetland habitats vulnerable to degradation by human-induced disturbances. Their small size, topographic location, and linear shape make them prone to disturbances when adjacent uplands are altered. The unique microclimate of riparian and associated aquatic areas supports some vegetation, fish, and wildlife that have relatively narrow environmental tolerances. This microclimate is easily affected by vegetation removal within or adjacent to the riparian area, thereby changing the habitat suitability for sensitive species (Thomas et al. 1979a, O’Connell et al. 1993).

Factors affecting riparian wetlands in this subbasin are summarized in the paragraphs below, as well as in

Table 12. One or all of these factors has influenced riparian wetland habitat conditions throughout the subbasin in different ways depending on their location. Restoration plans for these habitats must take in to consideration the location of the habitats, the historic conditions under which they operated, the alterations that have occurred to impact their function, and the possibilities that currently exist to adequately address the stresses in a cost-effective manner.

Exclusion of the River from its Floodplain

Transportation ways (road and railroad) and levee development has restricted the floodplain in some areas. Land conversion from riparian wetland habitat to agricultural, residential, gravel mining, or recreational uses has also occurred behind the levees and roads. Riparian wetland restoration must take in to consideration the effects of restoration on lands that have been converted away from flooded habitats. Restoration priority should be given to protecting those areas that have not experienced floodplain exclusion and to areas within which floodplain reconnection is economically and culturally possible.

Alteration of Sediment Dynamics

Riparian wetland habitats are spatially and temporally dynamic. Floodplain processes creating and altering these habitats are largely dependent on cut and fill alluviation. The activities creating the altered hydrograph, the floodplain restrictions, the agricultural drainage of sediment-laden water into the waterways, the loss of green vegetation, and the reduction in woody debris have disrupted the sediment processes necessary for healthy riparian wetland conditions. Certain watersheds are experiencing increased sedimentation. Management actions often can correct alterations in sediment dynamics in localized areas. Priority should be given to projects that include the restoration of sediment processes.

Loss or Alteration of Riparian Wetland Vegetation

Vegetation loss and alteration is caused by multiple factors. All of the impacts listed above result in loss and alteration of riparian wetland vegetation communities. In areas unaffected or receiving little alteration by the factors listed above, vegetation alteration can also occur through heavy grazing or clearing. In areas that have experienced little hydrologic and landscape alteration, vegetation restoration may be as simple as reducing the grazing or vegetation removal practices. In situations where the hydrology or landscape has been altered in a significant manner, these impacts must be addressed if vegetation restoration is to be successful. Many riparian wetland vegetation reintroduction projects fail because the hydrologic impacts have not adequately been addressed. Priority should be given to projects that adequately address the reasons for vegetation loss or alteration.

Reduction in Large Woody Debris

Healthy riparian wetland habitats create large amounts of dead woody materials. Cottonwood gallery forests are famous for their ability to provide standing and downed snags. The processes mentioned above interact with this dead woody material to supply nesting and feeding opportunities for many fish and wildlife species. This material is responsible, as well, for influencing the floodplain dynamics, especially cut and fill alluviation, necessary for riparian wetland and cottonwood forest health. As cottonwood stands age, the large dead material produced will collect sediment, block side channels, and force the establishment of new channels. The new channels will create exposed gravel and sediment conditions upon which new cottonwood trees will become established. The result is a diverse mosaic of cottonwood stands of different ages within a floodplain area. Restoration of large woody debris, then, is dependent on the restoration of healthy cottonwood stands. This activity requires floodplain areas large enough to provide space for cottonwood stands of various ages. Restoration areas too small may experience declines in the health of the cottonwood forests as they age and are not replaced with new stands. Restoration priority should be given to projects large enough to provide sufficient floodplain conditions conducive to the continued development of healthy cottonwood forests.

Reduction of Beaver Activity

American beaver were central to the maintenance of healthy riparian wetland habitats. Their abundant activity created flooded conditions throughout the subbasin. A testimony to their abundance is reflected in the fact that the Pacific Northwest was revered for its fur trade. Extensive trapping is routinely listed as a major factor in their decline. Healthy beaver populations, however, are returning to many restoration areas in the lower portions of this subbasin. Beaver damage complaints often will increase in areas adjacent to restoration projects. Restoration managers must be prepared to address these affects if projects are to succeed in the long term. Priority should be given to projects that address the factors necessary to support healthy populations of beavers and to address the unintended impacts to adjacent lands.

Increase in Invasive Non-Native Vegetation

This subbasin is in no means an isolated area. Global markets and economies cause human interactions unheard of a century ago. Because of this, the introduction of vegetation from exotic locals increases every year. Habitat conversion in the intensively developed irrigated agricultural portions of the subbasin compounds the effects of these introductions. Weed management is becoming an increasingly important component of riparian wetland restoration and management. A list of noxious weed species occurring in this subbasin is included in Appendix D, table D.4.

To combat these invasive species, techniques must be used that fit the situation within which they are arising. A comprehensive, integrated approach to pest management involves many tools. One such tool is to restore current habitat conditions as close as possible to historic conditions. Restoring native plant species and habitat conditions often provides the best defense against infestation by exotic vegetation. Intensive weed control may be necessary to reestablish these native communities. Weeds are much more pervasive in the lower portions of the subbasin, but are increasing in the upper basin as well. Restoration projects should include, and give priority to activities that include credible, integrated plans to address exotic vegetation issues.

Human Disturbance

Fish and wildlife populations need habitats relatively free of human activity. The best habitat will not provide the needs of wildlife if the level of human disturbance is high. Restoration areas must balance the needs of the fish and wildlife with the needs of the local communities. Priority should be given to projects adequately addressing human disturbance issues.

Reduction in Anadromous Fish Populations

Many native wildlife species and habitats in this subbasin were dependent on the constant energy sources brought up from the ocean by the large anadromous fish runs. The loss of these fish runs caused a large reduction in energy entering the system, altering wildlife population dynamics.

Priority should be given to riparian wetland restoration activities that emphasize anadromous fish as well as wildlife benefits that promote an increase in the inter-specific interactions.

Table 12 Summary of potential effects of various land uses on riparian wetland habitat elements needed by fish and wildlife (Knutson and Naef 1997)

Potential Changes in Riparian Elements Needed by Fish and Wildlife	Land Use						
	Forest Practices	Agri-culture	Unmanaged Grazing	Urban-ization	Dams	Recreation	Roads
Riparian Habitat							
Altered microclimate	X	X	X	X		X	X
Reduction of large woody debris	X	X	X	X	X	X	X
Habitat loss/fragmentation	X	X	X	X	X	X	X
Removal of riparian vegetation	X	X	X	X	X	X	X
Reduction of vegetation regeneration	X	X	X	X	X	X	X
Soil compaction/ deformation	X	X	X	X		X	X
Loss of habitat connectivity	X	X	X	X		X	X
Reduction of structural and functional diversity	X	X	X	X		X	X
Stream Banks and Channel							
Stream channel scouring	X	X	X	X		X	X
Increased stream bank erosion	X	X	X	X	X	X	X
Stream channel changes (e.g., width and depth)	X	X	X	X	X	X	X
Stream channelization (straightening)	X	X		X			
Loss of fish passage	X	X	X	X	X		X
Loss of large woody debris	X	X	X	X	X	X	X
Reduction of structural and functional diversity	X	X	X	X	X		X
Hydrology and Water Quality							
Changes in basin hydrology	X	X		X	X		X
Reduced water velocity	X	X	X	X	X		
Increased surface water flows	X	X	X	X		X	X
Reduction of water storage capacity	X	X	X	X			X
Water withdrawal		X		X	X	X	
Increased sedimentation	X	X	X	X	X	X	X
Increased stream temperatures	X	X	X	X	X	X	X
Water contamination	X	X	X	X		X	X

4.3.1 Yellow Warbler (*Dendroica petechia*)

Rationale for Selection

The yellow warbler is a common native species strongly associated with riparian and wet deciduous habitats. The yellow warbler is a good indicator of functional subcanopy/shrub habitats in riparian areas. It is a locally common breeder along rivers and creeks in the Columbia Basin, where it is declining in some areas. Yellow Warblers are HEP species and occur on the Oregon PIF list. For these reasons, they were chosen as a focal species for the Interior Riparian Wetlands wildlife habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Partners in Flight (PIF) established the following biological objectives for this species in the lowlands of eastern Oregon and eastern Washington (Altman 2001):

- >70%cover in total cover {shrub (<3 m, 10 ft) and subcanopy (>3m, 10 ft) layers};
- Subcanopy layer contributing >40%of the total cover;
- Shrub layer cover 30-60%of total cover (includes shrubs and small saplings), height > 2m (6.5 ft;
- >70% cover should be native species, and
- Edge and small patch size (heterogeneity)

General

The yellow warbler is a riparian obligate species most strongly associated with wetland habitats and deciduous tree cover and is a good indicator of functional subcanopy/shrub habitats in riparian areas.

Yellow warbler abundance is positively associated with deciduous tree basal area, and bare ground. Abundance is negatively associated with mean canopy cover of Douglas-fir (Pseudotsuga menziesii), Oregon grape (*Berberis nervosa*), swordfern (*Polystuchum munitum*), blackberry (*Rubus discolor*), hazel (*Corylus cornuta*), and oceanspray (*Holodiscus discolor*) (Rolph 1998).

At the landscape level, the biological objectives for habitat included high degree of deciduous riparian heterogeneity within or among wetland, shrub, and woodland patches, and a low %age of agricultural land use (Altman 2001). Their habitat suitability index strongly associates them with a dense deciduous shrub layer 1.5-4 m. (5-13.3 feet), with edge, and small patch size (heterogeneity). Other suitability index associations include percent of deciduous shrub canopy comprised of hydrophytic shrubs (wetlands dominated by shrubs had the highest average of breeding densities of 2males/ha) and deciduous tree basal area (abundance is positively associated).

Negative associations are closed canopy and cottonwood proximity. Some nests have been found in cottonwood, but more often in shrubs with an average nest height of 0.9-2.4 m., maximum being 9-12 m. (Schroeder 1982).

Nesting

They are a common breeder in hardwood trees throughout Washington and Oregon at lower elevations. Breeding yellow warblers are closely associated with riparian trees, specifically willows, alders, aspen, or cottonwoods (Marshall et al. 2003). In Klickitat County, they are mostly confined to relatively dense riparian vegetation (Manuwal 1989). Optimal nesting habitat for the yellow warbler is provided in wet areas with dense, moderately tall stand of hydrophytic deciduous shrubs (Schroeder 1982).

Diet and foraging

The yellow warbler feeds mainly on insects. They are known to eat caterpillars, cankerworms, gypsy moths, bettles, and aphids, but the type and proportion of insects varies depending on location (Stokes 1996, Marshall et al. 2003).

Population Status and Trend

Core zones of distribution in Washington are the forested zones below the subalpine fir (*Abies lasiocarpa*) and mountain hemlock (*Tsuga mertensiana*) zones, plus steppe zones other than the central arid steppe and canyon grassland zones, which are peripheral. In Oregon, the yellow warbler is a common to abundant breeder on the east slope of the Cascades and in the Blue and Wallowa mountains below 5,000 feet (1,524 m). In other areas east of the Cascades, including the Columbia Plateau, they are common along watercourses, or to a lesser extent, in residential areas (Marshall et al. 2003).

Within the Washington State, yellow warblers are apparently secure and are not of conservation concern (figure 9). Information from Breeding Bird Surveys indicates that the population is stable in most areas. However, yellow warblers have shown population declines in various regions during well-defined time periods. Because the Breeding Bird Survey dates back only about 30 years, population declines in Washington resulting from habitat loss prior to the survey would not be accounted for by that effort.

In Oregon, Gabrielson and Jewett (1940) listed the yellow warbler as an "abundant summer resident throughout state" and common in every county. More recent Breeding Bird Surveys confirm an average population decline of 1.7% statewide between 1966-2000. A likely cause is the loss of riparian habitat to grazing and conversion to agriculture (Marshall et al. 2003). Most (>94%) of the riparian wetland habitat in the Umatilla/Willow subbasin is estimated to be under no or low protected status. Strategies aimed at increasing protection and enhancement by working with private landowners should be emphasized.

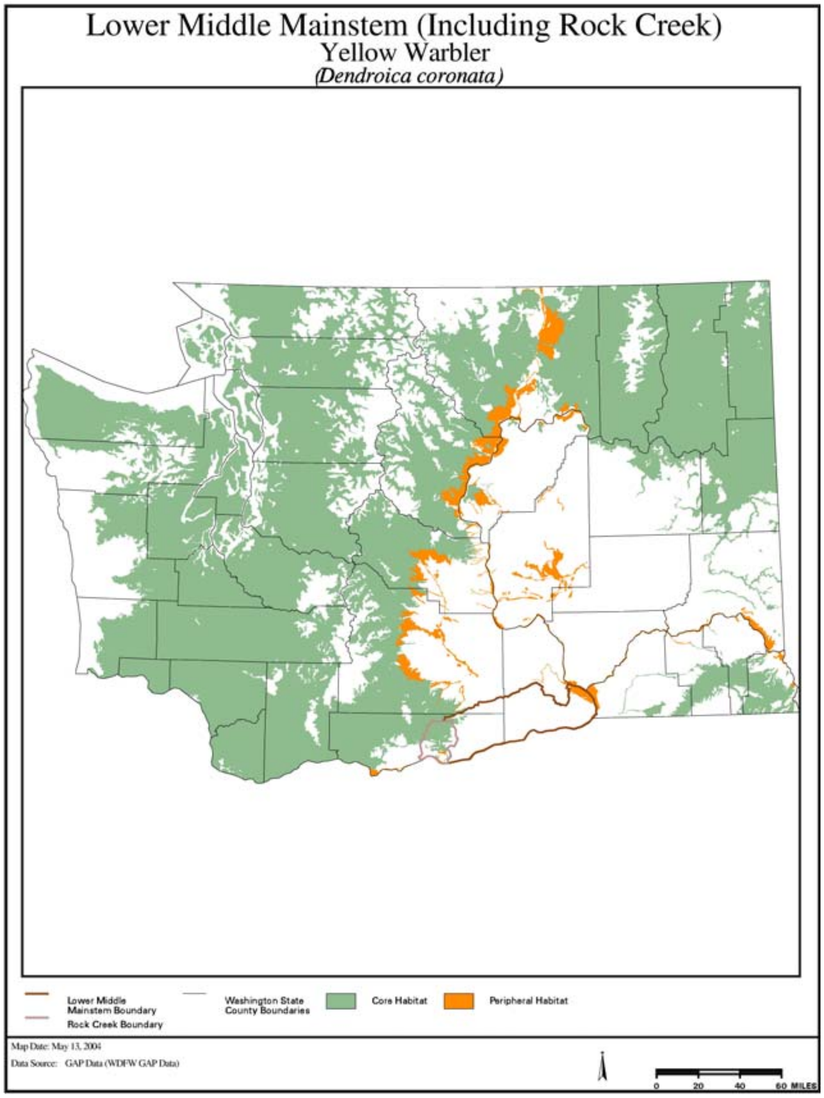


Figure 7 Potential habitat for yellow warblers in the Lower Mid-Columbia Mainstem (including Rock Creek) and Washington State (Smith et al. 1997)

They are most abundant in riparian areas in the lowlands of eastern Washington and Oregon. Numbers decline in the center of the Columbia Basin, but this species can be found commonly along most rivers and creeks at the margins of the Basin.

Management Issues

No specific yellow warbler management issues were identified in this subbasin.

Out-of-Subbasin Effects and Assumptions

The yellow warbler is a long-distance Neotropical migrant. Spring migrants begin to arrive in the Columbia River Basin in April; dates of 2 April and 10 April have been reported from Oregon and British Columbia, respectively (Gilligan et al. 1994, Campbell et al. in press). The peak of spring migration in the Lower Mid-Columbia mainstem occurs in mid- to late May (Marshall et al. 2003, Gilligan et al. 1994).

Fall migration is somewhat inconspicuous for the yellow warbler. Southward migration begins in late July (Oregon) and early August (Washington), and peaks in late August to early September; very few migrants remain in the region by late September and October (Marshall et al. 2003, Lowther et al. 1999). The yellow warbler winters from southern California, southwest Arizona, northern Mexico and the Bahamas south through Middle and South America to Peru, Bolivia and Brazil (Marshall et al. 2003).

In Yakima County, earliest arrival dates are in late April with most breeders present by mid- to late-May; by late July/early August numbers begin to decline and by early September most yellow warblers have migrated out of the county (Stepniewski 1998).

Poor riparian habitat and increased pesticide use are two negative effects Yellow Warblers may encounter as they migrate. Increased pesticide use in the metropolitan areas, especially with the outbreak of mosquito born viruses like West Nile Virus, may impact food availability.

Relationship with Riparian/Fisheries Issues

Healthy riparian vegetation is important to yellow warbler, and to other terrestrial and aquatic species as well. Riparian vegetation helps stabilize stream banks, reducing sedimentation input in the stream. Riparian vegetation also shades the stream keeping stream temperatures stable. The trees that yellow warbler need for nesting provide large woody debris when they die, increasing refugia for fish and other aquatic vertebrates and invertebrates. Riparian restoration that improves habitat for yellow warblers will also improve riparian aquatic and terrestrial habitat for other species including fish.

Factors Affecting Population

Habitat loss

Hydrological diversions and control of natural flooding regimes (e.g., dams), inundation from impoundments, cutting and spraying riparian woody vegetation for water access, gravel mining, and urban development have negatively affected yellow warblers in the subbasin.

Vegetation and Habitat degradation

Degradation of riparian habitat includes: loss of vertical stratification of riparian vegetation, lack of recruitment of young cottonwoods, ash (Sorbus spp.), willows, and other subcanopy species; stream bank stabilization which narrows stream channels, reduces the flood zone, and reduces extent of riparian vegetation; invasion of exotic species such as reed canary grass (Phalaris arundinacea) and blackberry; inappropriate grazing which can reduce understory cover; reductions in riparian corridor widths which may decrease suitability of the habitat and may increase encroachment of nest predators and nest parasites.

Presence of Development

Hostile landscapes, particularly those in proximity to agricultural and residential areas, may have high density of nest parasites (brown-headed cowbird, *Molothrus ater*) and domestic predators (cats), and be subject to high levels of human disturbance.

Recreational Disturbance

Recreational disturbances during nesting season, particularly in high-use recreation areas, may contribute towards nest abandonment.

Pesticide and Herbicide Use

The use of pesticides and herbicides associated with agricultural practices may reduce the warbler's insect food base.

4.3.2 American Beaver (*Castor canadensis*)

Rationale for Selection

American Beavers are an indicator of healthy riparian systems. Beavers are dependent on permanent riparian systems with consistent year round stream flow rates, adequate stream-side an in-stream vegetation and presence of in-stream downed woody debris. Beavers are also an important tool in maintaining and repairing properly functioning riparian systems. Because of their strong relationship with healthy riparian systems, they were chosen as a focal species for the Interior Riparian Wetlands wildlife habitat.

Summary

Recommended habitat objectives include the following:

- Permanent source of water (Slough and Sadleir 1977).
- Ability to build lodges:
- Mild or no annual or seasonal water level fluctuations (Murray 1961, Slough and Sadleir 1977),
- Slow water flow (Collins 1976b),
- Low stream channel gradient (Slough and Sadleir 1977, Williams 1965):
- Stream channel gradients of 6%or less have optimum value as beaver habitat; streams of 15%or more are uninhabitable (Retzer et al. 1956).
- Presence of food source:
- Herbaceous plants include aspen, willow, cottonwood, alder) (Denney 1952) and aquatic vegetation (Collins 1976a),
- Woody stems cut by beavers are usually less than 7.6 to 10.1 cm (3 to 4 inches) dbh (Bradt 1947, Hodgdon and Hunt 1953, Longley and Moyle 1963, Nixon and Ely 1969).

General

All wetland cover types (e.g., herbaceous wetland and deciduous forested wetland) must have a permanent source of surface water with little or no fluctuation in order to provide suitable beaver habitat (Slough and Sadleir 1977). Water provides cover for the feeding and reproductive activities of the beaver.

Lodge Building

Lodges and/ or burrows are built by beavers for cover (Rue 1964). Lodges may be surrounded by water or constructed against a bank or over the entrance to a bank burrow. Water protects the lodges from predators and provides concealment for the beaver when traveling to and from food gathering areas and caches.

The lodge is the major source of escape, resting, thermal, and reproductive cover (Jenkins and Busher 1979). Mud and debarked tree stems and limbs are the major materials used in lodge construction although lesser amounts of other woody, as well as herbaceous vegetation, may be used (Rue 1964). On lakes and ponds, lodges are frequently situated in areas that provide shelter from wind, wave, and ice action.

For beavers to build dams, there must be a low seasonal and annual water level fluctuations, slow water flow and a low stream channel gradient. In the lower mid-Columbia mainstem embayments are of special importance to beaver (and muskrats) because of the reduced water fluctuations. (Embayments are shallow water habitats typically connected to the mainstem Columbia River via culverts or small channels; water fluctuates less in most empayments than in the river because of culvert or inlet channel elevations. The magnitude of waves is also relatively low.)

Lakes and reservoirs that have extreme annual or seasonal fluctuations in the water level will be unsuitable habitat for beaver. Similarly, intermittent streams, or streams that have major fluctuations in discharge (e.g., high spring runoff) or a stream channel gradient of 14%or more, will have little year-round value as beaver habitat.

Diet and Foraging

Assuming that there is an adequate food source available, small lakes [< 8 ha (20 acres) in surface area] are assumed to provide suitable habitat. Large lakes and reservoirs [> 8 ha (20 acres) in surface area] must have irregular shorelines (e.g., bays, coves, and inlets) in order to provide optimum habitat for beaver.

Various factors, including the poor placement, construction and maintenance of road systems in the subbasin, have contributed to changes in stream channel morphology. Stream channels have become incised, secondary channels have been lost, and beaver access to floodplains has been reduced. These factors contribute and relate to a decline in the recruitment of aspen and cottonwood, both food sources for beaver. The loss of wetlands is an additional factor limiting beaver populations.

An adequate and accessible supply of food must be present for the establishment of a beaver colony (Slough and Sadleir 1977). The actual biomass of herbaceous vegetation will probably not limit the potential of an area to support a beaver colony (Boyce 1981). However, total biomass of winter food cache plants (woody plants) may be limiting. Low marshy areas and streams flowing in and out of lakes allow the channelization and damming of water, allowing access to, and transportation of, food materials. Steep topography prevents the establishment of a food transportation system (Williams 1965, Slough and Sadleir 1977).

Population Status and Trend

The American beaver is widespread in the Columbia Basin and can be found in suitable habitats throughout Washington (Verts and Carraway 1998) and Oregon (Johnson and O'Neill 2001). It is almost always associated with riparian or lacustrine habitats bordered by a zone of trees, especially cottonwood and aspen (*Populus*), willow (*Salix*), alder (*Alnus*), and maple (*Acer*) (Verts and Carraway 1998). Small streams with a constant flow of water that meander through relatively flat terrain in fertile valleys and are subject to being dammed seem especially productive of beavers (Hill 1982). Beaver distribution occurs from the Columbia River to mid-elevation forested regions (Kirsch, pers. comm., 2001).

Because of the high commercial value of their pelts, beavers figured importantly in the early exploration and settlement of western North America. Thousands of their pelts were harvested annually, and it was not many years before beavers were either exterminated entirely or reduced to very low populations over a considerable part of their former range. By 1910 their populations were so low everywhere in the United States that strict regulation of the harvest or complete protection became imperative. In the 1930s live trapping and restocking of depleted areas became a widespread practice which, when coupled with adequate protection, has made it possible for the animals to make a remarkable comeback in many sections (see map of current habitat and locations,**Figure 4**). Currently, the American beaver is a managed game species.

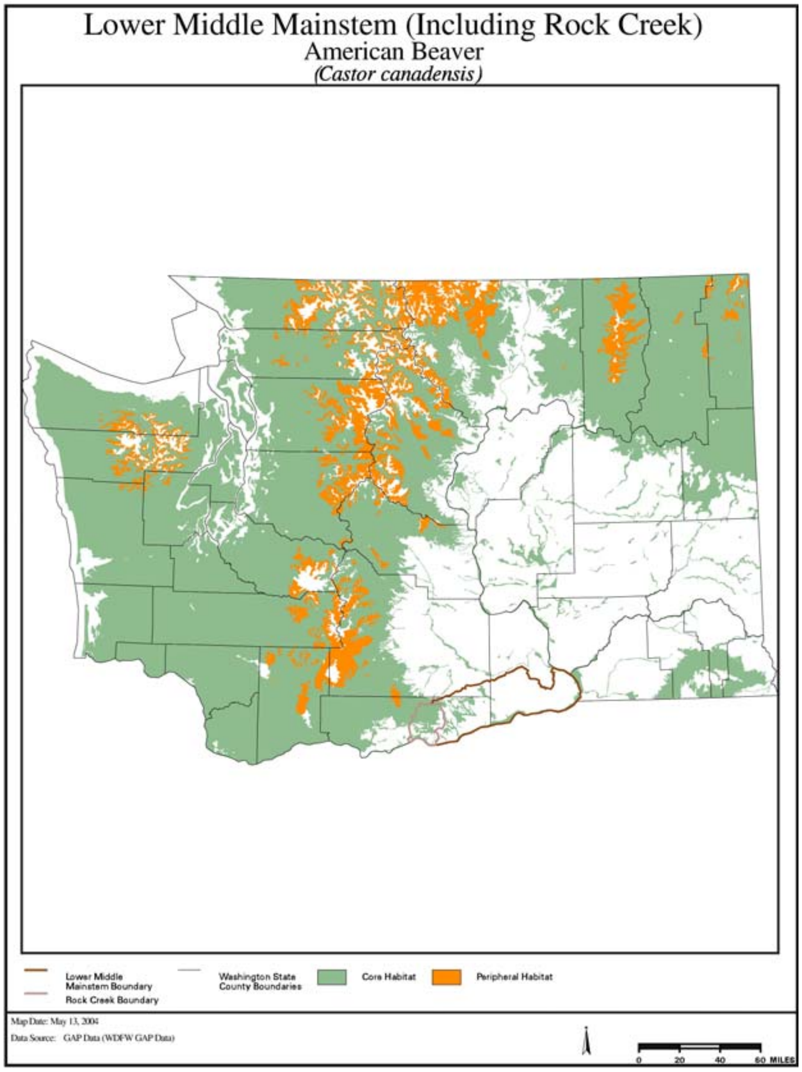


Figure 8 Potential habitat for American beavers in the lower mid-Columbia mainstem (including Rock Creek) and Washington (Johnson and Cassidy 1997)

Management Issues

Trapping removed almost all of the beaver from the subbasin. Once this happened, they were no longer available to provide activities necessary to maintain the early-successional habitats on which they depend. Without beaver, a cycle is broken and important ecosystem and riparian/wetland functions are lost. In upland riparian habitats, beavers are unable to re-colonize the area with restoration and management efforts.

Transplants do occur of “problem” beaver from lower elevation riparian areas to higher elevation riparian areas. Little documentation is available on when this occurs and whether transplanted beaver have been successful in living in their new locations. Research and organization of these transplants would be valuable. Transplanting beaver could also be used to assess the quality of riparian restoration efforts, as well as act as a tool in speeding up restoration efforts.

There are many other human activities that have implications to both beavers and their habitat (Cederholm et al. 2000). Some examples include timber activities, presence of roads and cattle grazing. Timber activities can fragment wildlife habitat. It can also decrease woody debris available to streams and increase sedimentation. High amounts of sediment can increase water temperature, making streams unsuitable for fish, amphibian and aquatic macroinvertebrate species. Roads fragment habitat and creating barriers to migrating species. Roads can also cause sediment increase and edge degradation. Grazing both degrades terrestrial and aquatic vegetation, impacting both wildlife and fish.

The American Beaver is a managed fur-bearing species in Oregon. ODFW's American Beaver Management Plan provides guidance for managing this species in the subbasin.

Relationship with Riparian/Fisheries Issues

Beavers have long co-existed with salmon (*Oncorhynchus* spp.) in the Pacific Northwest, and have had an important ecological relationship with salmon populations (Cederholm et al. 2000). The beaver created and maintained a series of beneficial aquatic conditions in many headwater streams, wetland, and riparian systems, which serves as juvenile salmon rearing habitat. Beavers have multiple effects on water bodies and riparian ecosystems that include altering hydrology, channel morphology, biochemical pathways, and stream productivity. This function, however, has been severely altered by people. It is difficult to imagine the amount of influence beavers have had on the landscapes, most Pacific Northwest streams had been void of beaver activity for many decades before ecologists had the opportunity to study them.

Beavers are extremely important in contributing to large woody debris, which is a critical structural component in streams. Large woody debris provides important structural complexity as well as vital nutrients to streams. Large woody debris and beaver dams decreases stream velocity and temperature. It also provides refugia to migrating fish.

Beaver dams can obstruct channels and redirect channel flow and the flooding of stream banks and side channels (Cederholm et al. 2000). Damming streams and creating ponds, beavers create habitats for aquatic species and raise water tables, resulting in wetlands (Johnson and O'Neill 2001). By ponding water, beaver dams create enhanced rearing and over-wintering habitat that protect juvenile salmon during high flow conditions. Beaver dams are often found associated with riverine ponds called "wall-base channels" along main river flood plains, and these habitats are used heavily by juvenile coho salmon (*Oncorhynchus kisutch*) and cutthroat trout (*Oncorhynchus clarki*) during the winter.

Factors Affecting the Population

Habitat Loss and Fragmentation

The lack of habitat and the loss of proper ecosystem and riparian functioning have hindered the natural re-colonization of beaver in this subbasin. Multiple factors have influenced the loss of habitat and riparian processes. The poor placement, construction, and maintenance of road systems in the subbasin, have contributed to changes in stream channel morphology. Stream channels have become incised, secondary channels have been lost, and beaver access to floodplains has been reduced. Beaver have also suffered high mortaliy from being hit by trains and cars because of the proximity of highways and railroads to the shoreline of the Columbia River.

Water fluctuations, waves, the inundation of habitat, and the alternating flooding and exposing of dens from hydropower development and operation also decreases beaver production. Only 19 of 43 den sites surveyed by Tabor et al. (1981) between The Dalles and Priest Rapids dams were considered suitable if predicted dam operations were achieved.

Food availability

Availability of food is a limiting factor. Degradation of streams contributes and relates to a decline in the recruitment of aspen and cottonwood. In winter, the amount of available winter food cache plants (woody plants) may be limiting (Boyce 1981). At lower elevations, riparian habitat along some waterways has been removed to plant agricultural crops, which removes important habitat and food sources for beaver.

Dam removal

Beavers create dams that restrict fish passage. These dams are then removed to restore fish passage.

Trapping

Historically, trapping removed beavers from the subbasin, resulting in the alteration of their riparian/wetland habitats. Currently, the American beaver is a managed game species.

4.3.3 Lewis' Woodpecker (*Melanerpes lewis*)

Rationale for Selection

The Lewis' woodpecker is listed as a species of concern in Washington State, a sensitive species in the state of Oregon, and is on the Oregon Partners in Flight list. They are considered to be an indicator of healthy cottonwood forest systems, and therefore are a focal species for the Interior Riparian Wetland wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives for Lewis' woodpecker in Interior Riparian Wetland habitat include the following:

- Adequate numbers of snags (1 or more of adequate size);
- Diameter at breast height (dbh) ≥ 30 cm (Thomas et al. 1979b);
- Optimal height ≥ 9.1 m (Thomas et al. 1979b), range used 1.5-51 m (Bock 1970);
- Tree canopy closure ≤ 30%(closure exceeding 75%is unsuitable), and
- Understory cover ≥ 50 %, not as vital in riparian habitats.

General

Lewis' Woodpecker typically inhabits dry open woods, orchards, farmlands, and foothills (Stokes 1996). Drought and overgrazing pose continued threats to riparian habitats in arid regions (Stokes 1996, Ehrlich et al. 1992).

Nesting

Lewis' woodpeckers prefer an open woodland canopy and large-diameter dead or dying trees. Tree species often used include ponderosa pine, cottonwood, Oregon white oak, juniper (*Juniperus* spp.), willow, and paper birch (*Betula papyrifera*). Of 53 nests found on the eastern edge of Mt. Hood, Oregon in 1989, the mean dbh of nest trees was 26 in (66cm) with a range of 12.5-43 in (31.8-109 cm), and the mean height of nest trees was 41 ft. (12.5 m) with a range of 10-100 ft (3-30 m) (Galen 1989).

At lower elevations, breeding habitat is provided by riparian cottonwood groves (Bock, pers. comm.). Riparian woodlands have been identified as important nesting habitat for Lewis' woodpeckers (Saab and Vierling 2001). Suitable conditions for breeding in these habitats are provided by the same structural features important in ponderosa pine forests, except that shrub cover is apparently not a critical habitat feature. Vierling (1997) found that Lewis' woodpecker nest in dead or decaying cottonwoods (*Populus deltoids*, not found in Washington) and located their nest holes an average of 11.1 m high in riparian habitat in Colorado. Nest trees selected are often taller and larger in diameter than surrounding trees not used for nesting (Vierling 1997).

Lewis' woodpeckers are considered weak excavators and rarely excavate their own nest cavity. They prefer to use nest holes previously excavated by other woodpeckers (Marshall et al. 2003) or to excavate nest cavities in soft snags or dead trees (Lewis et al. 2002).

Diet and Foraging

Lewis' Woodpeckers feed opportunistically on bountiful, convenient supplies of insects during spring and summer and on acorns and fruits during fall and winter. Their diet inclues crickets, ants, grasshoppers, flies, wasps, beetles, nuts, berries and orchard fruits (Marshall et al. 2003, Stokes 1996).

In deciduous cover types, the presence of shrubs is considered to add to the food value, but will not be limiting to food suitability. Although the reasons for such a difference in the importance of shrubs is unclear, it may be due to different feeding strategies in coniferous and burned habitats compared to riparian and oak habitats.

Population Status and Trend

Status

The current overall distribution in Oregon has not changed from historical patterns, but has become more spotty due to habitat deterioration. It is only common year round in the white oak-ponderosa pine belt east of Mt. Hood. It also breeds in low numbers in open habitat along eastern Oregon river and stream valleys (Marsahll et al. 2003). Lewis' woodpecker is present year round in the Columbia Basin, but is uncommon (ODFW 1993). It is a confirmed breeder in the southwest corners of Sherman and Gilliam counties and is possibly breeding in other portions of these counties (Marshall et al. 2003).

The Lewis' woodpecker has been included in the Audubon Society's Blue List since 1975 (Tate 1981). The list is intended as an early warning list of species exhibiting noncyclical population declines or range contractions. Competition for nest sites from starlings (*Sturnus vulgaris*) may be a possible cause of the decline. Along the Klickitat River, a nesting pair was found near milepost 11 on SR 142 just west of the river (Manuwal 1989).

Trends

According to the Interior Columbia Basin Ecosystem Management Project (ICBEMP), terrestrial vertebrate habitat analyses, historical source habitats for Lewis' woodpecker occurred in most watersheds of the three ERUs within our planning unit (Wisdom et al. in press). Within this core of historical habitat, declines in source habitats have been strongly reduced from historical levels, including 97% in the Columbia Plateau. Within the entire Interior Columbia Basin, overall decline in source habitats for this species was the greatest among 91 species of vertebrates analyzed (Wisdom et al. in press).

Lewis' woodpecker populations tend to be scattered and irregular and are considered rare, uncommon, or irregularly common throughout their range (see **Figure 9** for range in Washington State); local abundance may be cyclical or irregular (Tobalske 1997). Based on North American Breeding Bird Survey (BBS) data, numbers in the U.S. may have declined more than 60%overall between the 1960s and mid-1990s (Tobalske 1997). BBS data indicate a significant decline in the United States for the period 1966-1996 (-3.3%average annual decrease; P = 0.01; N = 62 survey routes) and a nonsignificant declining trend between 1980 and 1996 (-1.7 %; P = 0.22; N = 53). Thirty-year trends were negative but not statistically significant survey-wide and for the Western BBS Region and California; likewise trends were positive but not statistically significant for these analysis areas from 1980 to 1996. Mapped trends for 1966-1996 show steep declines throughout the range. Overall, however, BBS sample sizes are relatively low for robust trend analysis (Sauer et al. 1997).

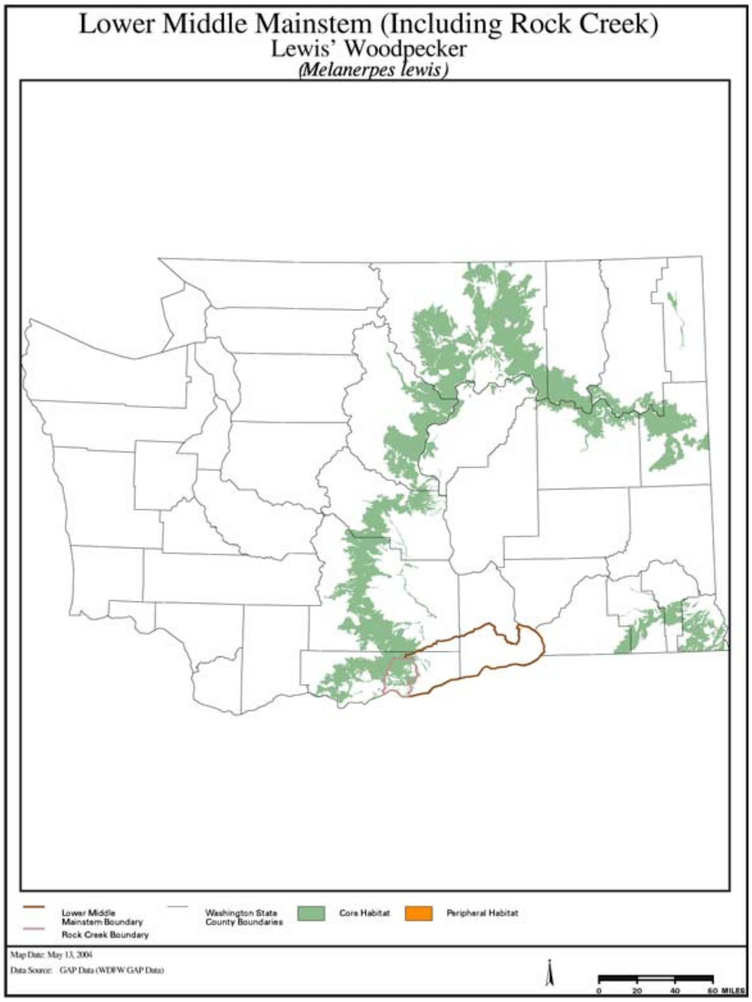


Figure 9 Potential habitat for Lewis' woodpecker in the Lower Mid-Columbia Mainstem subbasin and Washington (including Rock Creek) (Smith et al. 1997)

Oregon has also experienced a substantial decrease in Lewis' woodpecker since the mid-1960s. The decrease has been attributed to the destruction of lowland oak habitat and competition with the European Starling (Marshall et al. 2003).

Lewis's woodpeckers appear to be common near Lyle, Washington, based on annual Christmas Bird Counts (CBCs) of 61 birds from 1997 to 2001. In the Columbia Hills-Klickitat Valley CBC circle, a mean of 19/year were counted between 1996 and 2001. Although numbers were highly variable in both counts, there were no apparent decreases in populations during the time period that surveys were conducted (Hansen 2002).

Relationship with Riparian/Fisheries Issues

Healthy riparian vegetation is important to Lewis' woodpecker, and to other terrestrial and aquatic species as well. Riparian vegetation helps stabilize stream banks, reducing sedimentation input in the stream. Riparian vegetation also shades the stream keeping stream temperatures stable. The trees that Lewis' woodpecker need for nesting provide large woody debris when they die, increasing refugia for fish and other aquatic vertebrates and invertebrates. Riparian restoration that improves habitat for Lewis' woodpecker will also improve riparian aquatic and terrestrial habitat for other species including fish.

Out-of-Subbasin Effects and Assumptions

The Lewis's woodpecker is highly migratory during the non-breeding season. The bird winters in milder locations extending from northern Oregon south to northern Mexico and west Texas. In Oregon, it winters in oak savannah east of Mt. Hood, the upper Rogue River valley, and along Bear Creek near Medford. Winter populations are highly dependent on acorns and often migrate in large numbers to locations with acorn crops (Marshall et al. 2003).

Large mature cottonwoods, as for breeding habitat, are important for winter activities (Vierling 1997). Because the habitat needs of Lewis' woodpeckers are more specialized in winter than during the breeding season, destruction of winter range represents a greater potential threat to the species than loss of breeding habitat (Bock, pers. comm.).

Factors Limiting Population

Alteration of Hydrology

Alteration of stream flows from their natural state has virtually eliminated the natural reproduction of cottonwoods in eastern Washington. Cottonwoods require just the right combination of exposed streambed and moisture conditions for their seeds to germinate. Regulation of water levels for irrigation, fish production, and flood control limits these conditions, thereby almost eliminating germination. Without the incorporation of new trees, many cottonwoods continue to age and die with little or no recruitment to replace them. Thus, nest sites for Lewis' woodpeckers within low elevation riparian habitat will continue to decline overtime.

Land Conversion and Development

Lewis woodpecker habitat continues to be lost to ongoing urban, rural, and agriculture development which often occurs in or near riparian areas. Human development also favors the proliferation of exotic species and aggravates inter-species relationships. The Lewis woodpecker experiences heavy competition for nest sites with European Starlings. In the Columbia Basin, over 50% of the land inhabited by Lewis' woodpecker is privately owned (ODFW 1993), suggesting that strategies should emphasize increased protection and enhancement by working with private landowners.

Inappropriate Grazing

Grazing, although historically common within riparian areas of the intermountain west, may reduce the grass and forb components of riparian habitats. This may reduce populations of insect prey depended on by Lewis' woodpeckers during the breeding season.

4.3.4 Interior Riparian Wetlands Key Findings, Limiting Factors, and Working Hypotheses

Table 13 Key findings, limiting factors and working hypotheses for the Interior Riparian Wetlands focal habitat and its representative focal species

INTERIOR RIPARIAN WETLANDS HABITAT		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat has suffered degradation and loss of hydrological function.	Overall Loss of Riparian Vegetation	Properly managed grazing in riparian areas will help reduce the damage to riparian understory vegetation, which will in turn avoid the narrowing of stream channels and reverse increases in water temperature.
	Reduction in Floodplain Acreage	In riparian habitat, restoring habitat on abandoned roads or railroads and relocating problematic roads would allow for wider floodplain zones, decrease stream bank erosion, decrease sediment, and decrease disturbance to nesting species.
	Displacement of Native Riparian Vegetation with Non-native Vegetation	Reduction of acres dominated by invasive non-native plant species will help improve riparian habitat conditions for focal species and overall riparian habitat viability.
	Incised Stream Reaches	Restoring stream channels in selected reaches will allow for hydrologic reconnection into wetland habitats.
	Upper Watershed Hydrologic Alteration	Appropriate silvicultural practices that maintain and enhance riparian habitat will decrease sediment discharge and maintain bank stabilization.
	Loss of Stream Complexity and Increased Flows	Appropriate silvicultural practices that maintain and enhance riparian habitat will increase presence of large woody debris in streams. This will increase both fish and wildlife focal species presence and population sizes.
Habitat has suffered loss and fragmentation, removing corridors necessary for wildlife movement.	Loss of Riparian Habitat and Function	Restoring and maintaining riparian habitat will provide corridors used by wildlife as well as habitat and forage. This will also retain water storage availability of riparian terrestrial habitat for release in drier seasons.
	Fragmentation of Habitat	
INTERIOR RIPARIAN WETLANDS FOCAL SPECIES		
Yellow Warbler		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat loss and degradation has negatively affected yellow warblers in the subbasin.	Reduction in Floodplain Acreage	Identifying critical habitat, inventorying habitat remaining in Washington and Oregon, and monitoring habitat changes, both locally and at a landscape level, will increase the

INTERIOR RIPARIAN WETLANDS HABITAT		
Key Findings	**Limiting Factors**	**Working Hypotheses**
	Overall Habitat Loss	effectiveness future management and protection of yellow warblers and reduce loss of habitat due to limiting factors.
	Fragmentation of Habitat	
	Reduced Base	Decrease misuse of herbicides and pesticides in riparian areas will decrease mortality of food base of key species.
American Beaver		
Key Findings	**Limiting Factors**	**Working Hypotheses**
American Beavers are unable to reestablish into many historical locations due to habitat fragmentation, loss and degradation.	Fragmentation of Habitat	Reestablishing corridors of movement would help enable beaver to reestablish themselves in historical locations.
	Overall Loss of Riparian Vegetation	Restoration of riparian vegetation would increase food availability and quality for beaver, increasing survivorship and reestablishment efforts.
American Beavers have disappeared throughout many riparian systems they were once found in due to historical trapping for their pelts.	Reduction in Floodplain Acreage	Increasing beaver presence to historic level would help restore hydrological function to floodplains.
Lewis' Woodpecker		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Loss of large cottonwoods and cottonwood recruitment along riparian edges has decreased nesting sites for Lewis' woodpecker	Reduction in Floodplain Acreage	Restoration efforts that repair natural stream hydrology will increase recruitment of cottonwoods in riparian habitat and increase available breeding locations for Lewis' woodpecker.
Riparian habitat degradation and fragmentation has decreased presence and numbers of Lewis' woodpeckers in their historical range.	Fragmentation of Habitat	Decreasing fragmentation of riparian habitat by decreasing future conversion of riparian habitat will preserve habitat currently used by Lewis' woodpecker.
	Overall Loss of Riparian Vegetation	Properly managed grazing will decrease loss of native understory and prey base for Lewis' woodpecker increasing breeding success and hatchling survivorship.
	Reduced Food Base	Decrease misuse of herbicides and pesticides in riparian areas will decrease mortality of food base of key species.

4.4 Shrub Steppe/Interior Grasslands

Rationale for Selection

Shrub steppe and interior grasslands were selected as a focal habitat because changes in land use over the past century have resulted in the loss of over half of these once expansive habitat types in eastern Washington and Oregon. Adequate mapping data illustrating where these two types exist within the subbasin does not exist. Therefore, the interior grassland type was combined with the shrub steppe type into the Shrub Steppe/Interior Grassland wildlife focal habitat for this plan.

Shrub Steppe

Shrub-steppe habitats are common across the Columbia Plateau of Washington and Oregon. It extends up into the cold, dry environments of surrounding mountains. Basin big sagebrush shrub-steppe occurs along stream channels, in valley bottoms and flats throughout eastern Oregon and Washington. Wyoming sagebrush shrub-steppe is the most widespread habitat in eastern Oregon and Washington, occurring throughout the Columbia Plateau and the northern Great Basin. Mountain big sagebrush shrub-steppe habitat occurs throughout the mountains of the eastern Oregon and Washington. Interior shrub dunes and sandy steppe and shrub-steppe habitat is concentrated at low elevations near the Columbia River (Crawford and Kagan 1998-2003).

Shrub-steppe habitat defines a biogeographic region and is the major vegetation on average sites in the Columbia Plateau, usually below Ponderosa Pine Forest and Woodlands, and Western Juniper and Mountain Mahogany Woodlands habitats. It forms mosaic landscapes with these woodland habitats and Eastside Grasslands, Dwarf Shrub-steppe, and Desert Playa and Salt Scrub habitats. Livestock grazing is the primary land use in the shrub-steppe although much has been converted to irrigation or dry land agriculture. Elevation range is wide (300-9,000 ft [91-2,743 m]) with most habitat occurring between 2,000 and 6,000 ft (610-1,830 m). Habitat occurs on deep alluvial, loess, silty or sandy-silty soils, stony flats, ridges, mountain slopes, and slopes of lake beds with ash or pumice soils (Crawford and Kagan 1998-2003).

Much of the shrub-steppe habitat has been eliminated or fragmented since the arrival of European settlers. Homesteads, livestock grazing, and conversion to farmland have eliminated native vegetation and facilitated invasion of non-native species such as cheatgrass, Russian thistle, and Jim Hill mustard *Sisymbrium altissimum*. Poor land use practices exacerbated problems with soil erosion as well, further reducing native vegetation. Approximately 55% of grassland habitat and 87% of shrub-steppe habitat have been lost due to irrigated and dryland agricultural conversion, or to inundation of the Columbia River and associated urban expansion (Ward 2001). In the Washington portion of the basin, over 60% of the native shrub-steppe has been lost or highly fragmented (Washington Department of Fish & Wildlife, WDFW, unpublished data).

The Boardman/BAIC/Horn Butte site in Oregon contains the best remaining examples of sandy bunchgrass habitats and open sand dune habitats in the Columbia River Basin. It also has the best quality remnants of sagebrush / bluebunch wheatgrass, Palouse bunchgrass steppe, as well as the only high quality remnant of bitterbrush / bunchgrass steppe habitat in Oregon. It includes most of the habitat in Oregon for the Washington ground squirrel and several endemic plants.

Collectively, the site includes approximately 36,000 ha of native steppe and shrub-steppe habitat Ward 2001).

The Boeing Agricultural Industrial Company (BAIC) holds a 40-year agricultural and industrial lease over 40,000 ha of State of Oregon land located adjacent to the Boardman Bombing Range. BAIC subleases a portion of the property for agricultural purposes to Inland Land Company, LLC, and R.D. Offut Company--NW, which irrigate and farm the property. Approximately 10,000 ha on the BAIC leased lands still support high quality shrub-steppe and steppe habitat. Recently, water rights for existing and increased irrigation have been challenged, and settlements requiring mitigation have been negotiated that may provide an opportunity to protect the native-habitats portion of the leased lands (Ward 2001).

Shrub steppe communities support a wide diversity of wildlife. The loss of once extensive shrub steppe communities has reduced substantially the habitat available to a wide range of shrub steppe-associated wildlife, including several birds found only in this community type (Quigley and Arbelbide 1997, Saab and Rich 1997). More than 100 bird species forage and nest in sagebrush communities, and at least one of them (Brewer's sparrow) is an obligate in this subbasin (Braun et al. 1976). In a recent analysis of birds at risk within the interior Columbia Basin, the majority of species identified as of high management concern were shrub steppe species (Vander Haegen et al. 1999). Moreover, over half these species have experienced long-term population declines according to the Breeding Bird Survey (Saab and Rich 1997).

Interior Grasslands

Land use practices in the past 100 years have reduced grassland habitat by 97 %. This habitat type is found primarily in the Columbia Basin Oregon, and Washington, at mid- to low elevations and on plateaus in the Blue Mountains, usually within the ponderosa pine zone in Oregon. Within the subbasin, this habitat type historically occurred at the transition zone between shrub steppe and forest and where fires killed shrubs within the shrub steppe. Despite its importance as a wildlife habitat it was limited in distribution within the subbasin historically. Modern altered fire intervals and conversion into agriculture have converted large portions of remaining shrub steppe into grassland habitat.

Description of Habitat

Historic

Historic vegetation patterns can only be inferred from sites thought to resemble historic conditions. Several shrub and grass associations were commonly interspersed with one another forming a diverse floral mosaic. The combination of elevation, aspect, soil type, and proximity to surface and/or ground water contributed to the vegetation potential of a site. Fire was likely the primary disturbance factor with intervals ranging between 50 and 100 years (Stinson et al. 2004); large mammals such as Rocky Mountain elk (*Cervus elaphus nelsoni*), small mammals such as ground squirrels (*Spermophilus* sp.), mass wasting, and flooding in perennial and ephemeral streams probably contributed secondary localized disturbance roles. Shrubs and perennial bunchgrasses co-dominated with a micro-biotic crust of lichens, mosses, green algae, and micro-fungi on the surface of the soil (Belnap et al. 2001). Biotic crusts are critical for binding soil particles together protecting the soil from wind and water erosion, fixing nitrogen, accumulating nutrients used by vascular plants, and out competing invasive species (Stinson et al. 2004).

Estimates for historic shrub cover at undisturbed sites vary between 5 and 30% (Daubenmire 1970, Dobler et al. 1996, Crawford and Kagan 2001). Perennial bunchgrass cover was estimated to vary between 69-100% (Daubenmire 1970).

The dominant shrub-grass association was Antelope bitterbrush (*Purshia tridentata*) and bluebunch wheatgrass (*Agropyron spicata*) (Daubenmire 1970). Scattered throughout this dominant cover type were many other bunchgrasses including Sandberg's bluegrass (*Poa secunda*), needle and thread (*Stipa comata*), Thurber's needle grass (*Stipa thurberina*), Idaho fescue (*Festuca idahoensis*), Indian rice grass (*Achnatherum hymenoides*), squirreltail (*Elymus elymoides*) and Cusick's bluegrass (*Poa cusickii*). Scattered shrubs also included two rabbitbrush species (*Chrysothamnus viscidiflorus* and *Chrysothamnus nauseosa*), short-spine horsebrush (Tetradymia spinosa), spiny hopsage (*Grayia spinosa*), rigid sagebrush (*Artemesia rigida*), basin sagebrush (*A. tridentata tridentata*) and three-tip sagebrush (*A. tripartita*) (Crawford and Kagan 2001).

Most of these shrub species had their own unique association with one or more bunchgrasses and dominated a portion of the landscape. For example, at higher elevations and north facing slopes three-tip sagebrush and Idaho fescue was the dominant association. On ridge tops where shallow soils (i.e., basaltic lithosols) were common, rigid sagebrush and Sandberg's bluegrass and/or bluebunch wheatgrass dominated. Rabbitbrush was common in areas where fires had recently burned. Within the shrub steppe landscape there also were alkaline adapted community types, usually associated with drainage bottoms, perennial and ephemeral streams, or seeps and springs.

A diversity of flowering herbaceous plants, known as forbs, were present with these shrub-bunch grass associations. Perennial forb species included several balsamroots (e.g., *Balsamorrhiza careyana, B. hookeri, B. sagitata*), milkvetches (e.g., *Astragalus columbianus, A. spaldingii*), desert parsleys (e.g., *Lomatium triternatum, L. gormanii, L. canbyi*) and burrow weed (*Hyplopopus bloomer*)(Daubenmire 1970).

Sagebrush/bunchgrass obligates within the subbasin included Brewer's sparrow (*Spizella breweri*) and the sagebrush vole (*Lemmiscus curtatus*). Other shrub steppe species include Rocky Mountain mule deer (*Odocoileus hemionus hemionus*)/Columbian black-tailed deer (*Odocoileus hemionus columbianus*), short-eared owl (*Asio flammeus*), loggerhead shrike (*Lanius ludovicianus*), lark sparrow (*Chondetes grammacus*), grasshopper sparrow (*Ammodramus leconteii*), western rattlesnake (*Crotalus viridis*), short-horned lizard (*Phrynosoma douglasii*), and the great basin spadefoot (Scaphiopus intermontanus).

A decade or more is required for big sagebrush to recolonize depending on fire severity and season, seed, rain, postfire moisture, and plant competition (Crawford and Kagan 2001); whereas three-tip sagebrush is a late seral species that reestablishes (from seeds or commonly from sprouts) within 5-10 years following a disturbance (Crawford and Kagan 2001).

Ephemeral wetlands have historically been an important feature of shrub steppe. There is very little literature on this landscape feature, but many bird species have been observed using these wetlands (D. Lichtenwald, pers. comm.) and arid species such as the great basin spadefoot are known to breed in these temporary pools (Leonard et al. 1993). Further study of these wetlands is needed to determine their importance to this subbasin.

Current

Shrub Steppe

Shrub-steppe habitat still dominates most of southeastern Oregon although half of its original distribution in the Columbia Basin has been converted to agriculture (Crawford and Kagan 1998-2003). The pattern of agricultural conversion has resulted in a disproportionate loss of deep soil communities not reflected in typical measures given for habitat loss (Vander Haegen et al. 2000). Alteration of fire regimes, fragmentation, livestock grazing, and the addition of >800 exotic plant species have changed the character of shrub-steppe habitat. Quigley and Arbelbide [181] concluded that Big Sagebrush and Mountain Sagebrush cover types are significantly smaller in area than before 1900, and that Bitterbrush/Bluebunch Wheatgrass cover type is similar to the pre-1900 extent. They concluded that Basin Big Sagebrush and Big sagebrush-Warm potential vegetation type's successional pathways are altered, that some pathways of Antelope Bitterbrush are altered and that most pathways for Big Sagebrush-Cool are unaltered. Overall this habitat has seen an increase in exotic plant importance and a decrease in native bunchgrasses. More than half of the Pacific Northwest shrub-steppe habitat community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Crawford and Kagan 1998-2003).

The Biological Resources Division of the U.S. Geological Service has identified native shrub and grassland steppe in Oregon and Washington as an endangered ecosystem, with an 85-90% decline in habitat acreage (Noss et al. 1995). An estimated 10.4 million acres of shrub-steppe existed in Washington prior to the 1800s of which approximately 40% remains (Dobler et al. 1996). Ask Jimmy Kagan. In Klickitat County, WA., 60,168 acres are enrolled in the U.S. Department of Agriculture's Conservation Reserve Program (CRP) and in Oregon, 67,255 and 81,72 acres are enrolled in Gilliam and Sherman counties, respectively (as of: 9/30/04) (USDA-FSA 2004).

Most of the shrub steppe in Klickitat County is owned by agricultural producers and livestock ranchers. The State of Washington owns and manages several smaller but key parcels as well. Shrub steppe included in cropped private land tends to be fragmented into relatively small patches (Dobler et al. 1996). There are a few exceptions where relatively large (<12,000 acres) shrub steppe parcels exist in close proximity to public land. They are usually associated with steep topography such as on ridges that were historically not productive for cultivation. A redeeming quality is they remain mostly intact and, at a minimum, act, as wildlife (e.g., elk, mule deer) corridors for dispersal between public lands with a mixed quality of management. For example, wildife originating on the Klickitat Wildife Area, owned by WDFW, must cross private land to access the Simcoe Mountains and Grayback wildlife area to the North.

Stresses

Altered fire regimes

Fire alone is capable of setting back to a seral stage many sagebrush-steppe dependent species from the subbasin. Not only does wildfire kill sagebrush it may open the community to expansion of invasive alien species such as cheatgrass (*Bromus tectorum*), and knapweeds, especially on south facing slopes. North facing slopes of ridges appear to be more resilient to invasion following fire probably because of cooler microclimates. Cheatgrass can germinate when some native bunchgrasses are dormant during the cold season. Native bunchgrasses, including Sandberg and Big Bluegrass compete effectively with Mediterranean annuals. South facing slopes tend to be warmer with less snow accumulation. Warmer soil temperatures permit cheatgrass to germinate. As a result, many remaining shrub steppe areas in the Subbasin have significant cheatgrass problems on south facing slopes. Techniques for restoring shrub steppe into healthy bunchgrass stands need further development. However, conservation agencies have observed significant voluntary efforts at restoring shrub steppe habitat communities.

In the Rock Creek watershed, fire intervals are similar to other historical fire intervals in eastern Washington, except in the upper reaches of Rock Creek, where fire intervals are longer, possibly up to 50 years, compared to 10-20 year fire intervals in the lower reaches of Rock Creek (Beeks pers. comm.).

Inappropriate Grazing

Of the 894,000 acres of privately owned land used for grazing in Klickitat County, 47% is rangeland. Open native grassland used for grazing by livestock and wildlife is mainly on river breaks and in mountainous areas, including east of the Klickitat River, from south of the Simcoe Mountains to the Columbia River, and east of Bingen, Washington along the Columbia River.

Rangeland in the best ecological condition usually is interspersed with areas of small grain cropland. Because a cropping system of winter wheat-summer fallow is used in the area, these areas of rangeland are rested from grazing during alternate growing seasons.

Generally, the range of plants in the survey area is suited to grazing in fall and winter or early spring. Grazing should be deferred from year to year. The plants are not suited to continuous grazing early in the growing season. Use of practical grazing methods, a high level of management, and range improvements to speed up ecological processes are beneficial to the areas of rangeland.

Very shallow areas of rangeland generally are in good or excellent condition because the short period of plant growth generally does not correspond with the periods of livestock grazing. Areas that are over used and in poor condition generally are those where the periods of livestock grazing overlap with the critical periods of use by wildlife in the spring.

To maintain the condition of the rangeland, livestock should be moved to irrigated pastures or to areas of grazeable woodland in summer. Range plants can be grazed intensively for a brief period, and then they should be allowed to recover for the remainder of the growing season (Guenther 1997).

Development and Land Conversion

Many sources contribute to increased fragmentation. Collectively, these comprise a significant threat to the ecological integrity of shrub steppe biota. Agriculture and residential development are the two most significant sources of fragmentation across the subbasin. The construction of roads and other infrastructure completely change the nature of the landscape. Many of these lands were formerly under cultivation and have potential for restoration under farm conservation programs (such as Conservation Resource Program). Restoring native vegetation to agricultural land in key areas may offer valuable opportunities for reducing fragmentation in important habitats.

Invasive Non-Native Plant Species

While linked in many areas to inappropriate grazing practices, other sources also exacerbate this stress, including recreational use, residential development, and frequent fire. As with habitat fragmentation, we cannot point to a single highly ranked source for this limiting factor across the site. However, in selected locales throughout the subbasin, invasive non-native species pose a serious threat to biotic integrity of the shrub steppe. The abundance of such locations, the diversity of sources, and the continued or increasing nature of this threat, combines to yield a medium-high rank for this limiting factor.

Off Road Vehicles

Off Road Vehicle (ORV) use can cause damage to shrub steppe and grassland vegetation, especially the fragile microbiotic crust layers. This type of activity is often unregulated and unmanaged in this subbasin (J. Hill, pers. comm.). Limiting ORV traffic to specific marked areas, or eliminating it completely, will protect shrub steppe/grassland habitat, reduce stream sedimentation from snowmelt, rain fall runoff from tire tracks, dirt roads. By not degrading shrub steppe and grassland habitat with vehicles off of designated roads, better quality feed will result for wildlife and livestock. Overall quality of wildlife habitat will be improved.

4.4.1 Rocky Mountain Mule Deer (*Odocoileus hemionus hemionus*)/Columbian black-tailed deer (*Odocoileus hemionus columbianus*)

The Washington Department of Fish and Wildlife (WDFW) identifies deer east of US-97 as Rocky Mountain mule deer and deer west of US-97 as Columbian black-tailed deer. In Oregon, black-tailed deer are found primarily west of the Cascade Mountain Range and mule deer are native to eastern Oregon (ODFW 2004d). In reality, throughout the east slopes of the Cascades, there is a hybrid zone, where the deer are a mix of both subspecies' genotypes. Phenotypically, these deer look like black-tails, albeit large black-tails until you get out of the coniferous forest associated with the Cascade foothills. Once you get into the open country, the deer quickly become Rocky Mountain deer phenotypes (S. McCorquodale, pers. comm.) For simplicity, in this writing both subspecies will be referred to as deer, unless information is specific to only one subspecies. This writing will cover general information on both subspecies as well as regional information on both subspecies and their hybrids.

Rationale for Selection

Historically, deer have been important to the people and ecology of Oregon and Washington, and remain so today. Deer serve as a food and clothing source for Native Americans. Additionally, they provide recreational opportunities for hunters and wildlife watchers, and contribute tremendous economic benefits to local communities. Deer also occupy an important ecological niche. They convert tremendous volumes of plant matter into animal protein, provide prey for a wide variety of predators and scavengers, and contribute to the cycling of nutrients (E. Holman, pers. comm.). Furthermore, deer are the most widely distributed and numerous native species of ungulate in Washington and Oregon. As such, mule/black-tailed deer have been chosen as a focal species to represent Shrub Steppe/Interior Grasslands wildlife focal habitat, which provides important deer habitat, especilly during winter months.

Key Life History Strategies: Relationship to Habitat

Summary

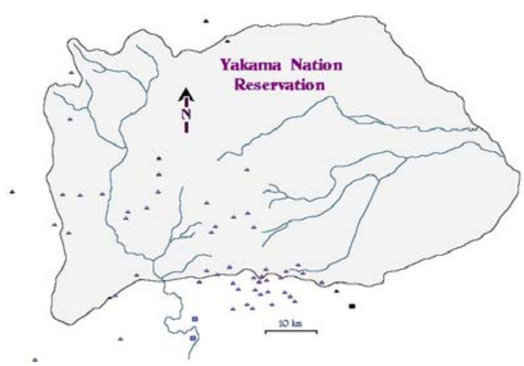
The most important habitat factors affecting deer in this subbasin are:

- Winter range: Deer need suitable cover and forage to survive harsh winter conditions. Large sagebrush is important for both of these.
- Forage (year round): Deer need available forage year round. Fire can destroy sagebrush, an important food in winter.

General

Habitat requirements vary with vegetative and landscape components contained within each herd range. Deer tend to frequent steep, brushy slopes of canyon walls and adjacent ridges (Ward 2001). Deer occupying mountain-foothill habitats live within a broad range of elevations, climates, and topography, which includes a wide range of vegetation; many of the deer using these habitats are migratory. Deer occupy a wide variety of habitats in Washington and Oregon; some live in desert shrubs, some in woodlands, and some in conifer forests. These areas include, but are not limited to: canyon complexes along the major rivers, the conifer-dominated forests of western Washington and Oregon, the shrub-steppe habitats of eastern Washington and Oregon, various mountainous habitats in the Cascade, Blue and Selkirk ranges, etc. Some of these areas are dominated by native bunch grasses or shrub steppe vegetation. Deer also occupy agricultural areas, which were once shrub steppe or native grassland.

The terrestrial habitats of the Lower Mid-Columbia Mainstem subbasin provide important winter and breeding habitat for a variety of species. Shrub steppe habitat provides important wintering areas for mule/black-tailed deer (*Odocoileus hemionus hemionus/Odocoileus hemionus columbianus)*. These deer migrate annually from their summer range on the Yakama Reservation, in the Klickitat and Yakima subbasin, and from their winter ranges in both the Klickitat and Rock Creek subbasins (figure x). In the Rock Creek watershed, the oak/shrub steppe fringe provides important food and cover for deer. Here, sagebrush, bitterbrush and acorns make up part of their winter diet. These migrating deer were part of a Klickitat basin deer study conducted by the Yakama Nation (McCorquodale 1999).



Note: Black square represents trapping area in the Rock Creek subbasin, and blue squares are trapping areas in the Klickitat subbasin

Figure 10 Map showing winter trapping areas (squares) and summer-fall activity centers of radio-collared deer (triangles) (McCorquodale 1999).

During summer, deer are scattered over much of eastern Washington and Oregon. Preferred summer habitat provides adequate forage to replace body reserves lost during winter and to maintain normal body functions. Summer habitat also includes areas specifically used for reproductive purposes. These areas must have an adequate amount of succulent vegetation, offering highly nutritional forage. In addition, areas used for reproduction should provide isolation from other deer, security from predators and minimal competition from other ungulates. Summer habitat can be found in areas varying from lowland agricultural lands to high elevation mountain areas (ODFW 2003a).

Diet and Foraging

Although mule deer commonly are considered to be "browsers", they consume a wide variety of plant materials and in some seasons graze extensively (ODFW 2004e). During the fall season, high quality forage should be available to allow does to recover from the rigors of nursing fawns and prepare for the leaner winter months. In the subbasin late summer/fall rains may create a green-up that is very important for deer. The fall green-up provides the nutrition necessary to maintain body condition for the coming winter, and maintain the fertility of does that breed in late fall. Good spring range conditions are important because they provide the first opportunity for deer to reverse the energy deficits created by low quality forage and winter weather.

Winter can be a difficult time for deer. Winter weather forces deer to migrate to lower elevations and forage quality and availability may be limited. Energy demands elevate at the end of gestation and jump dramatically when does start supporting their young after parturition (S. McCorquodale, pers. comm.). Ideally, deer winter range should be free of disturbance and contain abundant, high quality forage. Poor winter range conditions and severe winter weather can result in high mortality, especially among the old and young. Severe winters, particularly winters with cold temperatures and deep and/or hardpacked snow, would likely be the major weather-related cause of death among adults (S. McCorquodale, pers. comm.).

In winter, new growth of twigs of shrubs and trees is browsed, especially that of species high in fat content (ODFW 2004e). Deer generally do not do well on strict grass diets, as these tend to have low digestibility when mature. Deer do not need as much food as elk, but they need higher quality forage. (S. McCorquodale pers. comm.). Woody browse that is known to be highly palatable and nutritious, such as antelope bitterbrush, is an important component of quality deer winter range. Sagebrush, rabbit-brush, juniper, and mountain-mahogany, are also among those typically browsed. In the most productive winter ranges of central Oregon, favorite shrubs such as bitterbrush and mountain- mahogany stand above the snow, in typical years, providing food and shelter (ODFW 2004-Mule deer Intro.).

In the Klickitat subbasin, McCorquodale (1999) found that deer ate grasses and shrubs such as antelope bitterbrush, snowberry, and ceanothus (*Ceanothus* spp.) in winter and a lot of forbs, some grasses, and quite a few shrub leaves (e.g. currant) during the growing season. The absence or presence of highly digestible shrubs, such as bitterbrush, is essential to survival (Hobbs 1989).

Weather, especially severe winters, often leads to public requests or demands to initiate supplemental feeding. However, artificial feeding programs can easily divert the public's attention away from the real problem: maintenance and enhancement of habitat needed for year-round support of mule deer. Although natural strategies developed by deer for winter survival (e.g. migration, animal distribution, dispersal, and foraging behaviors) are preferred to artificial feeding, game managers recognize that human intervention to control damage or increase survival may, at times, be necessary (ODFW 2003a).

Forage preferences of deer in grassland-dominated habitats also are dependent upon time of year. In a report published on the ecology of mule deer on the Yakima Training Center, Yakima County (1995), deer were found to avoid a bunchgrass cover type in spring and summer but favored that habitat during winter months (Raedeke et al 1995). A diet analysis from this study showed that 47%of the deer diets were forbs, 39%were shrubs, and only 13%were grasses. Preferred forbs were balsamroot (*Balsamorhiza* spp.), buckwheat (*Eriogonum* spp.), and lupine (*Lupinus* spp.). Shrubs included antelope bitterbrush and willow, while cheatgrass and steppe bluegrass (*Poa secunda*) were important grasses. Deer were more dependant on browse during the summer months when energetic needs are at their highest (Raedeke et al. 1995).

Establishing Dens

Mule deer in the subbasin often use islands as a location to give birth. Does likely select islands because of the security from land predators, primarily coyotes. The small number of islands in the subbasin, the apparent loss of size (possibly existence) of some islands to erosion, the formation of land bridges to some islands during low water levels, and the inundation of some islands during periods of high water levels limits this use of islands in the subbasin by mule deer (Ward 2001).

Wintering

In the Klickitat subbasin, deer winter range is associated with south facing breaks and uplands of the lower Klickitat River Canyon, which is south of the Yakama Nation Reservation (McCorquodale 1999). In the Klickitat subbasin, the WDFW owns and manages the Klickitat Wildlife Area. For wintering deer, habitat with an oak component is very important in this region.

For deer in the Rock Creek watershed, corporate timberlands provide some winter range in the upper reach. In the lower reaches of Rock Creek, winter range consists of shrub steppe and is supplemented with agriculture.

Winter habitat is found predominately in lower elevation areas of Eastern Oregon. These areas usually have minimal amounts of snow cover and provide a combination of geographic location, topography, and vegetation that provides structural protection and forage. Due to the low nutritive values of available forage during the winter, deer are forced to rely on their body reserves acquired during the summer for winter survival. Big-game winter ranges have been delineated during implementation of county planning and federal land-management planning efforts. Identified big-game winter ranges typically are used by both deer and elk. Due to the combined use by these species, the winter range designations can have limitations if used to determine specific deer winter range areas (ODFW 2003a).

Population Status and Trend

Status

Historically, deer where thought to have occupied much of what is now as eastern Washington and Oregon. Today, deer can be found in every county within eastern Washington (**Figure 11**) and Oregon (McCorquodale 1999, ODFW 2003a), from higher elevations (6,000 ft.) in the mountains, to the lowland farming areas (Ashley and Stovall 2004). Mule deer are widespread in the Columbia Plateau Province in Oregon (ODFW 1993) and deer winter range extends along south-facing slopes and associated uplands in the Klickitat subbasin of Washington (McCorquodale 1999).

As is commonly the case in many western big game populations, the Klickitat deer herd has an abundance of summer range but winter range is limited. The last three decades have marked considerable conversion of deer winter habitat to land uses that are less favorable to deer. Current habitat conditions likely are not able to support high wintering deer populations. Further development or habitat loss will continue to reduce the capacity of the landscape to support deer. Managers should continue to make winter habitat maintenance, enhancement and acquisition a priority (McCorquodale 1999).

Additionally, the importance of habitat conditions on summer range has recently been shown to be of significance to ungulate populations such as deer. Specifically, adequate quantities of high-quality forage must be available during spring and summer months to allow for recovery from winter food shortages, successfully recruit young, assure pregnancy in females, secure nutritional reserves prior to the coming winter, etc. (Holman, pers. comm.). In addition to the aforementioned management priority of winter range, habitat maintenance and enhancements on summer range should be conducted as well.

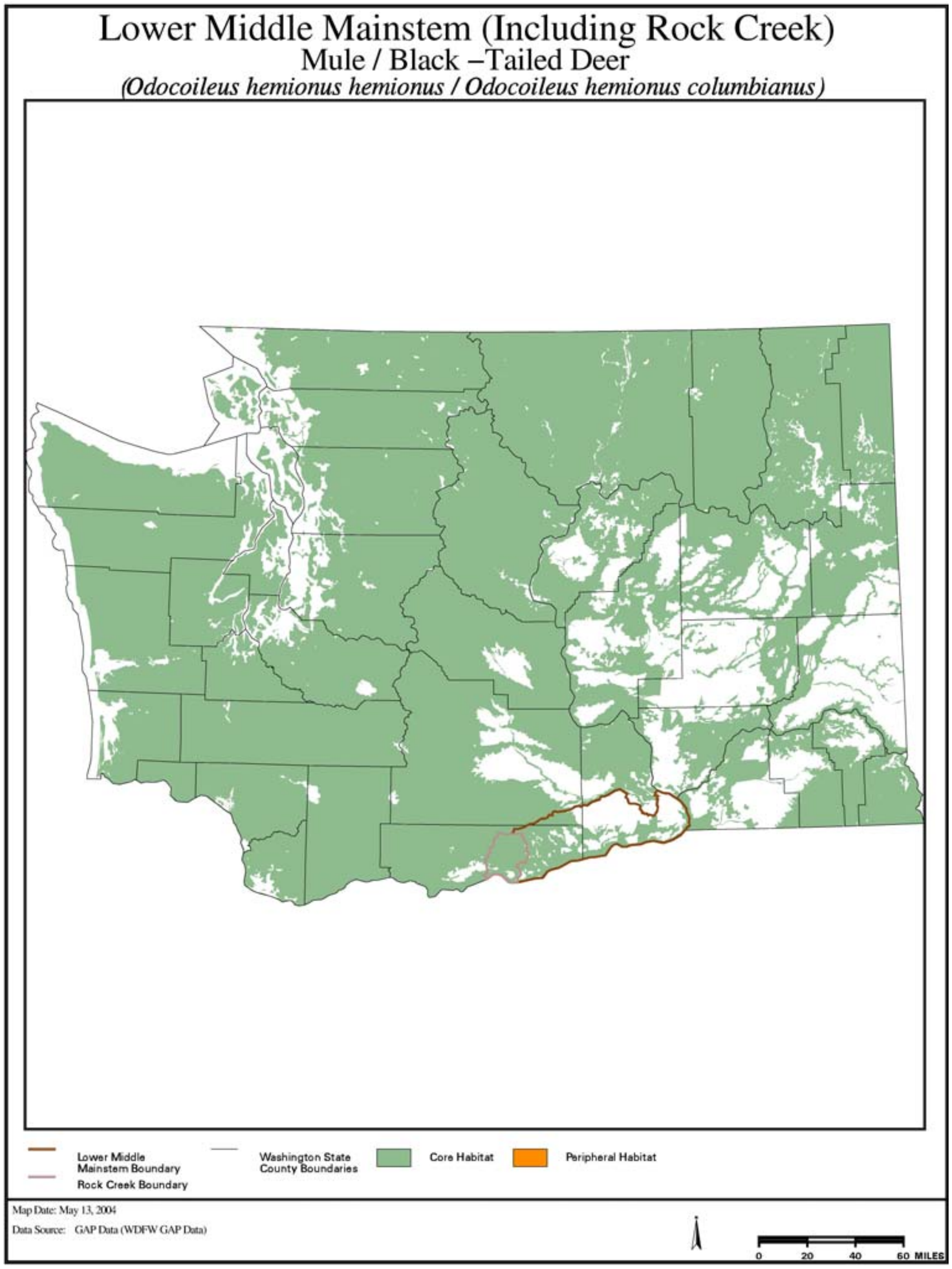


Figure 11 Potential habitat for mule/black-tailed deer in the lower mid-Columbia mainstem (including Rock Creek) subbasin and Washington (Johnson and Cassidy 1997)

Trends

Washington

Historic population levels in Klickitat County are unknown but are generally thought to be higher than current deer numbers (McCorquodale 1999). In a comparative deer harvest report from 1948 to 1986, harvest numbers rose from 814 in 1948 to a peak of 6,300 in 1964, and dropped to 1,391 animals by 1986 (Oliver 1986). In its best year, Klickitat County contributed only 9.9%of the total statewide harvest.

In 1959, a retired Wildlife Agent, Dick Thompson, claimed that "deer were as thick as rabbits" (Oliver 1986) but landowners soon took to large kills of deer to control damage to crops. Record harvests in the mid 1960s coupled with severe winter conditions drastically reduced deer populations. Deer have never fully recovered in Klickitat County (Oliver 1986). Deer population numbers continue to fluctuate drastically due to weather, hunting of "problem deer," and other factors.

Harvest data may not always be a reliable source for population trends. In the Rock Creek watershed, number of deer harvested has likely dropped due to the decrease in hunters over the past 50 years. This decrease is, in part, the result of an increase in private hunting clubs formed by local landowners.

There are various hypotheses as to why historical deer populations were maintained. One theory is that periods of high population levels were also associated with infrequent severe winters; perhaps the large-scale conversion of historical winter range to agricultural and residential development reduced deer numbers. An additional possibility is that in lieu of the increased agricultural production, deer use of crop forage led to higher population levels. The Rock Creek drainage east of the Klickitat is approximately 95,000 ha and has habitats similar to the Klickitat (McCorquodale 1999). Historically, it was thought that deer summering in the Klickitat possibly winter in the Rock Creek subbasin.

According to McCorquodale (1999), deer populations largely reflect the recent history of winter severity. Populations increase during mild winters while severe winters can cause a crash in the population. Most deer herds are currently thought to be stable or declining across much of eastern Washington. There are exceptions to the current, widespread decline, most notably, herds in southeastern Washington and portions of Grant, Douglas, Spokane, and Whitman Counties.

Oregon

Oregon's mule deer population was estimated at 39,000 to 75,000 animals from 1926 to 1933 (Bailey 1936). Mule deer populations increased and peaked from the mid-1950s through the mid-1970s. The estimated spring population in 1990 was 256,000 animals and the estimated 2001 population was 283,000 (ODFW 2003a).

ODFW normally conducts mule deer surveys twice annually. Trend counts are conducted during March and April and are used to measure overwinter survival of populations. They are made along the same routes or areas each year and are traveled by vehicle, horseback, aircraft, or on foot. All observed deer are counted, and the number is compared to the previous year's information to determine if populations have increased or decreased. Population trends for the Biggs and Columbia Basin GMU's between 1998 and 2001 are detailed in **Table 14** (ODFW 2000-2001).

Table 14 Mule deer population trends for the Biggs and Columbia Basin GMU's (1998-2001), OR.

	Miles Traveled	**Deer Observed**			
		2001	2000	1999	1998
Biggs #43	270		1,519	567	108
Columbia Basin #44	67	86	255	248	87

Herd composition counts are conducted during November and December and again along with spring trend counts during March and April. Deer are classified as bucks, does, and fawns to calculate ratios of bucks, fawns, and does in each management unit. All of the information collected is used to simulate yearly gains and losses through computer modeling and are compared with management objectives for each unit to determine if objectives are being met (ODFW 2000-2001).

Table 15 Mule deer herd composition counts for Biggs and Columbia Basin GMUs (2000-2001), OR.

	Bucks		Does		Fawns		Total	
	2001	2000	2001	2000	2001	2000	2001	2000
Biggs #43		122		652		279		1,053
Columbia Basin #44	64	38	709	275	367	144	1,140	457

Management Issues

Washington

The management of deer in the eastern Klickitat County is the responsibility of the WDFW, Yakama Nation, two large forest landowners (Boise Cascades and Campbell Group), and many smaller-scale forest, agricultural, and residential landowners. WDFW's Game Management Plan, 2003-2009 (2003), will guide their management of hunted wildlife through 2009.

The focus of the plan is on the scientific management of game populations, harvest management, and other significant factors affecting game populations. Many factors that determine deer population levels are beyond the control of state wildlife managers-such as weather, wild fires, disease, and timber harvest. As such, preferred strategies emphasize improvements in population monitoring, mule deer research, and refinement of population model inputs such as mortality and recruitment rates. Hunting season changes will maintain current, general season strategies while ensuring that a variety of hunting opportunities are available and balanced within each of WDFW's seventeen districts.

Rocky Mountain elk were historically uncommon in the Klickitat County but during the last 10 years, the number of wintering elk has increased (McCorquodale 1999). Deer have been shown to be sensitive to elk and it is thought that deer will avoid areas where there are elk. In Oregon at the Starkey project, radio collared deer actually moved into areas where roads were recently built to avoid the elk that had moved out of that area (Stephenson, pers. comm.). Additionally, ongoing research efforts at the Starkey Experimental Forest suggest that the presence of cattle leads to an increase of interspecific competition among elk and deer (Holman, pers. comm.). Specifically, in the absence of cattle, deer and elk tend to select different foods, with elk making much more extensive use of grass than deer. With the introduction of cattle, the supply of grass available to elk is reduced causing them to browse more extensively on shrubs and forbs preferred by deer. Elk are generally more adaptable, capable of utilizing a wider variety of foods, require more food and are better able to cope with severe winter conditions than are deer (Holman, pers. comm.).

Deer populations in Game Management Unit's (GMU's) 588 and 382 in Klickitat County persist at a level where landowners sometimes complain about too many deer on their winter wheat, and in their gardens or landscaping. Partially in response to these concerns, the WDFW establishes hunting seasons designed to result in limited antlerless deer harvest and a relatively stable overall deer population. In some limited cases, WDFW has authorized "hotspot" hunts to reduce damage and complaints from landowners (McCorquodale 1999).

Oregon

The management of mule Deer in the Oregon portion of the subbasin is the responsibility of ODFW. In response to declining deer populations and increasing hunting pressure, the first Mule Deer Plan was written and adopted in 1990. ODFW's Oregon Mule Deer Management Plan was updated in 2003 and provides guidance for managing this species in the subbasin. The goal of the plan is to manage mule deer populations to attain the optimum balance among recreational uses, habitat availability, primary land uses, and other wildlife species. The focus of the plan is three-fold: to maintain, enhance, and restore mule deer habitat; optimize recruitment of mule deer populations and maintain buck ratios at approved levels; and enhance all recreational uses of the resource (ODFW 2003a).

Approximately 60,167 acres of CRP have been created in the farmlands of Klickitat County, WA. and a total of 149,038 acres in Gilliam and Sherman counties, OR. by converting cropland to grassland. This has resulted in an improvement in habitat conditions for deer. The CRP lands provide both food and cover in agricultural areas where little existed after post settlement and development and before CRP was created.

Relationship with Riparian/Fisheries Issues

The presence of streams is an important water supply in the arid environments of the Lower Mid-Columbia River Subbasin. Healthy and abundant riparian areas can serve as buffers against extreme weather/environmental conditions such as drought or severe winters. Healthy and abundant riparian areas may also serve to provide habitat for deer that is more attractive than agricultural or residential habitats, thereby partially reducing the undesirable effects of a robust deer population, i.e. damage claims (Holman, pers. comm.).

Out-of-Subbasin Effects and Assumptions

Mule deer populations are either non-migratory or migrate to avoid deep snows (Severson and carter 1978, Eberhardt et al. 1984), or to find more nutritious forage (Garrott et al. 1987) and drinking water (Rautenstrauch and Krausman 1989). McCorquodale (1999) noted that although deer wintering in the lower Klickitat were both migratory and resident, most individuals were migratory and exhibited strong fidelity to their seasonal home ranges. He found that wintering radio collared deer from the Klickitat Wildlife Area and Rock Creek dispersed widely during the spring through fall period. Rock Creek migrants summered northwest through west of their home range while Klickitat deer migrated north or east of their winter home ranges (figure 13). Spring migrations started around the end of March and concluded during the second week of May. Peak activity for deer movement was recorded in April. Summer ranges, for the most part, were snowfree by mid-April. Summer to winter home range migrations were found to generally occur between late September and early December.

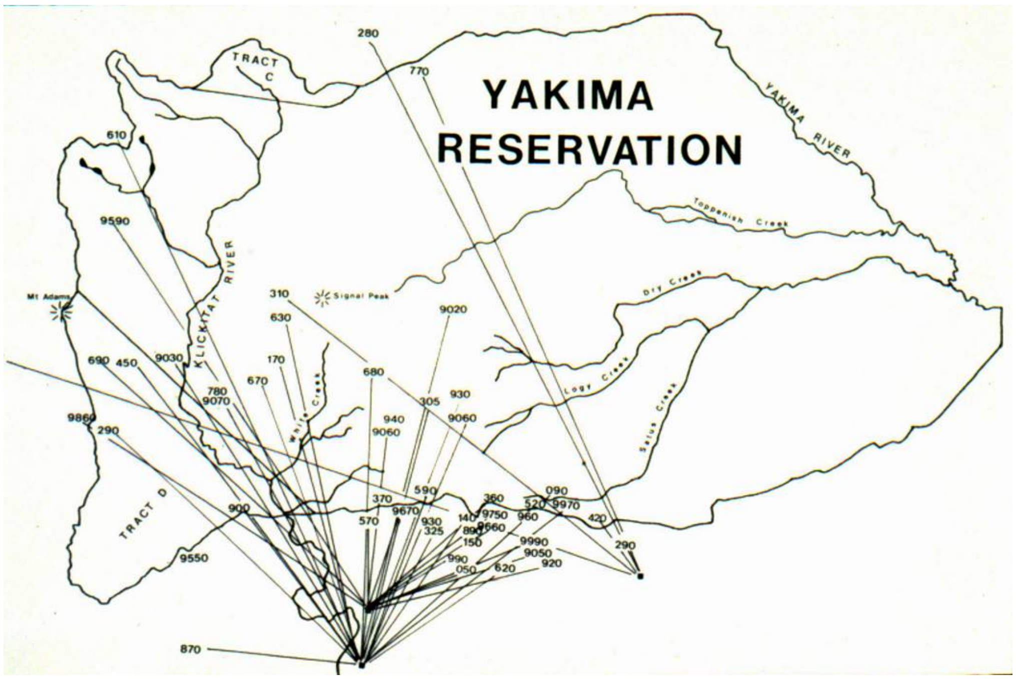


Figure 12 Movements of radio-collared deer from the Rock Creek and Klickitat subbasin (McCorquodale 1999)

Factors Affecting Population

A multitude of factors limit the ability of landscapes to support populations of deer. These factors are both human-caused and climactic in nature and include nutrition, weather, habitat quality, predation, and accidents, among others. These factors may work independently or in concert to suppress deer populations. Loss of suitable forage to weeds may cause deer to concentrate on habitats near highways where accidental deaths and disturbance may be higher than desirable. Deer populations are primarily a function of the availability of high-quality habitat. Logically, when habitat conditions are compromised, deer populations are suppressed. In contrast, deer are very reproductively fit and when conditions are favorable, they readily increase in number and occupy available habitats. Populations existing under high-quality habitat conditions generally increase to the point of carrying capacity at which point, some limiting factor suppresses the population. WDFW and ODFW attempt to manage deer populations at a level where large-scale winter mortality does not become the primary source of this population suppression (Holman, pers. comm.).

Some of the factors that collectively limit deer populations are listed below.

Land Conversion

The conversion of shrub steppe and grassland habitat to agricultural croplands has resulted in the alteration of hundreds of thousands of acres of deer habitat in eastern Washington and Oregon. This has been mitigated to some degree by the implementation of the Conservation Reserve Program (CRP). Approximately 1,386,359 acres in southcentral and southeast Washington and 494,865 acres in eastern Oregon have been converted to CRP (USDA-FSA 2004). (This includes counties which historically had large concentrations of shrub steppe and grassland habitat). Furthermore, agricultural areas may provide an extensive supply of food for deer such as winter green-up in harvested wheat fields or standing alfalfa. However, large numbers of deer may not be tolerated by landowners in agricultural areas and WDFW is legally mandated to address damage caused by wildlife (Holman, pers. comm.).

Land conversion to residential, commercial, and industrial uses also results in the direct loss or severe degradation of habitat for deer. Specifically, establishment of impervious surfaces, fencing, removal of vegetation, etc. all reduce the ability of a given landscape to support populations of deer. Although many mule deer ranges in Oregon will no longer support historic deer population levels, moderate population increases may be attained in some units with careful management (ODFW 2003a).

Fire Management

Fire suppression has resulted in a decline of habitat conditions in the mountain and foothills of the Blue Mountains, as well as other portions of Washington and Oregon. Increased fire suppression has contributed to the encroachment of woody vegetation, the loss of desirable shrub and forage species, and lowered the nutritional value of shrub plants for deer (ODFW 2003a). Browse species need to be regenerated by fire in order to maintain availability and nutritional value to big game. Lack of fire has allowed many browse species to grow out of reach for deer (Young and Robinette 1939, Leege 1968; 1969).

Wildfires in sagebrush habitats often burn vast acres, burn extremely hot and can result in the loss of critical winter range habitat. In many areas, it may take 30 to 50 years before the areas have recovered to a level to support significant numbers of deer (ODFW 2003a).

Hunting

Technological advancement in outdoor equipment (e.g. weapons, ammunition, transportation, GPS, radios, cellular phones, and waterproof and insulated clothing) has increased hunter efficiency and is changing the way many people hunt. Technological improvements in hunting equipment will continue and game managers will be constantly challenged to determine how new technologies may impact future hunting opportunities and may be required to develop rules that limit the effectiveness of the hunter or equipment (ODFW 2003a).

Mortality in one study (McCorquodale 1999) was mainly associated with hunting except for the period of 1992-1993. Most hunting mortalities occurred in off-reservation areas, although deer made considerable use of reservation lands (McCorquodale 1999). Illegal take of female deer was quite common during the study period of 1988-1995. The majority of the does were killed during the branch-antlered male deer season. WDFW uses recreational hunting to manage deer within the biological capacity of the species to support an annual harvest and provide recreation. WDFW’s deer population objectives and therefore seasons are partially established in response to the impact of deer on private landowners, primarily agricultural (Holman, pers. comm.).

Deer often cause problems for landowners. In the past landowners often took matters into their own hands. In the early 1960’s, the Klickitat County Farmers Wildlife Control Association was formed among landowners in Goldendale, White Salmon, Glenwood and elsewhere (Oliver 1986). Hundreds of deer were killed in the Goldendale and White Salmon River Valley. Today deer populations are considerably smaller, problems with deer are smaller and more sporadic, and the killing of “problem” deer is much more closely managed. Landowners still influence the

In Washington, the Lower-Mid-Columbia Mainstem subbasin is comprised of the East Klickitat (# 372) and Kiona (#382) GMUs. The total mule deer harvested in these two GMUs for 2001, 2002, and 2003 totaled 586, 761, and 519, respectively (WDFW 2001-2003). Black-tailed deer are not found in the East Klicktat and Kiona GMUs and none were harvested during this time period.

Only mule deer occupy the Oregon side of this subbasin. Columbian black-tailed deer primarily inhabit that portion of the state west of the Cascade summit. The mule deer harvest in Oregon State was generally low during the 1930s, with a reported harvest of 6,506 deer in 1934. The end of World War II brought a substantial increase in hunting pressure with 53,030 and 90,126 deer harvested in 1952 and 1955, respectively. Harvest peaked during the 1960s with an average of 82,540 mule deer taken, and a peak of 97,951 deer harvested in 1961. In 1991, controlled buck hunting was initiated in response to low post-season, buck-to-doe ratios in many WMUs and hunter numbers were substantially reduced. Twelve units already had limited-entry hunting due to deer recruitment problems that started during the winter of 1983-84. Total hunter numbers were reduced from 104,745 in 1990 to an average of 85,991 from 1991-1999, a decrease of approximately 18%. During this same time period, mule deer harvest decreased from 36,668 in 1990 to an average of 31,952 (1991-1999), a reduction of 13% (ODFW 2003a, 1999).

Within Oregon, the LMM subbasin is comprised of the Biggs (#43) and Columbia Basin (#44) GMUs. In 2000, the 2,777 hunters harvested (archery and rifle) a total of 1,813 mule deer in the Biggs unit and 3,285 hunters harvested 1,897 mule deer in the Columbia Basin unit. Black-tailed deer are not found in the Biggs and Columbia Basin GMUs.

Weather

Weather conditions can play a major role in the productivity and abundance of deer. Drought conditions can have a severe impact on deer because forage does not replenish itself on summer or winter range, and nutritional quality is low. Drought conditions during the summer and fall can result in low fecundity in does, and poor physical condition going into the winter months. Winter weather can result in high mortality of all age classes, but the young, old, and mature bucks usually sustain the highest mortality depending on the severity. In McCorquodale’s 1999 study, the dominant form of non-hunting mortality resulted from winterkill. If deer are subjected to drought conditions in the summer and fall, followed by a severe winter, the result can be high mortality rates and low productivity the following year. The 1992-1993 period marked the greatest loss of deer of all ages from winterkill because that was also a period of high snow depths. Deer populations in central and eastern Washington are reported to be growing in some locations in response to recent mild winters (WDFW 2003).

Invasive non-native plants

Establishment of invasive plants such as yellow star thistle and cheat grass have reduced the capacity of the landscape to support deer.

Roads

The construction of roads and railways are detrimental to deer. These activities result in the direct loss of habitat due to the establishment of hardened surfaces, vegetation removal, etc. Additionally, roads and railways fragment habitats, facilitate human access to remote areas (as in forest roads), interrupt migration corridors, increase disturbance and may cause direct mortality due to deer-vehicle collisions.

Disturbance

Deer are sensitive to a variety of primarily human-caused sources of disturbance. Such activities as ATV use, snowmobile use, the driving of forest roads, hiking, mountain-biking, uncontrolled pets, etc., all disturb deer. Deer are especially sensitive to such disturbance during winter when energy reserves are low. During such times, deer conserve energy by reducing their metabolic rate and attempting to move as little as needed. Disturbances during this time can cause the loss of important energy reserves and therefore reduce the ability of given habitats to support deer (Holman, pers. comm.).

Energy Development

The impacts of energy development are varied. In the Klickitat subbasin these impacts currently consist primarily of the inundation of reservoirs in former deer habitat, the establishment of transmission lines with the associated roads, weed dispersal, disturbance, etc. (Holman, pers. comm.). The potential for future energy related limiting factors exists as well. Such future developments likely include oil and gas exploration and wind power.

Certain species in the Columbia River basin were selected during the USFWS Habitat Evaluation Procedure (HEP) loss assessment process, and used to model impacts from adjacent hydro-development. The mule deer was one of those selected.

Klickitat County is in the process of developing a county-wide Environmental Impact Statement (EIS) that considers the cumulative environmental and fish and wildlife impacts of potential emergy development in the county. The EIS will guide the development of an “energy overlay” in County zoning ordinances that will direct future energy development away from environmentally/fish and wildlife sensitive areas.

Interspecific competition

As previously mentioned, deer compete with many other species for available forage and other habitat components. The most significant of these competitive relationships occur among deer, elk, and livestock.

Predation

Mule deer are preyed upon by cougars, bobcats, coyotes, and black bears (Ashley and Stovall 2004). The most significant predators of mule deer in Oregon are coyotes and cougars. Cougars rely on deer and elk as their primary prey, feeding on both adults and young throughout the year. In Oregon, cougars have increased from an estimated population of 200 in 1961 to more than 4,000 in 2001 (ODFW 2003a). Coyote predation on fawns can have a significant impact on the deer population when coyote populations are high, and fawn productivity is low (Ashley and Stovall 2004). Coyote populations in Oregon increased significantly after use of the poison compound 1080 was banned on federal lands in 1972. In general, population numbers of both predators have increased during the past few decades. Large numbers of predators may function to negatively affect population increases in deer herds and the effects are most noticeable after those winters when deer populations experience high mortality rates (ODFW 2003a).

The effect of predation on mule deer is often difficult to determine due to numerous factors that can affect mule deer herds. Differences in deer and predator densities, species of predators, weather, disease, human harvest, and whether the prey population is at habitat carrying capacity influence study results (ODFW 2003a).

Herbicide

The use of herbicide to treat forest plantations following timber harvest is commonplace. The use of these chemical treatments greatly reduces the available forage that would be expected to occur following forest cover removal. Chemical treatments tremendously shorten and reduce the vigor of the period of early succession following timber harvest. These activities reduce the ability of the landscape to support populations of deer.

Disease

Several parasites are known to occur in mule deer and are common throughout the west. Ticks and deer keds are the most common external parasites found on deer. Both parasites feed by sucking blood from their hosts and can become a problem if an individual deer is in a weakened condition (ODFW 2003a).

Diseases are of greater concern because they are difficult to diagnose and have potential for a greater negative impact to deer populations. Mule deer populations that are relatively stable and that are found in good habitat rarely are in danger of disease epizootics. However, the danger of disease transmittal is more serious when deer herds are concentrated or suffer from nutritional deficiencies (in winter). Because mule deer share rangeland with other wild and domestic animals and often occur adjacent to big game farm facilities, the potential exists for transmission of certain diseases and parasites. Diseases in deer are best managed by maintaining healthy habitats, managing appropriate animal densities, and recognizing diagnostic symptoms of various diseases (ODFW 2003a).

4.4.2 Grasshopper Sparrow (*Ammodramus savannarum*)

Rationale for Selection

Throughout the United States, this sparrow has experienced population declines throughout most of its breeding range (Brauning 1992, Brewer et al. 1991, Garrett and Dunn 1981). BBS data (Robbins et al. 1986) have shown a decreasing long-term trend for the grasshopper sparrow (1966-1998) (Sauer et al. 1999). In 1996, Vickery (1996) reported that grasshopper sparrow populations have declined by 69% across the U.S. since the late 1960s. Grasshopper sparrows rely on healthy grasslands and prefer undisturbed, native bunchgrasses communities, a habitat that is being replaced by non-native grassland communities such as cheatgrass. Grasshopper sparrows are listed as a state candidate species in Washington, a sensitive species in Oregon (vulnerable/peripheral or naturally rare), and are on the Oregon PIF list. Due to their association with healthy grassland habitats, they have been chosen as a focal species for the Interior Grassland wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following:

- Vegetative composition dominated by native bunchgrasses (Altman and Holmes 2000);
- Vegetation complexity (Altman and Holmes 2000) with bunchgrass cover >15% and >60% total grass cover;
- Bunchgrass >25 cm (10 in) tall;
- Shrub cover <10%, and
- Large unbroken patches >40 ha (100 ac) (Altman and Holmes 2000).
- Patches should be undisturbed (exotic grass detrimental; vulnerable in agricultural habitats from mowing, spraying, etc.).
- Moderately deep litter and sparse coverage of woody vegetation (Smith 1963, Bent 1968, Wiens 1969, 1970, Kahl et al. 1985, Arnold and Higgins 1986).

General

Grasshopper sparrows use most types of grassland, especially tallgrass and midgrass, but also shortgrass where shrubs or tall forbs are present. In addition to native grasslands, they will nest in Conservation Reserve Program (CRP) lands planted to taller grasses and may be heavily reliant on these in the shortgrass region.

Abundance of grasshopper sparrows seems to be positively correlated with percent grass cover, percent litter cover, total number of vertical vegetation hits, effective vegetation height, and litter depth; abundance was negatively correlated with percent bare ground, amount of variation in litter depth, amount of variation in forb or shrub height, and the amount of variation in forb and shrub heights (Rotenberry and Wiens 1980).

They are highly territorial, and require the presence of tall forbs, scattered trees, or shrubs for singing perches. Grasshopper sparrows prefer grasslands of intermediate height and are often associated with clumped vegetation interspersed with patches of bare ground (Bent 1968, Blankespoor 1980, Vickery 1996).

Vander Haegen et al. (2000) found no significant relationship with vegetation type (i.e., shrubs, perennial grasses, or annual grasses), but did find one with the percent cover perennial grass. Grasshopper sparrows require some areas of bare ground since they forage on the ground. Some studies (Bock and Webb 1984, Whitmore 1981) show a preference for high-quality rangeland with only 20-25% bare soil.

Grasshopper sparrows occasionally inhabit cropland, such as corn and oats, but at a fraction of the densities found in grassland habitats (Smith 1963, Smith 1968, Ducey and Miller 1980, Basore et al. 1986, Faanes and Lingle 1995, Best et al. 1997).

Nesting

Although little is known of breeding in the state of Oregon, males have been observed singing as early as April 23 in eastern Oregon. A pair was observed carrying food in Morrow County on May 31st and the bird has been observed using stalks of the large velvet lupine that grows in this county (Janes 1983). Two nests were found in the Willamette Valley in early July and fledglings were observed in mid-July (Altman 1997 and OBBA). Males are rarely observed beyond July (Marshall et al. 2003).

Diet and Foraging

Grasshopper sparrows eat a wide wariety of insects, including grasshoppers. They also eat weed and grass seeds picked from the ground (Marshall et al. 2003).

Population Status and Trend

Status

Grasshopper sparrows have a spotty distribution at best across eastern Washington and Oregon (Figure 14). In Washington, they they have been found in various locales including Conservation Reserve Program (CRP) areas and appear to utilize CRP property in southeast Washington on a consistent basis (Denny, pers. comm.). East of the Cascades Mountains they occur in scattered, native bunchgrass remnants between cultivated fields on north-facing slopes or on marginal soils, including the Columbia Plateau (e.g. Sherman, Gilliam, Morrow, and Umatilla counties). Densitites in Morrow Co. varied from 1.1 individuals/100 ac (20.3 individuals/km^2) in the Boardman area to 8.2 individuals/100 ac. in the Heppner area (Janes 1983).

Conversion of bunchgrass prairies to dryland wheat and other crops presents a threat to this species in northcentral and northeast Oregon (Marshall et al. 2003). Interior grasslands in the Umatilla/Willow subbasin are estimated to have declined by 74% since historic times (c. 1850). Inaddition, subbasin planners believe that the quality of remaining grassland habitat has also decreased, although no quantitative data on habitat quality of historic or current interior grasslands of the subbasin are available through assessment databases, such as IBIS. Most grassland habitat is under no or low protected status and most is privately-owned, suggesting that strategies should emphasize increased protection and enhancement by working with private landowners.

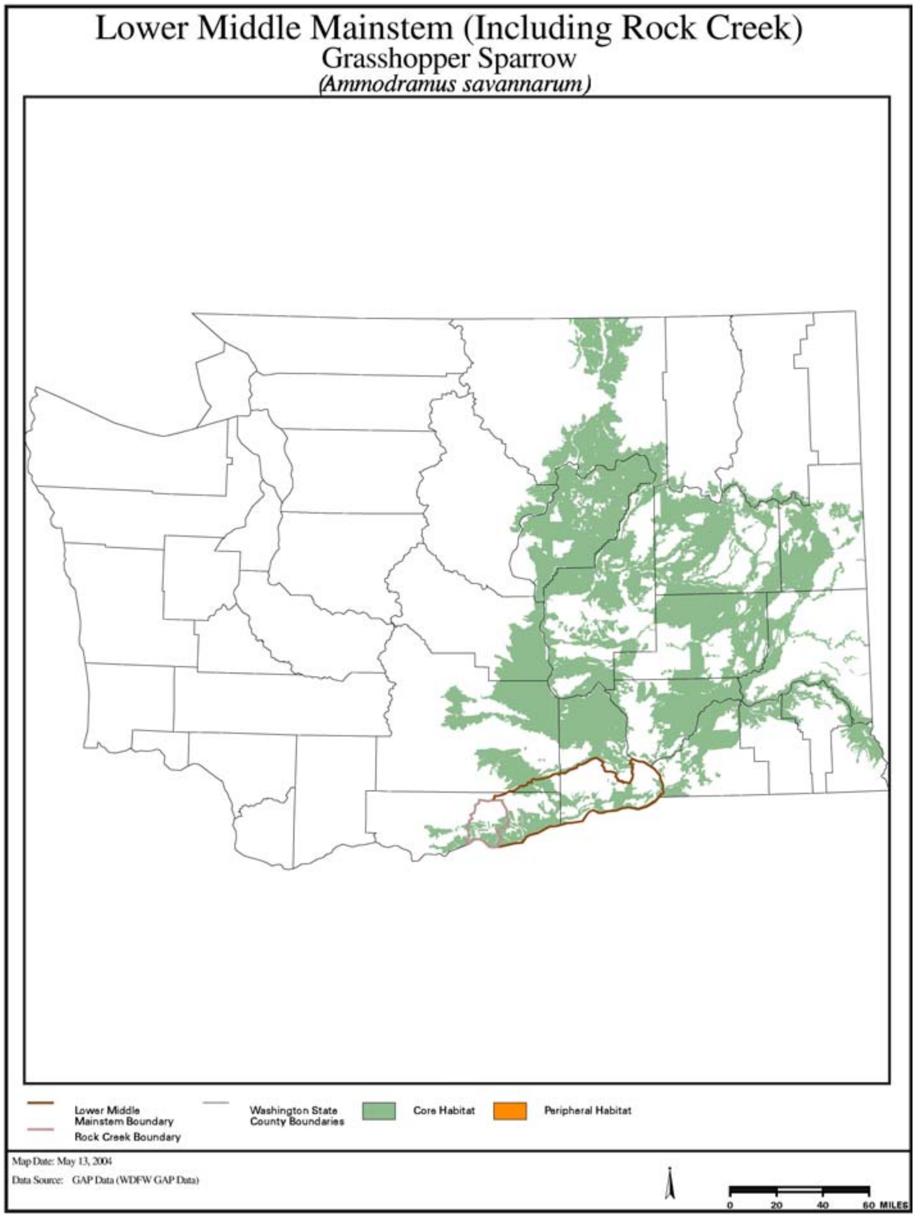


Figure 13 Potential habitat for grasshopper sparrow in the Lower Mid-Columbia Mainstem (including Rock Creek) and Washington (Smith et al. 1997)

Trend

Throughout the United States this sparrow has experienced population declines throughout most of its breeding range (Brauning 1992, Brewer et al. 1991, Garrett and Dunn 1981). In 1996, Vickery (1996) reported that grasshopper sparrow populations have declined by 69% across the U.S. since the late 1960s.

Accordingly, Breeding Bird Survey data show long term declines from 1980 through 2002 of –3.0, -1.6 and –10.7 for Washington, Oregon, and Idaho, respectively. The entire Intermountain Grassland area shows large decrease of –12.4 over this same time period.

Washington, Oregon and the entire intermountain grassland area show an increasing negative trend when looking at the more recent time period (1996-2002) indicating that recently, populations have decreased even more (Sauer et al. 2003).

Management Issues

Grasshopper sparrow populations can vary widely in a particular location from year to year, as the birds move around in response to changes in their habitat. This tendency is reinforced by its semi-colonial nesting habits. Incentives to public land managers and private landowners are needed to create a landscape mosaic of grassland parcels of different structural stages to provide grasshopper sparrow populations with options for establishing breeding grounds in any given year.

Grasshopper sparrows are considered a grassland-interior species. In several studies, including some in Colorado, breeding populations were more abundant in areas distanced from other land-use types, such as suburban developments, recreational trails, and cropland (Vickery 1996). Provide suitable habitat in patches large enough--at least 12 ha (30 ac)--to accommodate breeding birds.

Grasshopper sparrow populations usually respond negatively to grazing or burning in areas where grasses are already comparatively short and sparse (Saab et al. 1995), due to loss of needed nest cover and song perches. In some areas, vegetation requires several growing seasons to recover to conditions suitable to this species. Graze lightly or not at all in areas of short, sparse grasses. Burn grassland parcels in rotation, such that some unburned habitat is always available.

Mowing operations in hayfields often destroy nests or expose them to predators. Landowners should delay mowing until after the completion of nesting, i.e., late July (Shugaart and James 1973, Warner 1992).

Relationship with Riparian/Fisheries Issues

Healthy grasslands and shrub steppe is very important in maintaining healthy riparian systems. Upland and floodplain grassland/shrub steppe is important in capturing and holding onto water during snowpack and flooding. During snowpacks, shrubs and bunchgrasses hold onto snow and shade it, reducing the melt rate. When snow melts, the vegetation keeps the moisture from flowing along the surface, but instead infiltrating into the ground. The water than percolates through the soil, where it can be used by vegetation, eventually entering streams. By moving through soil, the water is cleaned, carrying less sediment into the stream then if it entered as runoff. The soil also acts to dissipate the kinetic energy of water as it moves down the elevational gradient. This is also very important during heavy rain and flooding. Grassland/shrub steppe also holds onto water longer, releasing it slowly into the drier seasons, keeping streams running longer, important to fish and other riparian dependent wildlife. Unhealthy grassland/shrub steppe can lead to eroded stream banks, high sediments loads, and more extreme flooding.

Out-of-Subbasin Effects and Assumptions

In spring, the grasshopper sparrow is a notably late migrant, arriving in southern British Columbia in early to late May (Vickery 1996). Grasshopper sparrows arrive in Colorado in mid May and remain through September. They winter across the southern tier of states and south into South America (Marshall et al. 2003).

Data regarding the movements of grasshopper sparrows outside of the breeding season is scarce due to their normally secretive nature (Zeiner et al.1990). Although diurnally active, grasshopper sparrows are easily overlooked as “they seldom fly, preferring to run along the ground between and beneath tufts of grass” (Pemberton 1917). Because of their secretive nature, the northern limit of their winter range is poorly known. Migratory individuals have been recorded casually south to western Panama (Ridgely and Gwynne 1989) and (in winter) north to Maine (PDV), New Brunswick, Minnesota (Eckert 1990), and western Oregon (Vickery 1996).

Factors Limiting Population

Fragmentation

Fragmentation is often a result of agricultural development and can have several negative effects on landbirds: insufficient patch size for area-dependent species; increases in edges and adjacent hostile landscapes; reduced productivity through increased nest predation, nest parasitism, and reduced pairing success of males. Making this loss of habitat even more severe is that the grasshopper sparrow, like other grassland species, shows sensitivity to the grassland patch size (Herkert 1994a and b, Samson 1980, Vickery 1994, Bock et al. 1999). Herkert (1991) in Illinois found that grasshopper sparrows were not present in grassland patches smaller than 74 acres despite the fact that their published average territory size is only about 0.75 acres. Minimum requirement size in the Northwest is unknown.

Inappropriate Grazing

Inappropriate grazing can trigger a cascade of ecological changes, the most dramatic of which is the invasion of non-native grasses escalating the fire cycle and converting sagebrush shrublands to annual grasslands. Historical heavy livestock grazing altered much of the sagebrush range, changing plant composition and densities. West (1988, 1996) estimates less than 1% of sagebrush steppe habitats remain untouched by livestock. The effects of grazing in sagebrush habitats are complex, depending on intensity, season, duration, and extent of alteration to native vegetation. Extensive and intensive grazing in North America has had negative impacts on this species (Bock and Webb 1984). The grasshopper sparrow responds negatively to grazing in shortgrass, semi-desert, and mixed grass areas (Bock et al. 1984). However, it has been found to respond positively to light or moderate grazing in tallgrass prairie (Risser et al. 1981).

Parasitism

Grasshopper sparrows are vulnerable to parasitism by brown-headed cowbirds (Elliott 1976, 1978; Davis and Sealy 2000). In Kansas, cowbird parasitism cost grasshopper sparrows about two young/parasitized nest, but there was a low likelihood of nest abandonment due to cowbird parasitism (Elliott 1976, 1978). An increase in livestock grazing intensity within shrubsteppe or grassland habitat could increase populations of cowbirds, making grassland species more susceptible to nest parasitism.

Altered Fire Regimes

The impact of fire on grassland birds in North America has shown similar results as grazing studies: namely, bird response is highly variable. Similarly, grasshopper sparrows have been found to experience positive (Johnson 1997), negative (Bock and Bock 1992, Zimmerman 1997, Vickery et al. 1999), and no significant (Rohrbaugh 1999) effects from fire. Confounding factors include timing of burn, intensity of burn, previous land history, type of pre-burn vegetation, presence of fire-tolerant exotic vegetation (that may take advantage of the post-burn circumstances and spread even more quickly) and grassland bird species present in the area. The invasion of non-native grass species, such as cheatgrass, has altered the natural fire regime in the western range, increasing the frequency, intensity, and size of range fires.

Mowing and haying

This affects grassland birds directly and indirectly. It may reduce height and cover of herbaceous vegetation, destroy active nests, kill nestlings and fledglings, cause nest abandonment, and increase nest exposure and predation levels (Bollinger et al. 1990). Studies on grasshopper sparrows have indicated higher densities and nest success in areas not mowed until after July 15 (Shugaart and James 1973, Warner 1992). Grasshopper sparrows are vulnerable to early mowing of fields, while light grazing, infrequent and post-season burning or mowing can be beneficial (Vickery 1996).

4.4.3 Brewer's Sparrow (*Spizella breweri*)

Rationale for Selection

Although not currently listed, Brewer's sparrows have significantly declined across their breeding range in the last 25 years, a cause for concern because this species is one of the most widespread and ubiquitous birds in shrub steppe ecosystems (Saab et al. 1995). Oregon-Washington Partners in Flight consider the Brewer's sparrow a focal species for conservation strategies for the Columbia Plateau (Altman and Holmes 2000). Brewer's sparrow is an indicator of healthy shrub steppe habitat and for that reason, they were chosen as a focal species for the Shrub Steppe/Interior Grassland wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following (Altman and Holmes 2000):

- Patches of sagebrush cover 10-30%;
- Mean sagebrush height > 64cm (24 in);
- High foliage density of sagebrush,
- Average cover of native herbaceous plants > 10%, and
- Bare ground >20%.

General

Vander Haegen et al. (2000) determined that Brewer's sparrows were more abundant in areas of loamy soil than areas of sandy or shallow soil, and on rangelands in good or fair condition than those in poor condition. Knopf et al. (1990) reported that Brewer's sparrows are strongly associated throughout their range with high sagebrush vigor. Brewer's sparrows prefer areas dominated by shrubs rather than grass (Knick and Rotenberry 1995). Brewer's sparrow abundance in eastern Washington increased significantly on sites where sagebrush cover approached the historic 10%level (Dobler et al. 1996).

In contrast, Brewer's sparrows are negatively correlated with grass cover, spiny hopsage, and budsage (Larson and Bock 1984, Rotenberry and Wiens 1980, Wiens 1985, Wiens and Rotenberry 1981). In eastern Washington, abundance of Brewer's sparrows was negatively associated with increasing annual grass cover; higher densities occurred in areas where annual grass cover i.e., cheatgrass was <20%(Dobler 1994). Removal of sagebrush cover to <10%has a negative impact on populations (Altman and Holmes 2000).

Nesting

Brewer's Sparrows are strongly associated with big sagbrush and tend to breed in shrublands with an average canopy height of less than 5 ft. (1.5 m) (Marshall et al. 2003). In the Great Basin, they also use greasewood, rabbitbrush, and shadscale.

Diet and Foraging

During summer, the Brewer's sparrow feeds on weed seeds and insects taken from foliage, the ground, and the bark of sagebrush (Stokes 1996, Wiens et al. 1987). Their winter diet consists primarily of seeds (Rosenberg et al. 1991) .

Population Status and Trend

Status

Brewer's sparrow is often the most abundant bird species in appropriate sagebrush habitats, comprising an aveage of 55% of all birds in shrub-steppe bird communities (Rotenberry and Wiens 1980) The bird is abundant east of the Cascades summit during the summer and is a probable and possible breeder in some portions of Sherman and Gilliam counties, Oregon (Marshall et al. 2003). However, widespread long-term declines and threats to shrub steppe breeding habitats have placed it on the Partners in Flight Watch List of conservation priority species (Muehter 1998). Saab and Rich (1997) categorize it as a species of high management concern in the Columbia River Basin. See **Figure 14** for map of potential habitat.

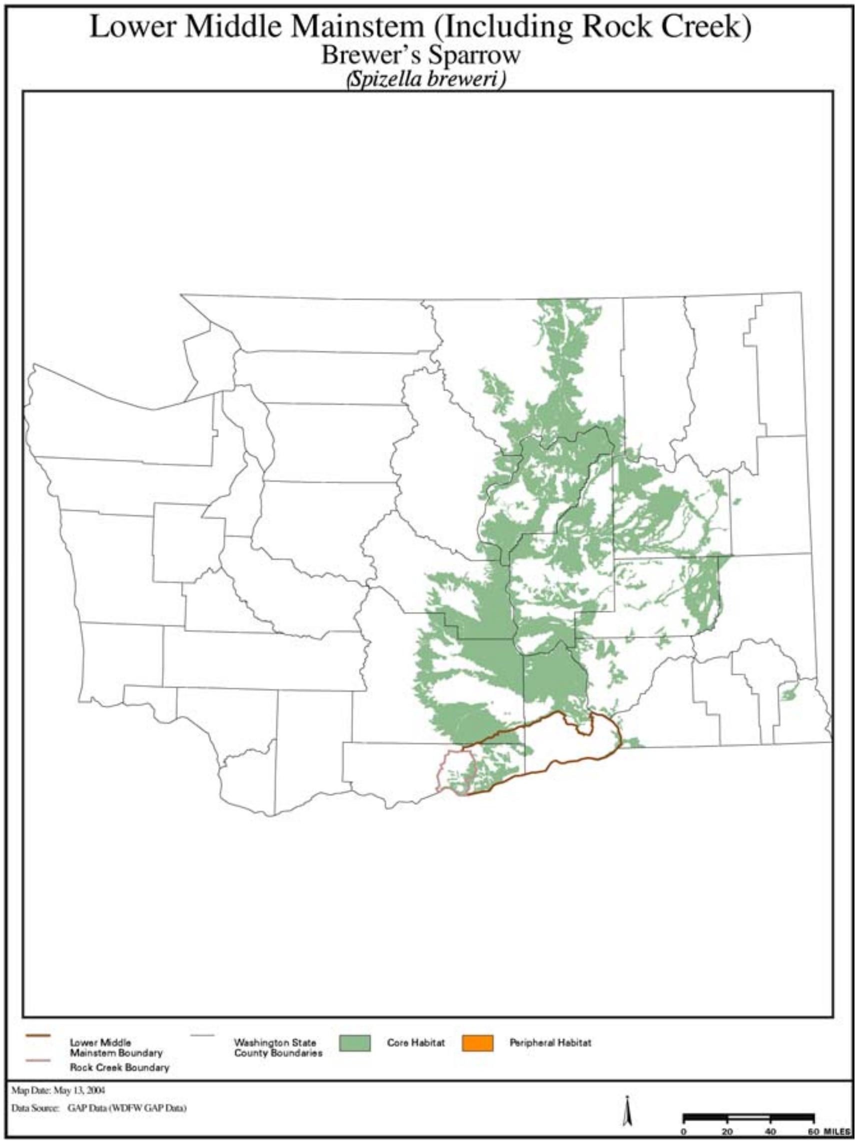


Figure 14 Potential Brewer's sparrow habitat in the Lower Mid-Columbia Mainstem (including Rock Creek) and Washington (Smith et al. 1997)

Trends

BBS data for Washington state indicate a significant population decline of about 3.1% per year fom 1996-1998. Oregon has experienced a decline of 2.6% per year for the same time period (Sauer et al. 1999). Within the entire Interior Columbia Basin, over 48% of watersheds show moderate or strong declining trends in source habitats for this species (Wisdom et al. in press) (from Altman and Holmes 2000). Surveys have shown significant declines in Brewer's sparrow in many other states, but sample sizes for Washington are too small for accurate estimates of trends.

Relationship with Riparian/Fisheries Issues

Healthy grasslands and shrub steppe is very important in maintaining healthy riparian systems. Upland and floodplain grassland/shrub steppe is important in capturing and holding onto water during snowpack and flooding. During snowpacks, shrubs and bunchgrasses hold onto snow and shade it, reducing the melt rate. When snow melts, the vegetation keeps the moisture from flowing along the surface, but instead infiltrating into the ground. The water then percolates through the soil, where it can be used by vegetation, eventually entering streams. By moving through soil, the water is cleaned, carrying less sediment into the stream then if it entered as runoff. The soil also acts to dissipate the kinetic energy of water as it moves down the elevational gradient. This is also very important during heavy rain and flooding. Grassland/shrub steppe also absorbs water and releases it slowly during the drier seasons to keep streams running and to enhance riparian habitat for fish and wildlife. Unhealthy grassland/shrub steppe can lead to eroded stream banks, high sediments loads, and more extreme flooding.

Out-of-Subbasin Effects and Assumptions

A few Brewer's sparrows arrive at their spring breeding grounds in Oregon in early April, but most arrive between late April and early July. Southward migration begins in mid-July and peaks during late August. Most have dispersed by mid-September (Marsall et al. 2003).

No data could be found on the migration and wintering grounds of the Brewer's sparrow. It winters from the southwest edge of the U.S. to the southern tip of Baja California and central Mexico (Rotenberry et al. 1999, Sauer et al. 1999, AOU 1998) and, as a result, faces a complex set of potential effects during its annual cycle. Habitat loss or conversion is likely happening along its entire migration route (Ferguson, pers. comm.). Management requires the protection or enhancement of shrub, shrub steppe, desert scrub and grassland habitats, and the elimination or control of noxious weeds. Migration routes and wintering grounds need to be identified and protected.

Factors Affecting Population

Habitat Loss and Fragmentation

Direct habitat loss due to conversion of shrublands to agriculture coupled with sagebrush removal/reduction programs and development have significantly reduced available habitat and contributed towards habitat fragmentation of remaining shrublands. Within the entire Interior Columbia River Basin, nearly 60% of native shubsteppe has been lost to agriculture (Dobler et al. 1996) and over 48% of watersheds show moderately or strongly declining trends in source habitats for this species (Wisdom et al. in press, from Altman and Holmes 2000).

Inappropriate Grazing

Grazing can trigger a cascade of ecological changes, the most dramatic of which is the invasion of non-native grasses escalating the fire cycle and converting sagebrush shrublands to annual grasslands. Historical heavy livestock grazing altered much of the sagebrush range, changing plant composition and densities. West (1988, 1996) estimates less than 1%of sagebrush steppe habitats remain untouched by livestock; 20%is lightly grazed, 30%moderately grazed with native understory remaining, and 30%heavily grazed with understory replaced by invasive annuals. The effects of grazing in sagebrush habitats are complex, depending on intensity, season, duration and extent of alteration to native vegetation. Rangeland in poor condition is less likely to support Brewer's sparrows than rangeland in good and fair condition.

Invasive Non-Native Weeds

Introduced vegetation such as cheatgrass readily invades disturbed sites, and has come to dominate the grass-forb community of more than half the sagebrush region in the West, replacing native bunchgrasses (Rich 1996). Cheatgrass has altered the natural fire regime in the western range, increasing the frequency, intensity, and size of range fires.

Altered Fire Regimes

Fire kills sagebrush and where non-native grasses dominate, the landscape can be converted to grasslands dominated by introduced vegetation as the fire cycle escalates, removing preferred habitat (Paige and Ritter 1998). Crested wheatgrass and other non-native annuals have also fundamentally altered the grass-forb community in many areas of sagebrush shrub steppe, altering shrubland habitats.

4.4.4 Shrub Steppe/Interior Grasslands and Focal Species Key Findings, Limiting Factors and Working Hypotheses

Table 16 Key findings, limiting factors and working hypotheses for the Shrub Steppe/Interior Grasslands focal habitat and its representative focal species

SHRUB STEPPE/INTERIOR GRASSLANDS HABITAT		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat has undergone structural and compositional changes. This includes lost species diversity, reduced microbiotic crust, changes in shrub cover and invasion by noxious weeds	Loss of Habitat Quality	Encouraging proper grazing will improve range conditions by reducing future spread of invasive exotic plant species and helping to reestablish a native plant community. Proper livestock management can also reduce soil disturbance in sensitive areas and benefit microbiotic crusts. Properly managed grazing in critical areas will help reduce the damage to native grasses and shrubs will improve Brewer's sparrow habitat and increase population size and presence.
	Vegetation and Soil Damage	Limiting ORV traffic to specific marked areas, or eliminating it completely, will protect shrub steppe/grassland habitat, reduce stream sedimentation from snowmelt, rain fall runoff from tire tracks, dirt roads.
	Displacement of Native Vegetation with Non-Native Vegetation	Reduction of invasive non-native plant species will increase water availability to native shrubs, forbs and grasses and decrease danger of large wildfires.
	Reduction in Age Class, or Complete Loss, of Shrub Steppe Vegetation	Increasing fire frequency intervals and thereby reducing fire intensity will allow native shrub species to reach late seral conditions and reestablish areas they were once historically found. Microbiotic crusts will increase in quantity and quality as well.
	Loss of Ephemeral Wetlands	Ephemeral wetlands are a uniquely important part of the shrub steppe and grasslands adding diversity and stability to the plant community.
Habitat has historically undergone and continues to undergo loss of large contiguous patches resulting in fragmentation of both habitat and wildlife populations.	Loss of Shrub Steppe/Grassland Habitat	Halting new development on shrub steppe/grassland habitat and implementing current shrub steppe and grassland conservation will reverse the fragmentation of this habitat and maintain existing patches.

SHRUB STEPPE/INTERIOR GRASSLANDS HABITAT		
Key Findings	**Limiting Factors**	**Working Hypotheses**
SHRUB STEPPE/INTERIOR GRASSLANDS - FOCAL SPECIES		
Mule/Black-Tailed Deer		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Deer are an important species economically, culturally and ecologically.	Loss of Shrub Steppe Habitat Within Winter Range	Protecting important wintering areas from land conversion and development will increase winter survival.
	Reduction in Age Class, or Complete Loss, of Shrub Steppe Vegetation	Decrease fire in shrub steppe will protect sagebrush, important in winter for cover and forage.
	Hunting Mortality	Responsible management of deer for hunting in the subbasin will benefit both people and deer.
Grasshopper Sparrow		
Key Findings	**Limiting Factors**	**Working Hypotheses**
The principal factors reducing grasshopper habitat is: habitat loss and fragmentation and habitat degradation and alteration.	Loss of Grassland Habitat within Breeding Range	Restoring converted, abandoned habitat back into native bunchgrass habitat will increase available habitat and reverse population declines.
	Loss of Grassland Habitat Quality	Properly managed grazing will decrease spread of non-native understory plant species and help reestablish a native plant community.
	Displacement of Native Vegetation with Non-Native Vegetation	Control of non-native weeds will maintain and increase habitat available to grasshopper sparrow.
Brewer's Sparrow		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Brewer's sparrows have suffered loss of habitat from land conversion and degradation reducing their population size and distribution.	Loss of Shrub Steppe Habitat within Breeding Range	Restoring converted, abandoned habitat back into shrub steppe will increase available habitat and reverse population declines.
	Loss of Shrub Steppe Habitat Quality	Properly managed grazing in critical areas will help reduce the damage to native grasses and shrubs will improve Brewer's sparrow habitat and increase population size and presence.

SHRUB STEPPE/INTERIOR GRASSLANDS HABITAT		
Key Findings	**Limiting Factors**	**Working Hypotheses**
	Displacement of Native Vegetation with Non-Native Vegetation	Controlling the spread of non-native weeds, and removing weeds from historical shrub steppe/grassland habitat will improve habitat for Brewer's sparrow and increase population size and presence.

4.5 Ponderosa Pine (*Pinus ponderosa*)/Oregon White Oak (*Quercus garryanna*)

Rationale For Selection

Due to the alteration of ponderosa pine/Oregon White Oak habitat and loss of late seral pines, and due to the importance of large pines to wildlife, the Ponderosa Pine/Oregon White Oak wildlife habitat type was chosen as a focal wildlife habitat. This habitat type occurs primarily on the Washington side of the subbasin. In the Oregon portion of the subbasin, this habitat is restricted to a narrow strip of ponderosa pine dominant forest within the northern edge of the Umatilla National Forest (See IBIS map,). This area was not covered in this subbasin plan (See **Figure 1**); it was included in the Umatilla Subbasin Plan along with other information on Willow Creek and its tributaries.

Ponderosa Pine

This habitat occurs in much of eastern Washington and eastern Oregon, including the eastern slopes of the Cascades (Crawford and Kagan, 1998-2003). Much of the ponderosa pine forest in Washington State lies at lower elevations under state and private ownership. Ponderosa Pine habitat generally occurs on the driest sites supporting conifers in the Pacific Northwest. It is widespread and variable, appearing on moderate to steep slopes in canyons, foothills, and on plateaus or plains near mountains. In Oregon, this habitat can be maintained by the dry pumice soils, and in Washington it can be associated with serpentine soils. Average annual precipitation ranges from about 14 to 30 inches (36 to 76 cm) on ponderosa pine sites in Oregon and Washington and often as snow. This habitat can be found at elevations of 100 ft (30m) in the Columbia River Gorge to dry, warm areas over 6,000 ft (1,829 m). Timber harvest, livestock grazing, and pockets of urban development are major land uses (Crawford and Kagan, 1998-2003).

Much of the ponderosa pine land base in this subbasin was heavily harvested in the first part of the last century, leaving very little late seral or old growth habitat today. Fire suppression and grazing had additional impacts. Noss, et al. (2001) considers ponderosa pine ecosystems to be one of the most imperiled ecosystems of the West and the USGS Biological Resources Division classifies old-growth ponderosa pine (Pinus ponderosa) forests in the northern Rocky Mountains, Intermountain West, and eastside Cascades Mountains as endangered (85-98% decline) (Noss et al. 1995). Much of this land is now over stocked with an understory of Douglas-fir and grand fir (*Abies grandis*) or smaller diameter pine. The loss and alteration of historic vegetation communities has impacted landbird habitats and resulted in species range reductions, population declines and some local and regional extirpations (Altman 2000). Interior Columbia Basin studies (Wisdom, et al. 2999) found that wildlife species declines were greatest in low-elevation, old-forest habitats. A more detailed discussion of habitat dynamics for this forest type can be found in Johnson and O'Neil (2001).

There is major dependency on ponderosa pine habitats by white-headed woodpecker (*Picoides albolarvatus*), western gray squirrel (*Sciurus griseus*), Lewis' woodpecker (*Melanerpes lewis*) and flammulated owl (*Otus flammeolus*). Other species that are dependent upon or benefit substantially from this habitat include the pygmy nuthatch (*Sitta pygmaea*) and Williamson's sapsucker (*Sphyrapicus thyroideus*). Other birds that seem to prefer mature ponderosa pine stands are western wood-peewee (*Contopus sordidulus*), mountain chickadee (*Poecile gambeli*), red-breasted nuthatch (*Sitta canadensis*), hermit thrush (*Catherus guttatus*), western tanager (Piranga ludoviciana), chipping sparrow (*Spizella passerine*), Cassin's finch (Cardopacus cassinii), red crossbill (*Loxia curvirostra*) and evening grosbeak (*Coccothraustes vespertinus*) (Hutto and Young 1999). Clark's nutcracker (*Nucifraga columbiana*) and brown creepers (*Certia americana*) also use ponderosa pine as a food source (Dixon, pers. comm.).

Oregon White Oak

Oregon white oak woodlands consist of stands of pure oak or oak/conifer associations. In oak/conifer associations, ponderosa pine and Douglas-fir are important conifer components of these habitats. East of the Cascades, important oak habitat stands should generally be ≥ 5 acres in size to be functional habitat for wildlife. In more developed areas, though, single oaks or small stands of oaks that are < 1 acre in size, can also be valuable to wildlife when the oaks are late seral. These oaks are larger in diameter, contain more cavities for nesting, produce more acorns, and have a large canopy. Late seral oaks are an important component of all oak forests.

Oregon white oak, known by many as Garry oak, is Washington's only native oak species (Miller 1985). It provides a unique plant community that provides forage, nesting and cover habitat to oak obligate species as well as many other more generalist species. There is a diversity of wildlife species found in all of Washington's oak forests, but in the oak forests found along Klickitat River, there are several bird species present not otherwise found in Washington State (Manuwal 1989). These include acorn woodpecker (*Melanerpes formicivorus*), scrub jays (*Aphelocoma coerulescens*), and dusky flycatchers (*Empidonax oberholseri*).

Over the last two centuries, oak habitats have changed due to land conversion, timber practices and fire suppression. Today's oak stands are denser with smaller trees. Younger, denser stands do not provide as good wildlife habitat as the older, more open stands. Late seral oak stands are important to western gray squirrels, white-headed woodpeckers and Lewis' woodpecker. In upland oak-pine stands, some of the more common birds include the chipping sparrow, Nashville warbler (*Vermivora ruficapilla*), lazuli bunting (*Passerina anoena*), red-breasted nuthatch, western tanager, and ash-throated flycatcher (*Myiarchus cinerascens*). In the oak-pine riparian areas, some of the most common birds are the spotted towhee (*Pipilo erythrophthalmus*), black-headed grosbeak (*Pheucticus melanocephalus*), American robin (*Turdus migratorius*), black-throated gray warbler (*Dendroica nigrescens*), MacGillivray's warbler (*Oporornis tolmiei*), lazuli bunting and red-breasted nuthatch. Reptiles found in oak habitats include the California Mountain king snake (*Lampropeltis zonata*), sharptail snake (*Contia tenuis*), western rattlesnake (*Crotalus viridis*), southern alligator lizard (*Elgaria multicarinata*), and the western skink (*Eumeces skiltonianus*) (St. John 2002). There are also many invertebrates species that use oak forests.

Description of Habitat

Ponderosa Pine

Historic

Prior to 1850, much of the ponderosa pine habitat in this subbasin, and other parts of the inland northwest, was mostly open and park like with relatively few undergrowth trees. Ponderosa pine forests historically burned approximately every 5-30 years prior to fire suppression, preventing contiguous understory development and, thus, maintaining relatively open ponderosa pine stands. Similar fire cycles are likely in this subbasin as well.

The 1930s-era timber inventory data (Losensky 1993) suggests large diameter ponderosa pine-dominated stands occurred in very large stands, encompassing large landscapes. Such large stands were fairly homogeneous at the landscape scale (i.e. large trees, open stands), but were relatively heterogeneous at the acre scale, with “patchy” tree spacing, and multi-age trees (Hillis et al. 2001).

Ponderosa pine forms climax stands that border grasslands and is a common member in many other forested communities (Steele et al. 1981). Ponderosa pine is a drought tolerant tree that usually occupies the transition zone between grassland and forest. Climax stands are characteristically warm and dry, and occupy lower elevations throughout their range. Key understory associates in climax stands typically include grasslike species such as bluebunch wheatgrass (*Pseudoroegneria spicata*) and Idaho fescue (*Festuca idahoensis*), elk sedge (*Corex geyeri*), pine grass and shrubs such as bitterbrush (*Purshia tridentata*), various ceanothus pecies (redstem (*Ceanothus sanguineus*), deer brush (*C. integerrimus*), snowbrush (*C. velutinus*), squaw carpet (*C. prostrates*)) and common snowberry (*Symphoricarpus albus*). Ponderosa pine associations can be separated into three shrub-dominated and three grass-dominated habitat types.

Four community types are associated with ponderosa pine (Cooper et al. 1991):

- Ninebark (Physocarpus malvaceus);
- Common snowberry;
- Idaho fescue, and
- Bluebunch wheatgrass

Daubenmire and Daubenmire (1984) recognize two more habitat types within the ponderosa pine series:

- Needlegrass (*Stipa comata*)
- Bitterbrush

In some places, the change from steppe to closed forest occurs without the transitional ponderosa pine zone, for example, at locations along the east slopes of the north and central Cascades. More commonly, the aspect dependence of this zone creates a complex inter-digitization between the steppe and ponderosa pine stands, so that disjunct steep zone fragments occur on south-facing slopes deep within forest while ponderosa pine woodlands reach well into the steppe along drainages and north slopes.

The successional status of ponderosa pine can be best expressed by its successional role, which ranges from seral to climax depending on specific site conditions. It plays a climax role on sites toward the extreme limits of its environmental range and becomes increasingly seral with conditions that are more favorable. On more mesic sites, ponderosa pine encounters greater competition and must establish itself opportunistically, and is usually seral to Douglas-fir and true firs (mainly grand fir and white fir). On severe sites, it is climax by default because other species cannot establish. On such sites, establishment is likely to be highly dependent upon the cyclical nature of large seed crops and favorable weather conditions (Steele 1988).

Current

Quigley and Arbelbide (1997) concluded that the interior ponderosa pine habitat type is significantly less in extent than pre-1900 and that the Oregon white oak habitat type is greater in extent than pre-1900. They included much of this habitat in their dry forest potential vegetation group, which they concluded has departed from natural succession and disturbance conditions. The greatest structural change in this habitat is the reduced extent of the late-seral, single-layer condition. This habitat is generally degraded because of increased exotic plants, decreased overstory canopy, and decreased native bunchgrasses. One third of Pacific Northwest Oregon white oak, ponderosa pine, and dry Douglas-fir or grand fir community types listed in the National Vegetation Classification are considered imperiled or critically imperiled.

Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that gives the habitat a more closed, multi-layered canopy. For example, this habitat includes previously natural fire-maintained stands in which grand fir can eventually become the canopy dominant. Large late-seral ponderosa pine, and Douglas-fir are harvested for timber in much of this habitat. Under most management regimes, typical tree size decreases and tree density increases in this habitat. Ponderosa pine/Oregon white oak habitats are now denser than in the past and may contain more shrubs than in pre-settlement habitats. In some areas, new woodlands have even been created with tree establishment at the forest-steppe boundary.

Throughout most of the zone, ponderosa pine is the sole dominant in all successional stages. At the upper elevation limits of the zone, on north-facing slopes in locally mesic sites, or after long-term fire suppression, other tree species Douglas fir, grand fir, western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta latifolia*), western juniper (*Juniperus occidentalis*), or Oregon white oak may occur. At the upper-elevation limits of the zone, in areas where the ponderosa pine belt is highly discontinuous, and in cooler parts of the zone, Douglas-fir, and occasionally western larch, lodgepole pine, and grand fir become increasingly significant. In Yakima and Klickitat Counties, Oregon white oak may be present, especially in drainages (extensive Oregon white oak stands are assigned to the Oak zone). In the BIue Mountains, small amounts of western juniper commonly occur. Lodgepole pine is common in the northeast Cascades and northeastern Washington (Daubenmire and Daubenmire 1968).

Stresses

Timber Activities

The ponderosa pine ecosystem has been heavily altered by past forest management. Specifically, the removal of overstory ponderosa pine since the early 1900s and nearly a century of fire suppression have led to the replacement of most old-growth ponderosa pine forests by younger forests with a greater proportion of Douglas-fir than ponderosa pine (Habeck 1990). Clear-cut logging and subsequent reforestation have converted many older stands of ponderosa pine/Douglas-fir forest to young structurally simple ponderosa pine stands (Wright and Bailey 1982).

Ponderosa pine is shade intolerant and grows most rapidly in near full sunlight (Franklin and Dyrness 1973, Atzet and Wheeler 1984). Logging is usually done by a selection-cut method.

Older trees are taken first, leaving younger, more vigorous trees as growing stock. This effectively returns succession to earlier seral stages and eliminates climax, or old growth, conditions. Logging also impacts understory species by machine trampling or burial under slash. Clearcutting generally results in dominance by understory species present before logging, with invading species playing only a minor role in post logging succession (Atzet and Wheeler 1984).

Fire Suppression

Ponderosa pine has many fire resistant characteristics. Seedlings and saplings are often able to withstand fire. Pole-sized and larger trees are protected from the high temperatures of fire by thick, insulative bark, and meristems are protected by the surrounding needles and bud scales. Other aspects of the pine's growth patterns help in temperature resistance. Lower branches fall off the trunk of the tree, and fire caused by the fuels in the understory will usually not reach the upper branches. Ponderosa pine is more vulnerable to fire at more mesic sites where other conifers as Douglas-fir, and grand fir form dense understories that can carry fire upward to the overstory. Ponderosa pine seedlings germinate more rapidly when a fire has cleared the grass and the forest floor of litter, leaving only mineral rich soil (Fischer and Bradley 1987).

Fire suppression has lead to a buildup of fuels that, in turn, increase the likelihood of stand-replacing fires. Heavy grazing, in contrast to fire, removes the grass cover, reduce fine fuels that carry low intensity fires, and tends to favor shrub and conifer species. Fire suppression combined with grazing creates conditions that support cloning of oak and invasion by young conifers, including shade tolerant species such as grand fir.

Successional and climax tree communities are inseparable in this zone because frequent disturbance by fire is necessary for the maintenance of open woodlands and savanna. Natural fire frequency is very high, with cool ground fires believed to normally occur at 8 to 20 year intervals by one estimate and 5 to 30 year intervals by another. Ponderosa pine trees are killed by fire when young, but older trees survive cool ground fires. Fire suppression favors the replacement of the fire-resistant ponderosa pine by the less tolerant Douglas-fir and grand fir.

The high fire frequency maintains an arrested seral stage in which the major seral tree, ponderosa pine, is the "climax" dominant because other trees are unable to reach maturity. The ponderosa pine zone is most narrowly defined as the zone in which ponderosa pine is virtually the only tree. As defined in this document, the ponderosa pine zone encompasses most warm, open-canopy forests between steppe and closed forest, thus it includes stands where other trees, particularly Douglas-fir, may be co-dominant with ponderosa pine (Daubenmire and Daubenmire 1968).

The major defining structural feature of this zone is open-canopy forest or a patchy mix of open forest, closed forest, and meadows. On flat terrain, trees may be evenly spaced. On hilly terrain, the more common pattern is a mix of dry meadows and hillsides, tree clumps, closed forest in sheltered canyons and north-facing slopes, shrub patches, open forest with an understory of grass and open forest with an understory of shrubs. Without fire suppression, the common belief is that the forest would be less heterogeneous and more savanna-like with larger, more widely spaced trees and fewer shrubs (see Daubenmire and Daubenmire 1968 for a dissenting opinion).

Inappropriate Grazing

Excessive grazing of ponderosa pine stands in the mesic shrub habitat type tends to lead to swards of Kentucky bluegrass and Canada bluegrass (*Poa compressa*). Native herbaceous understory species are replaced by introduced annuals, especially cheatgrass and invading shrubs under heavy grazing pressure (Agee 1993). In addition, four exotic knapweed species (*Centaurea* spp.) are spreading rapidly through the ponderosa pine zone and threatening to replace cheatgrass as the dominant increaser after grazing (Roche and Roche 1988). Dense cheatgrass stands eventually change the fire regime of these stands.

Oregon White Oak

Historic

Oak and oak/conifer habitats are usually confined to drier microsites between conifer and grassland or shrubsteppe habitats (Stein 1980, Crawford and Kagan 1998-2003). Ponderosa pine and Douglas-fir are often important tree species components of oak habitats and can increase their value to wildlife. In our area, understory shrubs are often dominated by bitterbrush and big sagebrush (*Artemesia tridentata*) (Taylor and Boss 1975). Understory forbs are often dominated by the same species common to adjacent shrub steppe and grassland habitats, such as lupine, balsamroot, Idaho fescue, bluebunch wheatgrass, elk sedge, and other common grass-like species.

Nest cavities are an important component of oak forests. Many of the cavities found in oak trees are created by woodpeckers. Woodpeckers, which are primary excavators, cannot create cavities in all trees and snags (Jackman 1975). It is important to have trees of varying ages and diameters to increase the number of woodpecker-created cavities in an oak forest (Conner et al. 1975). In turn, the higher number of cavities present is directly related to the density of cavity-nesting species (Jackman 1975), such as the flammulated owl, a secondary cavity user. Cavities can also be created when decay-causing organisms infect a wound, such as a broken bole or branch, and the tree grows around the wound to contain the decay (Gumtow-Farrior and Gumtow-Farrior 1994). This can create large, deep cavities inside the tree that are used by species such as the western gray squirrel for nesting and rearing young.

Oak has always been an important food source for wildlife. Oaks support insects within its bark that are eaten by woodpeckers (Jackman 1975). The most important food source from oaks is acorns. Oak masts (acorns) make up the significant portion of the diet of many species of birds and mammals (Voeks 1981, Miller 1985, Larsen and Morgan 1998). Consumers of acorns include western gray squirrel, Douglas' squirrel (*Tamiasciurus douglasii*), Lewis' woodpecker, deer, acorn woodpeckers, scrub jays and black bear (*Ursus americanus*). Acorn production fluctuates yearly for unknown reasons (Larsen and Morgan 1998).

Leaves are an important food source for deer and elk, and contain significant amounts of protein (Miller 1985). Deer and elk, in turn, are an important prey item for several carnivores such as cougars (*Puma concolor*), whose population depends on the healthy deer population (Barrett 1980). Some invertebrates also rely on oak leaves during larval stages (Pyle 1989, Larsen and Morgan 1998). Leaf litter also may help retain soil moisture that aids in oak seedling survival.

Current

In Washington and Oregon, ponderosa pine-Douglas-fir woodland habitats occur along the eastern slope of the Cascades, the Okanogan Highlands, and in the Blue Mountains. Ponderosa pine woodland and savanna habitats occur in the foothills of the Blue Mountains, along the eastern base of the Cascade Range, the Okanogan Highlands, and in the Columbia Basin in northeastern Washington. Ponderosa pine is widespread in the pumice zone of south-central Oregon between Bend and Crater Lake east of the Cascade Crest. Ponderosa pine-Oregon white oak habitat appears east of the Cascades in the vicinity of Mt. Hood near the Columbia River Gorge north to the Yakama Nation and south to the Warm Springs Nation. Oak dominated woodlands follow a similar distribution as Ponderosa Pine-White Oak habitat but are more restricted and less common (Crawford and Kagan 1998-2003) (Figure 15).

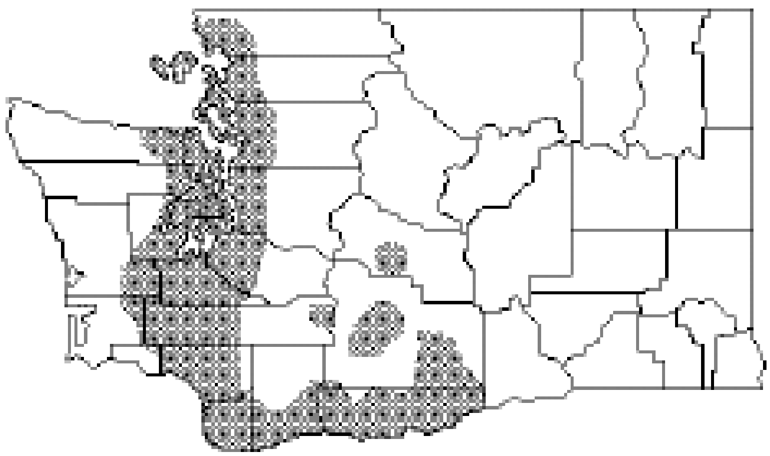


Figure 15 Range of Oregon white oak woodlands in Washington. Map derived from WDFW data files and the literature (Larsen and Morgan 1998)

Stresses

Fire Suppression

Fire suppression has created denser forests with smaller trees. In oak forests, it has led to denser understories, smaller trees and higher fuel loads. Historically, oak forests, like ponderosa pine, were more open and park-like. Open-canopy stands of oak generally have more complex plant understories than closed-canopy stands and can, therefore, support more wildlife species. Canopy cover of 25-50%provides ideal habitat for a variety of species as well as needed gaps for sunlight (Barrett 1980).

Although conifer encroachment is an issue in oak forests in many parts of Washington State, it may not be in eastern Washington. Conifer encroachment, predominately by Douglas-fir, occurs primarily west of the Cascade crest and in wetter areas on the east side, such as the White Salmon River drainage of the Columbia Gorge. In drier areas east of the Cascades, conifer competition with oaks is generally negligible. Oregon white oak is usually sub-climax and becomes climax only on dry, rocky, southerly exposures (UFS 1965).

Land Conversion

Most oak woodlands in Washington state are privately owned, and private parcels collectively comprise the largest contiguous tracts (WDW 1993, Larsen and Morgan 1998). Statewide mapping is underway by WDFW to quantify the extent of Washington State's oak habitat. Klickitat County and adjoining lands harbor the largest stands of Oregon white oak in

Washington State. Klickitat County alone, contains approximately 195,000 acres of oak and oak/pine woodlands with >25% canopy coverage. Within this area, there has been conversion of oak stands to agricultural lands, urban development, and losses from fuelwood cutting. These are believed to be the most significant contributors to oak woodland decline (Larsen and Morgan 1998). These land conversions are still taking place. Oregon white oak responds to fire by reestablishment through sprouting. Subsequent to settlement, fire control has resulted in less fire tolerant species competing for habitat with oak, thus replacing it in the community. This is arguably the significant impact to oak on private lands.

Woodcutting

Woodcutting may remove the largest trees from oak forests. Snags and snag recruitment trees may also be removed. Oak snags and dead portions of live trees harbor insect populations and provide nesting cavities and perches for birds and mammals.

Insects and Disease

Some trees succumb to defoliating insects or insects that attack by creating galls between the tree's bark and wood (UFS 1965). Recent insect blights have occurred in Klickitat County where already drought stressed trees have succumbed (Weiler, pers. comm.).

Thirty-one species of fungi also affect Oregon white oak. Some inhibit growth, and others kill trees. The major decay fungi are shoestring root rot (*Amillaria mellea*) and trunk rot (*Polyporus dryophilus*) (UFS 1965). Decomposing fungi, coupled with the rotting characteristics of this oak species, simplify the excavation of cavities for woodpeckers by softening wood (Jackman 1975). The process is often facilitated by the loss of limbs that expose heartwood (Gumtow-Farrior 1991).

A recent introduction of Sudden Oak Death syndrome, caused by the fungus Phytophthora ramorum, infects and kills other species of oak in California State. Oregon white oak is currently known to be a host to this fungus, but is not killed by it. Managers must stay aware of this fungus in case it mutates into a form deadly to our oaks.

Timber Activities

Clearcutting reduces oak habitat and the numbers of animals within, encourages conifer encroachment, and creates edges. The extent of this activity in this subbasin is currently low or is not occuring. Edges increase the frequency of predation on interior nesting species (Connel et al. 1973, Conner et al. 1979, Chasko and Gates 1982, Reed and Sugihara 1987).

Appropriate timber practices within oak stands vary according to location and tree species composition. When stands are thinned, Douglas-fir and ponderosa pine are harvested, temporarily leaving pure stands of oak. Selective cutting practices can allow for the retention of different age-class and species composition within stands (Conner et al. 1979), and age diversity within stands contributes to species richness and breeding bird diversity (Connel et al. 1973).

Failure to thin even-aged oak stands and failure to open canopy above overshaded oak sprouts and saplings may result in dense, even-aged oak stands of little diversity. Dense, even-aged oak stands support fewer kinds of wildlife.

Oak/Pine Mixed Zones

The difference between conifer encroachment and those oak/conifer associations valuable to wildlife is often unclear. Consultation with biologists from the WDFW and other oak specialists is strongly recommended whenever uncertainty prevails. Almost without exception, conifers associated with oaks in eastern Washington and along drier sites in the Columbia Gorge do not encroach negatively on oaks. Conifer/oak associations in these areas are limited and very valuable as actual or potential habitat, particularly for western gray squirrels and wild turkeys. Conversely, conifer encroachment on oaks in western Washington and along wetter sites in the Columbia Gorge, such as the White Salmon drainage, is prevalent and undesirable.

Oak/conifer associations provide contiguous aerial pathways for squirrels and other animals. Mixed oak/conifer associations are particularly important in potential western gray squirrel habitat and for increasing stand diversity for breeding birds (Rodrick and Milner 1991, WDW 1993).

Failure to provide conifer associations in oak woodlands may limit the number of species of breeding birds present. In addition, roost sites for wild turkeys and other birds, as well as feeding sites for squirrels, will be absent.

4.5.1 Western Gray Squirrel (*Sciurus griseus*)

Rationale for Selection

Although the western gray squirrel was once abundant and widespread throughout oak-conifer forests, its range in Washington State has contracted to three disjunct populations, one of which includes portions of Klickitat County and the Lower Mid-Columbia Mainstem Subbasin. The Oregon side of the subbasin lacks the western gray squirrel's preferred ponderosa pine/Oregon white oak habitat and the squirrel is not found in this area. Population loss and fragmentation is largely due to disease (i.e., mange) associated with invasion of California ground squirrels and seasonal weather differences, which effect acorn production. Habitat loss and degradation is also a likely long-term factor. In the future, competition from the introduced eastern grey squirrel may also be an issue. The western gray squirrel is heavily associated with both ponderosa pine and Oregon white oak forests. In the Columbia River Gorge, Oregon white oak-ponderosa pine forests prevail. These forests follow stream drainages northward toward Goldendale and into Yakima County (Franklin and Dyrness 1973).

A 1993 unpublished status review by the Washington Department of Wildlife found that the species was "in danger of extirpation from most of its range in Washington" (WDW 1993), although in Klickitat County the population appears to be stable. The western gray squirrel is now a state threatened species in Washington State and a federal species of concern. Due to their strong association with late seral oak and pine forests, the western gray squirrel was chosen as a focal species for the Ponderosa Pine/Oregon White Oak wildlife focal habitat.

Key Life History Strategies: Relationship to Habitat

Summary

Recommended habitat objectives include the following (Foster 1992):

- Contiguous canopy cover (mean = 60%);

- Nest tree age (69-275 yr, mean = 108 yr);
- Diameter at breast height (21-58 cm, mean = 40 cm; 8.2-22.6 in, mean = 15.7 in);
- Within 180 m (600 ft) of water;
- Adequate food sources with acorns important in winter and early spring and pine cones and seeds in late summer and fall, and
- Adequate habitat within home range -- In Klickitat County 95% home ranges from 10-187 ha (mean 73 ha) for males and 3-44 ha (mean 21 ha) for females (Linders 2000).

General

Western gray squirrels need a variety of mast-producing trees for food, cover and nesting sites (WDW 1993). The quality of the habitat is influenced by the number of mast-bearing tree species in and near the nest tree sites, the age and size of the trees, and proximity to permanent water (Cross 1969, Gilman 1986, Foster 1992). The western gray squirrel is usually associated with mature forests, which provide the above-mentioned characteristics (WDW 1993).

Generally, the squirrels require trees of sufficient size to produce an interconnected canopy for arboreal travel (Foster 1992). Barnum (1975) observed no use of a lone pine tree that was full of green cones, conceivably because there was no travel cover available.

Since extinction or extirpation rates are partly area-dependent, the size of reserves, spacing of reserves, and location of dispersal corridors are important. Individual reserves must be large enough to ensure stability of the ecosystem and to provide a buffer from disturbance (Frankel and Soulé 1981).

Oak was more common in Washington 10,000 years ago, before a long-term climatic change (Kertis 1986). The western gray squirrel was probably more widely distributed in prehistoric times and has diminished recently along with the oak woodlands (Rodrick 1987). Presently, both the oak and the squirrel are at the northern extent of their ranges and are subject to increased pressure from a variety of environmental factors.

Nesting

Most squirrels build round stick nests, approximately 60 cm (2 ft) in diameter, in pole to sawtimber-sized conifers, about one third of distance from the top of the tree and next to the trunk. The nests are lined with lichen, moss, and bark shavings (WDW 1993).

Population Status and Trend

Status

The Western Gray Squirrel is listed as a threatened species in Washington, while its status in Oregon is yet to be determined (ODFW 2004b). In a 2003 Status Review and 12-month finding for a petition to list the Washington population of the western gray squirrel (68 FR 34682), the USFWS concluded that listing was not warranted because the Washington population of western gray squirrels is not a Distinct Population Segment and, therefore, not a listable entity. The Washington populations are discrete from the Oregon and California populations and are declining; they are not “significant to the remainder of the taxon”. The U.S. Forest Service considers the squirrel to be a sensitive species, and uses it as an oak-pine community management indicator species in the Columbia River Gorge National Scenic Area.

Lewis and Clark (Thwaites 1904) described western gray squirrels as locally abundant in the Columbia River Gorge (see **Figure 16** for map of historic distribution). In a book written on the Klickitat area (Neils 1967), Norris Young, an early settler of the town of Klickitat, wrote in 1890 "About this time our grub was getting low. We had killed almost enough gray squirrels to cover our roof and fringe the eaves with squirrel tails. However, we stayed until our food was all gone and we started to live on meat alone."

Residents have noticed a decline of western grays in Klickitat County (Rodrick 196). Prior to the invasion of the California ground squirrel (*Spermophilus beecheyi*), local residents reported more western gray squirrels in the gorge in the 1920s (WDW 1993). Ground squirrel both competed for food and introduced mange to this population, likely contributing to the decline in western gray squirrels (WDW 1993). For example, during a study of western gray squirrels in Klickitat County conducted in 1998 and 1999, an outbreak of mange killed all but 4 of 22 squirrels being monitored by radiotelemetry (Cornish et al. 2001). Although exact reasons for their decline are unknown, changes in the landscape may have played a role.

Isolated populations remain in the southeast slope Cascade region, and the Columbia River Gorge, the latter being the largest in the state (figure 18). Recent records indicate that western gray squirrels are present in five major tributaries of the Columbia Gorge: the Klickitat River, Catherine, Majors, and Rock Creeks, and the White Salmon drainage. In Klickitat County, the population seems to have been stable during the past 20 years. Since 1973, D. Morrison (from WDW 1993, pers. comm.) has observed several western grays each year on the Klickitat Wildlife Area. The western gray squirrel appears to be widely distributed across forested habitats of Klickitat County, but populations are localized. The core population of the western gray squirrel is currently found in the lower Klickitat drainage from the southern Yakama Nation boundary to the mouth of the Klickitat River.

Figure 16 Historic distribution of western gray squirrels in Washington (Source: WDFW, unpub. data)

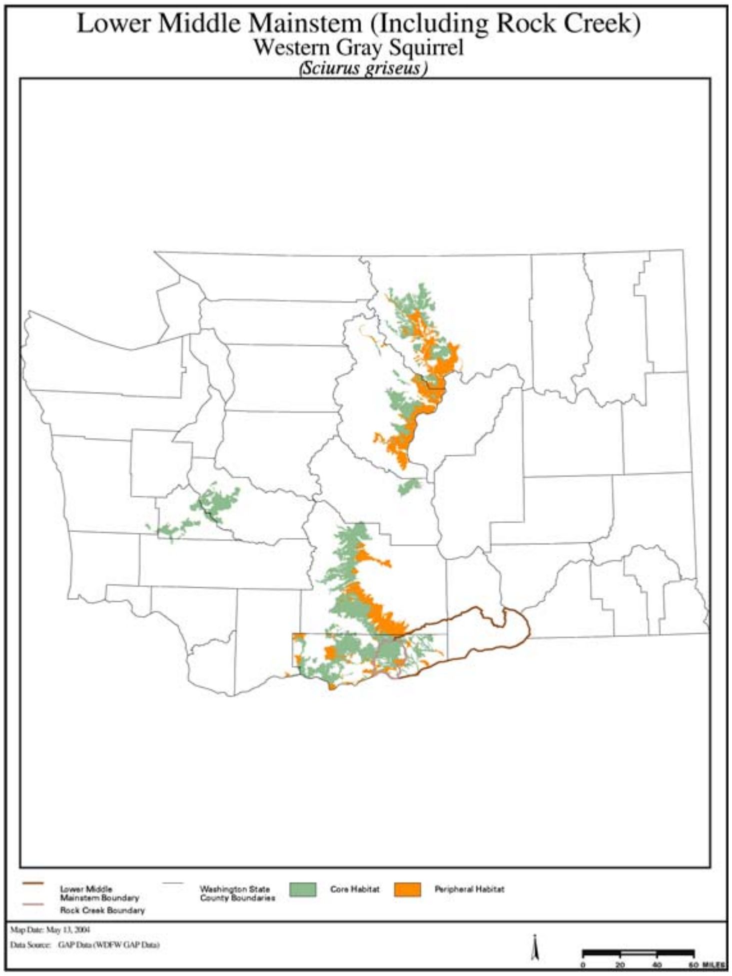


Figure 17 Potential habitat for western gray squirrel in the Lower Mid-Columbia Mainstem (including Rock Creek) subbasin and Washington State (Johnson and Cassidy 1997)

Trend

Long-term trends in the South Cascades population are unclear, although researchers did observe a decline in response to a widespread mange outbreak in 1998-9 and a subsequent rebound in the years following (M. Linders unpubl. data). In Klickitat County, the population seems to have been stable during the past 20 years.

Management Issues

Persistence of this species in the state of Washington will likely depend on state-level protections of oak-conifer habitats and voluntary efforts by landowners and federal entities.

The Washington Department of Fish and Wildlife is in the process of writing a draft recovery plan, which is expected to be due out for public review in the summer of 2004.

Anecdotal evidence suggests there was essentially no acorn crop in the Columbia Gorge in 1991, and an insignificant crop in 1992 (from WDW 1993), indicating that weather cycles associated with mast failures also may cause cyclical declines in squirrel populations.

Out-of-Subbasin Effects and Assumptions

A radio telemetry study of 25 western gray squirrels in Klickitat County, Washington, found 95% MCP year-round home ranges from 10-187 ha (mean 73 ha) for males and 3-44 ha (mean 21 ha) for females (Linders 2000). Home ranges of males were largest, then breeding females, with nonbreeding females having the smallest ranges (Linders 2000).

Relationship with Riparian/Fisheries Issues

In lower Columbia subbasins, oak habitat is commonly found along the main rivers and their tributaries. Large oak trees can provide shade for streams edges, while roots can provide bank stabilization. Healthy riparian terrestrial habitat provides habitat for wildlife as well as nutrients and woody debris, an important stream component for fish.

Factors Affecting Population

Weather

Annual fluctuations in rain and temperature can effect acorn production, which will result in annual fluctuation in western gray squirrel mortality.

Absence of late seral oak and pine

Older trees produce more acorns and pine seeds, vital food sources, and produce better nesting sites (cavities in oak, platforms in pine). There is also an increase in crown connectivity, which is important for arboreal travel.

Presence of non-historical squirrel species:

There has been an increase in California ground squirrels in this subbasin, but the affect on the western gray squirrel population is largely anecdotal. They moved up through Oregon naturally, but there was a rapid increase in their numbers here following the construction of dams and bridges across the Columbia River (WDW 1993). They likely compete for food and nesting, and it has been suspected that California ground squirrels transferred manage to the western gray squirrel population causing a population crash (Brady, pers. comm., 1993).

Eastern gray squirrels (*Sciurus carolinensis*) were introduced into western Washington. Although it is not clear whether eastern gray squirrels displace western gray squirrels, they do areas where westerns were found historically, but are no longer present. This may be due to easterns tolerance of developed areas that westerns do not have. This may have caused easterns to replace rather than displace westerns (WDW 1993). Eastern gray squirrels have been observed in the Big White Salmon subbasin (Anderson and Backus, pers. comm.). There presence in the Rock Creek watershed has not yet been determined.

4.5.2 White-Headed Woodpecker (*Picoides albolarvatus*)

Rationale for Selection

White-headed woodpeckers are a native species that is associated with healthy ponderosa pine forests. They are usually found in montane coniferous forest at 4,000-9,000 ft. elevation and depend on large, old growth (or late seral) ponderosa pines or mixed conifer forest dominated by ponderosa pine for nesting and food (Bull et al. 1986, Dixon 1995a,b, Frenzel 2000). They are also a Washington state candidate species, an Oregon State sensitive species (critical), and a partners in flight (PIF) species and are on the Priority Habitats and Species (PHS) list. Due to their strong association with ponderosa pine forests, they were chosen as a focal species for the Ponderosa Pine/Oregon White Oak focal wildlife habitat.

Key Life History Strategies: Relationship to Habitat

Summary

- Mature and old-growth ponderosa pine and mixed conifer forests (Lewis et al. 2002);
- Varying recommendations on average dbh (diameter at breast height): 10 trees per acre over 20 in. dbh and two trees per acre over 28 in. (Blair and Servheen 1993); mean of 10 trees per acre >21 in. dbh, at least 2 trees per acre > 31 in. dbh (Altman 2000); nine trees over 27 in. dbh per acre (Dixon 1995b); mean 28 in. (Frederick and Moore 1991), and mean of 1.1 trees per acre of 31 in. dbh, for nesting (Frenzel 1998);
- Recommendations also vary regarding large, decayed snags for nesting and roosting: mean average = 51.5 cm dbh (Buchanan et al. 2003), 39.6 cm dbh (J. Kozma, unpub. data); mean of 5 snags per acre over 21 in. dbh, for nesting (Frenzel 1998), and mean of 1.4 per acre > 8 in. dbh with > 50% > 25 in. dbh in a moderate to advanced state of decay (Altman 2000);
- Home Range: 333 acres – predominantly old growth habitat (Dixon 1995b), and 720 acres – fragmented habitat.
- Varying mean canopy closure recommendations include: 56% (Dixon 1995b, Frederick and Moore 1991), 10-40% (Altman 2000)and nesting may not occur in stands with > 26% canopy cover (Frederick and Moore 1991);
- Low tree density, mean 116 trees per acre (Frederick and Moore 1991), and
- Sparse understory vegetation, increased height of first canopy layer (Bate 1995).

Nesting

White-headed woodpeckers need old growth ponderosa pine forest habitats for healthy populations. Large pines eventually turn into large dead trees, or snags, which are ideal for nesting. White-headed woodpeckers favor selection of completely dead and moderately to well-decayed snags for nesting, but studies conducted in Oregon, Idaho, and California revealed the birds also use stumps, leaning logs, and the dead tops of live trees (Dixon 1995a, 1995b, Frederick and Moore 1991, Milne and Hejl 1989).

This species is a weak primary excavator and unable to excavate into hard wood (Raphael and White 1984, Milne and Hejl 1989, Dixon 1995). Therefore, snag decay is often a better predictor of nest site selection in white-headed woodpeckers than diameter of the snag (Frederick and Moore 1991). These birds prefer to build nests in trees with large diameters with preference increasing with diameter. This species typically roosts in both live and dead ponderosa pine trees averaging 60 cm dbh and 7 m tall (Lewis et al. 2002). Oregon studies conducted in the Deschutes and Winema national forests (Dixon 1995 a,b) revealed a 25.6 in. (65 cm; for 43 nests) and 31.5 in. (80 cm; for 16 nests) mean dbh, respectively.

Diet and Foraging

The white-headed woodpecker forages primarily on ponderosa pine seeds. It also feeds on invertebrates (e.g. spruce budworm, larvae, ants, and cicadas) (Dixon 1995b) and insects (e.g. ants, beetles, and scale insects) (Garrett et al. 1996)

Large diameter trees reduce energy expenditure and decrease vulnerability to predation since more time is spent foraging on one tree rather than flying to many trees to find the same quantity of food. In addition, large diameter pine trees often have large cone crops providing a more abundant winter food source. Large conifers selected for foraging also have furrowed bark with numerous fissures; important for species like white-headed woodpeckers that forage predominately by peering and probing bark crevices for insects (Garret et al. 1996). During cold spring weather, birds foraged primarily on ponderosa pine cones, with stomach contents of two males and two females yielding 70-90%pine seeds (Ligon 1973). In early summer, males foraged primarily on the thick cluster of growing needles on branches, presumably taking mostly arthropods (Ligon 1973). In late summer, both males and females foraged on the main trunk of trees and unripened (green) pinecones.

Open stands are important, however, not as important as the presence of mature or veteran cone producing pines within a stand (Milne and Hejl 1989). Old growth ponderosa pine trees produce higher numbers of cones, an important source of food for white-headed woodpeckers. The understory vegetation is usually very sparse within the preferred habitat and local populations are abundant in burned or cut forest where residual large diameter live and dead trees are present. Milne and Hejl (1989) found 68%of nest trees to be on southern aspects.

Population Status and Trend

Historically, white-headed woodpeckers were likely widespread and patchy across the lower elevation forests dominated by large ponderosa pine in the Klickitat subbasin, Washington. North of the subbasin, in the Wenas Valley, bird watcher’s records at the site of an annual Audubon Society campout since the 1950s, indicate substantially reduced observations of this species over the years. The area has been logged for large diameter overstory trees several times during this period.

Although its overall range in Oregon appears to be similar to historic patterns (Gabrielson and Jewett 1940), the woodpecker’s distribution is believed to have become more patchy because of habitat deterioration associated with timber harvest and fire suppression. There is no ponderosa pine habitat in the areas of Oregon convered by this subbasin plan and the white-headed woodpecker is not known to inhabit the Columbia Plateau Province in Oregon (ODFW 1993).

Although populations appear to be stable at present, this species is of moderate conservation importance because of its relatively small and patchy year-round range and its dependence on mature, montane coniferous forests (figure 19). Knowledge of this woodpecker’s tolerance of forest fragmentation and silvicultural practices will be important in conserving future populations.

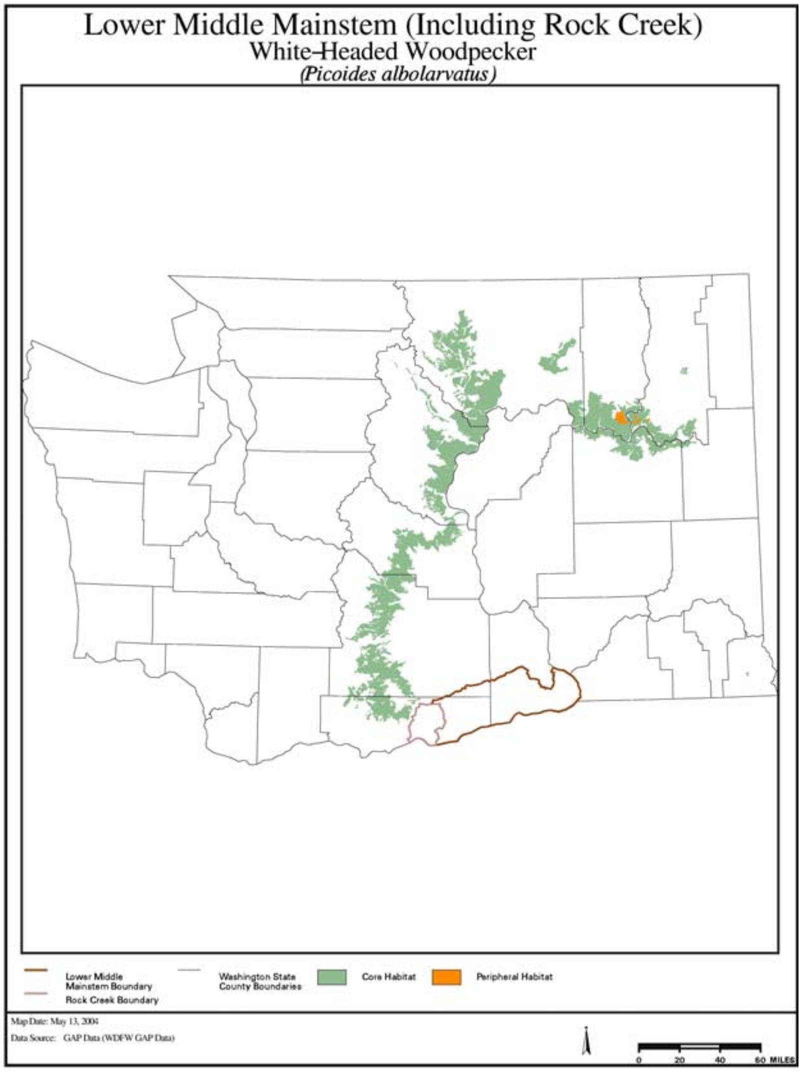


Figure 18 Potential habitat for white-headed woodpeckers in the Lower Mid-Columbia Mainstem (including Rock Creek) subbasin and Washington State (Smith et al. 1997)

Management Issues

Connor (1979) states that managing for the minimum habitat requirements may cause gradual population declines. Therefore, it is recommended that forests be managed using average rather than minimum suggested values.

Relationship with Riparian/Fisheries Issues

The historic heavy harvests of ponderosa pine forests resulted in increased runoff into adjacent streams, increasing sediment and raising temperatures for those streams. Maintaining appropriate buffers adjacent to streams capable of supporting white-headed woodpeckers will increase the health of the streams and reduce sedimentation. This will in turn provide better habitat for fish and other stream dependent species.

Out-of-Subbasin Effects and Assumptions

The white-headed woodpecker is a non-migratory bird and occupies the same home range year round. However, some birds have been recorded wandering to atypical habitats (lower elevation, suburban areas, etc.) during the winter. Local movement of birds may be in response to locally abundant food sources such as spruce budworms (*Choristoneura occidentalis*) and pine seeds (Garret et al. 1996). Most records of movement outside of normal breeding areas occur from August to April.

Factors Affecting Population

Timber Activities

Logging has removed much of the old growth cone producing pines throughout this species' range, which provide winter food and large snags for nesting. The impact from the decrease in old growth cone producing pines is even more significant in areas where no alternate pine species exist for the white-headed woodpecker to utilize.

Fire Suppression

Fire suppression has altered the stand structure in many of the forests. Lack of fire has allowed dense stands of immature ponderosa pine as well as the more shade tolerant Douglas-fir to establish. This has led to increased fuel loads resulting in more severe stand replacing fires where both the mature cone producing trees and the large suitable snags are destroyed. These dense stands of immature trees has also led to increased competition for nutrients as well as a slow change from a ponderosa pine climax forest to a Douglas-fir dominated climax forest.

4.5.3 Ponderosa Pine/Oregon White Oak Habitat and Focal Species Key Findings, Limiting Factors and Working Hypotheses

Table 17 Key findings, limiting factors and working hypotheses for the Ponderosa Pine/Oregon White Oak focal habitat and its representative focal species

PONDEROSA PINE/OREGON WHITE OAK		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Habitat communities have changed considerably in stand structure and composition compared to historical conditions.	Reduction of Large Diameter Trees and Snags	Appropriate silvicultural practices that retain old overstory trees, increase average diameter of dominant trees, increase snag density and size will recover ponderosa pine late seral composition and structure. These conditions increase habitat and forage available to wildlife.
	Increased Stand Density and Decreased Average Tree Diameter	Reintroduction of an ecologically-based fire regime will recover late seral ponderosa pine and Oregon white oak stand dynamics, ecological function by decreasing stand and stem density, improving wildlife habitat quality and decreasing susceptibility to disease and stand replacement fire.
	Loss of Native Understory Vegetation and Composition	Properly managed grazing will decrease spread of non-native understory plant species and help reestablish a native plant community. Presence of native grasses and forbs will provide good conditions for both wildlife and livestock.
Habitat communities have suffered habitat loss and fragmentation.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Silvicultural practices and land use that retain large tracts of intact late seral forests will decrease temporary fragmentation of focal species habitat.
PONDEROSA PINE/OREGON WHITE OAK - FOCAL SPECIES		
Western Gray Squirrel		
Key Findings	**Limiting Factors**	**Working Hypotheses**
Focal Species have suffered fragmentation between populations due in large part to fragmentation and degradation of late seral oak, pine and riparian conditions on which they depend.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Silvicultural practices that retain large tracts of intact late seral forests will decrease temporary fragmentation of western gray squirrel habitat.
	Increased Stand Density and Decreased Average Tree Diameter	Utilizing fire as a tool to improve used and potentially used wildlife habitat will increase the quality of degraded habitat and result in greater numbers of western gray squirrels.

PONDEROSA PINE/OREGON WHITE OAK		
Key Findings	**Limiting Factors**	**Working Hypotheses**
	Loss of Native Understory Vegetation and Composition	Properly managed grazing will decrease spread of non-native understory plant species and help reestablish a native plant community. Presence of native grasses and forbs will provide good conditions for both western gray squirrels and livestock.
	Loss of Individual, Late Seral Trees (From Woodcutting)	Discouraging woodcutting in old growth stands will help retain late seral trees in landscape.
Focal species have suffered declines from competition due to presence of squirrel species historically not present.	Increased Competition with Western Gray Squirrels	Reduction of California ground squirrels will increase survival of western gray squirrels locally, increasing numbers present in the subbasin.
White-Headed Woodpecker		
Loss of late seral pine trees has decreased nesting and foraging habitat for white-headed woodpeckers and fragmented potential habitat.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Silvicultural practices that retain large tracts of intact late seral forests will decrease temporary fragmentation of white-headed woodpecker habitat.
	Increased Stand Density and Decreased Average Snag Diameter	Utilizing fire as a tool to improve used and potentially used wildlife habitat will increase the quality of degraded habitat and result in greater numbers of white-headed woodpeckers.
	Reduction of Large Diameter Trees and Snags	Appropriate silvicultural practices that retain old overstory trees, increase average diameter of dominant trees, increase snag density and size will recover ponderosa pine late seral composition and structure. These conditions increase habitat and forage available to wildlife.
	Loss of Individual, Late Seral Trees (From Woodcutting)	Discouraging woodcutting in old growth stands will help retain late seral trees in landscape.

4.6 Habitat of Concern: Lower Mid-Columbia Mainstem

Mainstem/Riverine Habitat Conditions

Physical/Habitat Structure and Composition

Islands in the Columbia River and other parts of the subbasin are of extreme importance to several species of wildlife. Islands provide nesting habitat free of terrestrial predators for ground nesting birds such as Canada geese, ducks, pelicans, and other colonial nesting species. In addition, this subbasin supports one of the largest Northwest concentrations of wintering waterfowl, (Canada geese *Branta canadensis* and mallards *Anas platyrhynch* (ODFW 1993). Development of the hydropower system (increased open water habitat) and agricultural grain production have contributed to the increase in breeding and migrant/wintering waterfowl numbers. In John Day Reservoir, islands occupy approximately 700 ha (USACE 2000).

Embayments, which are shallow water habitats typically connected to the mainstem Columbia River via culverts or small channels, provide special wildlife values. In most embayments, water fluctuates less than in the river because of the elevation of the culvert or inlet channel. The magnitude of waves is also relatively low in embayments. The reduced water fluctuation and protection from wave action is beneficial to wildlife directly, and indirectly, as a result of conditions that promote diverse riparian and wetland vegetative communities. Embayments are of special importance to beaver and muskrats because of the reduced water fluctuations and also provide food resources and protected loafing and roosting areas for waterfowl and other water birds.

Abundance of embayments differs among reaches of the Columbia River. McNary Reservoir appeared to have 21 embayments in the mid-1970s (Asherin and Claar 1976). Approximately 17 embayments are connected to John Day Reservoir, with the largest being Paterson Slough in the Umatilla National Wildlife Refuge (approximately 420 ha). The Dalles Pool had 19 embayments in the mid-1970s (Tabor 1976).

River deltas and mudflats occur along McNary reservoir, particularly at the mouth of the Walla Walla River. These areas provide critical migration stop-over habitat for shorebirds, and are frequently used by waterfowl and wading birds. These extensive shallow-water areas and mudflats are critical for shorebird foraging. Because these areas attract shorebirds and waterfowl, they are often used by predators as well, including peregrine falcon, bald eagle, and others (Ward 2000).

The quantity of riparian and wetland habitat identified in mid-1970s inventories was small (Tabor 1976). An example is John Day Reservoir, where only 230 ha of riparian habitat and 925 ha of wetland habitat remain (USACE 2000). The implications of riparian area degradation and alteration are significant for fish populations that utilize these habitats for rearing and resting (Lautz 2000).

Vegetative Habitat Structure and Composition

Riparian areas within the Lower Mid-Columbia Mainstem subbasin have been degraded in part by the invasion of exotic plant species. One such species is False Indigo. Just 10 years ago, the shoreline and islands of the lower mid-Columbia River were comprised of shrub-steppe and grassland cover. Now, false indigo has displaced much of the native vegetation along the

Washington and Oregon shorelines, as well as the perimeter of many of the islands. One small island, Straight Six, is completely covered with this invasive weed (Morgan, ODFW, and Browers, USFWS, Pers. Comms. 2004).

Mainstem Wildlife Resources

The Northwest Area Committee, a multi-agency spill response planning group, identified a number of areas in Columbia River mainstem, including the Dalles, John Day, and McNary pools, where habitat resources and concentrations of waterfowl and shorebirds nest, breed, and winter. Within the Dalles Pool these areas include: 1) mouth of Deschutes River; 2) between Maryhill, WA and Rufus, OR; 3) mouth of Spanish Hollow Creek at Biggs Junction OR; 4) NE of Miller Island in the Columbia River Mainstem - sensitive nesting species, gull and tern nesting area; and 5) islands south and southeast of Brown's Island (includes concentration of diving ducks) (Northwest Area Committee 2004a).

The John Day pool includes the following waterfowl and shorebird habitats: 1) NE of I-82 bridge, near Plymouth WA; 2) second inlet west of Plymouth; 3) island between Irrigon and Umatilla, east and north entrances; 4) shallow water area, WA side, north of Irrigon, OR; 5) Paterson Slough; 6) WA side, east end of abandoned railroad tracks; 7) Big Blalock Island and two islands sw of Big Blalock; 8) Glade, Willow, and Alder creeks; 9) first set of small islands east of Long Walk Island, south end and se point of island, and area between Sand Island and island to the west; inlet east of Messner; 10) northeast corner and west end of Whitcomb Island; 11) Crow Butte Island; 12) inlet entrances to Threemile Canyon; 13) shallow water habitat, RM 255.8; 14) Jones Canyon and Sundale; 15) John Day River mouth and inlet just northwest of John Day Dam (Northwest Area Committee 2004b).

McNary Pool also has many habitat areas that attract large numbers of waterfowl and shorebirds: 1) Strawberry Island - Canada goose nesting habitat and wildlife refuge; 2) Sacajawea State Park shores; 3) inlet west of Highway 410 and inlet just east of Snake River railroad trestle (south end) - sensitive marsh habitat, Hood and Sacajawea Park; 4) inlet just west of Snake River railroad trestle, and inlet mouths south of Snake River railroad trestle (south end); 5) entrance to Villard Pond; 6) point south of and east end of Columbia River railroad trestle; 7) Foundation Island – geese, cormorants, shorebirds, herons; 8) entrance to Casey Pond; 9) south tip of Corps of Engineers habitat management area; 10) Badger Island; 11) mouth of Walla Walla River (various wildlife resources); 12) Juniper Canyon – marsh, Corps of Engineers habitat management area, shallow water habitat; 13) point on south shore opposite Spukshowski Canyon; 14) point northeast of Cold Spring Junction; 15) first island north of Cold Springs Junction; 16) northeast point of peninsula jutting out, north of Cold Springs Junction; 17) two largest islands east of Hat Rock State Park and passageways between the two islands (Northwest Area Committee 2004c).

Environmental/Population Relationships/Limiting Factors

The productivity of shallow water habitats is limited in the Columbia River portion of the subbasin because of fluctuating water levels that are caused by power production at the dams. Shallow water habitats can be very productive for submergent, emergent, and aquatic vegetation, in addition to benthic invertebrate populations. Aquatic plants and invertebrates are important forage resources for many wildlife species. Shallow water habitats comprise approximately 3,600 ha in John Day Reservoir (USACE 2000).

Deltas and mudflats along McNary reservoir and the mouth of the Walla Walla River are affected by fluctuating water levels. Mudflats may not be exposed during critical times, eliminating important food sources for this assemblage of birds.

Hydropower development and fluctuating water levels have also decreased beaver production by destroying their habitat, altering ecosystem and riparian function, and by alternately flooding and exposing their dens. In addition, beavers have been negatively impacted by changes in stream channel morphology, and direct mortality caused by road and railroad construction and maintenance in close proximity to the shoreline of the Columbia River. Degradation of streams through human development has contributed to a decline in the recruitment of aspen and cottonwood, important habitat and food sources for beaver.

Functional Relationship of Assessment Unit with Subbasin

Fluctuating water levels that result from power generation at the dams on the Columbia River have reduced the value of shoreline areas for wildlife (Tabor et al. 1981). Although impoundments have degraded fish and wildlife habitat, they have increased the amount of open water available for some species of wildlife including migrant/wintering waterfowl.

Riparian/Floodplain Condition and Function

The dominant shoreline type within the impoundments is usually rip-rap, followed by smaller rock or sand (Hjort et al. 1981). Shoreline gradient in rip-rapped areas is often very steep ($>45^{o}$). In the relatively common backwaters, banks are often eroded, and substrate is often smaller than in main reservoirs.

Stream Channel Conditions and Function

Mainstem reservoirs in the Columbia Plateau Province have little storage capacity, and discharges through dams are run-of-the-river; therefore, water velocity is generally fast enough to prevent occurrence of a thermocline and oxygen depletion in deep water.

4.7 Habitat of Concern: Agriculture

Agriculture has replaced much of the native habitats historically existing in the subbasin, especially interior grasslands and shrub steppe. Due to the extensive presence of agriculture, it is considered a habitat type today. Some native species still exist in this habitat type, but the diversity of wildlife and plant species is decreased compared to historical habitat that have been replaced by agriculture. Also, agriculture has resulted in introduced plants and animals in the subbasin, many spreading beyond the borders of the agricultural habitat, reducing the quality of native habitats still existing today. Due to the quantity, and likely permanence, of this habitat it must be considered in management of wildlife in the subbasin. It is not considered a focal habitat, but is a habitat of concern that must be addressed in this subbasin plan. Although there are no focal species chosen for this habitat type, some of the wildlife species that are found in these habitats are deer, great blue herons (*Ardea herodias*), Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos*), gopher snakes (*Pituophis catenifer*), as well as many other species.

Key Finding

This subbasin depends on agriculture as its leading economic base. Agricultural lands are also an important habitat component in the subbasin and are found in areas that were historically shrub steppe or interior grasslands. Athough not a historic land use, agriculture does provide many benefits to wildlife. A significant portion of what has been traditionally cropped is now in CRP (Conservation Reserve Program). This program provides permanent native grass with scattered native shrubs that create excellent habitat for wildlife. The remaining agricultural land is predominantly alfalfa, wheat, or pasture. Agriculture like most other industries is becoming more environmentally friendly. No till or direct seeding is now being used wherever it is feasible, reducing emissions, erosion, and conserving natural resources.

In Oregon’s Sherman, Gilliam, and Wasco counties, ESA consultation with NOAA/Fisheries has resulted in plans for conservation-oriented Resource Management Systems for dry cropland and range and pastureland. See 6. Inventory/Federal Plans.

5 Fish Assessment

5.1 Introduction

The subbasin assessment is a technical analysis to determine the biological potential of the subbasin and the opportunities for restoration. It describes the existing and historic resources, conditions, and characteristics within the subbasin with the emphasis on designated focal fish and wildlife species and focal habitat types. The bulk of the assessment work was was done by the Yakama Indian Nation and WDFW with support and involvement of Klickitat County and Oregon Department of Fish and Wildlife.

5.1.1 Fish Focal Species and Species of Interest

Four fish species were selected as primary focal species for this planning effort: white sturgeon (LMM) and steelhead, fall chinook, and coho. Lamprey were selected as species of interest.

Table 18 Fish focal species and their distribution within the Lower Mid-Columbia Mainstem subbasin

Focal Species	Distribution
White Sturgeon	Lower Mid-Columbia River Mainstem
Summer Steelhead	Lower Mid-Columbia River Mainstem, Rock Creek, Spanish Hollow, Fulton Canyon
Fall Chinook	Lower Mid-Columbia River Mainstem, Rock Creek
Coho	Lower Mid-Columbia River Mainstem, Rock Creek

5.1.2 Rationale for Selection of Focal Fish Species

Focal species and species of interest were chosen with the following considerations: 1) status under the Endangered Species Act; 2) ecological significance; 3) cultural significance; 4) *US v. Oregon* guidance. The determinations made by the aquatic technical committee to identify a species as a 'Focal Species' or 'Species of Interest' were made in consideration of the above factors as well as the amounts and types of information available. In addition, the committee limited the scope of focal species selection to a number of species that could be assessed within the limited time available.

Table 19 Focal Species and Criteria Used For Selection in LMM subbasin

Focal Species Criteria	Steelhead/Rainbow	Coho	Fall Chinook	White Sturgeon
ESA Status	Threatened	None	None	None
US v Oregon Significance	Yes	Yes	Yes	Yes
Has Ecological Significance	Yes	Yes	Yes	Yes
Has Cultural Significance	Yes	Yes	Yes	Yes
Anadromous and/or Resident	A and R	A	A	A

The following species were chosen as species of interest:

Table 20 Species of Interest and Criteria Used for Selection

Focal Species Criteria	Pacific Lamprey
ESA Status	None
US v Oregon Significance	No
Has Ecological Significance	Yes
Has Cultural Significance	Yes
Anadromous and/or Resident	A

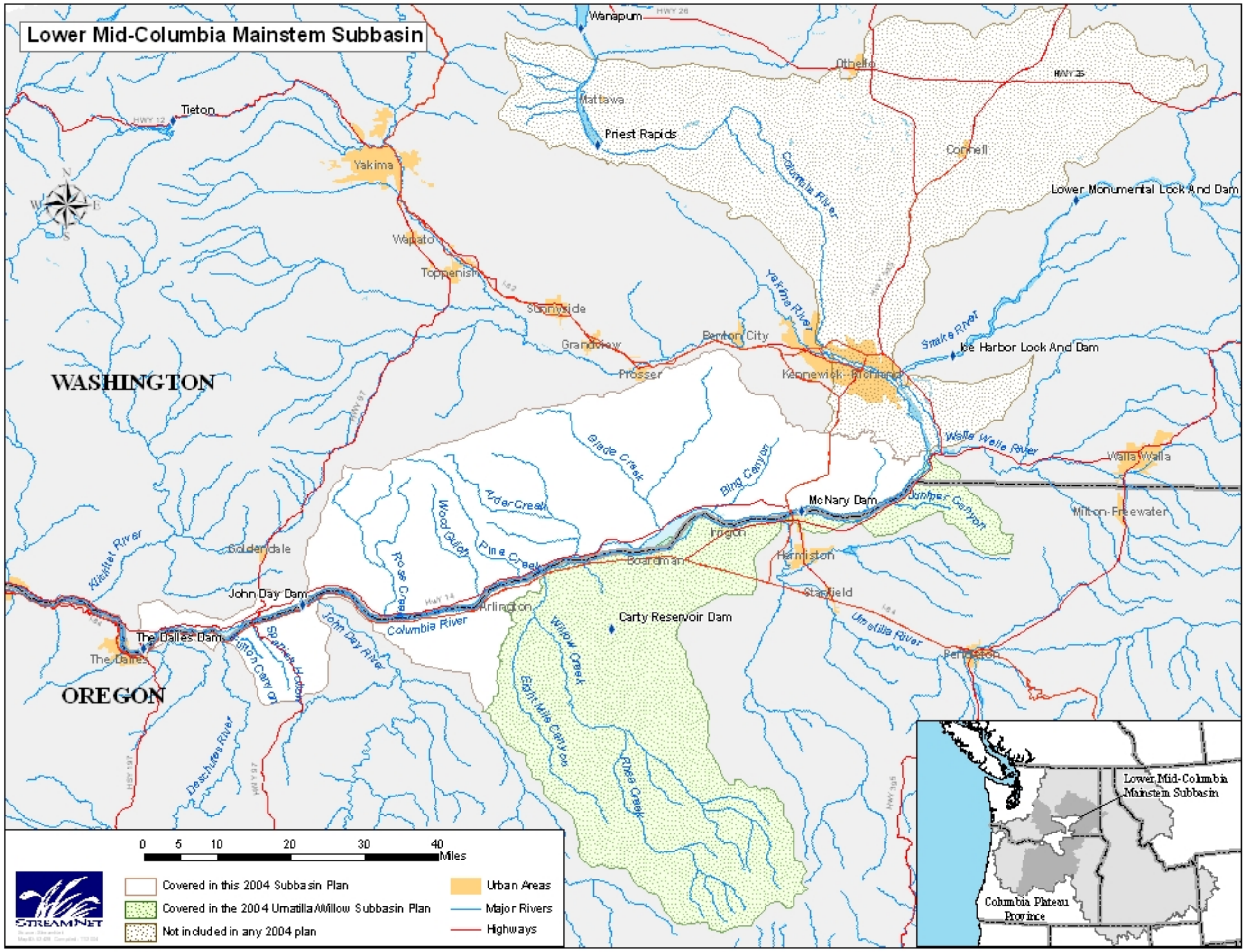


Figure 19 General location map for Lower Mid-Columbia Mainstem Subbasin

5.2 White Sturgeon

Rationale for Selection

White sturgeon (*Acipenser transmontnus*) are the largest of the North American sturgeon and the largest freshwater fish found in North America. Historically, a majority of these fish in the Columbia were anadromous, inhabiting the Columbia River from the mouth upstream into Canada, the Snake River upstream to Shoshone Falls and the Kootenai River upstream to Kootenai Falls (Miller et al, 2004, Scott and Crossman 1973). White sturgeon are found in the lower Mid-Columbia mainstem of the Columbia River, they are a culturally and economically significant species, and there is limited information regarding this species in the lower mid-Columbia mainstem of the Columbia River. For these reasons, white sturgeon were selected as a focal species for subbasin planning in the Lower Mid-Columbia Mainstem Subbasin Plan.

Key Life History Strategies, Relationship to Habitat

Historically, it is believed that a majority of white sturgeon in the Columbia River were anadromous. However, the construction of hydropower dams throughout the Columbia River Basin has resulted in fragmented populations of white sturgeon throughout the Basin. Miller et. al, (USGS Website 2004) identify three distinct populations of white sturgeon in the Columbia River, those below the lowest dam (Bonneville) with access to the ocean, fish isolated between dams (as in the Lower Mid-Columbia Mainstem), and fish in several large tributaries. Although research is limited, existing studies indicate that the dams have not only blocked upstream access for spawning and feeding, but have also impacted the amount and location of spawning habitat and may have altered food availability, natural flow patterns, and water temperatures.

Sturgeon spawn in the Columbia River from May to July in water temperatures of between 48 and 63 degrees F (Wydoski and Whitney, 1979). In an aquaculture setting, maturation seems to be determined more by size than by age (PSMFC 1992). However, maturation in an aquaculture setting may not relate directly to maturation in the wild.

Quoted from PSMFC (1992):

> In the wild, the size or age of first maturity is extremely variable. Wild males begin to mature at about 49 in (125 cm) and 26 lb (12 kg) as 12-year-old fish. In the Snake River, some males may mature at 28 in (71 cm) and about 2.4 lb (1 kg; Cochnauer 1981). Females require a longer period to mature, generally 15-32 years. A few fish mature as younger, smaller fish, but an increasing proportion of the population matures as size and age increase (Beamesderfer et al. 1989, 1990a). In the lower Columbia River 95% of female white sturgeon mature between 124 and 196 cm, corresponding to an age of 16 to 35 years (Welsh and Beamsesderfer 1993; DeVore et al. 1995). Welch and Beamesderfer (1993) estimated median length-at-maturity of 165 cm for female sturgeon in the Bonneville and The Dalles reservoirs, and 193 cm for female sturgeon in the John Day Reservoir.

Fecundity of white sturgeon varies with size, Wydoski and Whitney report that a 95.5 lb sturgeon contained 1.7 million eggs but that total fecundity could be as high as 3 million eggs. In a summary of the Columbia River sturgeon, Worldstar.com states that "spawning sturgeon generally avoid slack water for spawning preferring to deposit their eggs in rocky areas with fast flowing water". Parsley et al (1993) state that spawning and egg incubation occurred in water velocities that ranged from .8 – 2.8 m/s over substrates that were generally cobble, boulder or bedrock. Parlsey and Beckman (1994) report that there is suitable spawning habitat in the tailraces of four lower Columbia River Dams (McNary, John Day, The Dalles, and Bonneville) and that the amount of suitable spawning habitat tends to increase with increased river flow. The relationship between river flow and young of the year indexes of recruitment (and therefore spawning success), is depicted in **Figure 20**.

The incubation period of sturgeon eggs is 7-14 days, depending on water temperature (Bajkov 1951; Conte et al. 1988). Cultured broods tend to hatch synchronously (Conte et al. 1988). Hatching is complete within 20-48 hours (ODFW 2004a). Most hatching occurs in darkness in the laboratory and may represent adaptive avoidance of visual predators (Brannon et al. 1986). The optimum incubation temperature for subsequent larval viability in a culture situation is 52-63o F (11-17o C). Higher temperatures of 17-20o C result in higher mortality and hatching at earlier developmental stages (ODFW 2004a).

A recent hypothesis proposed by Coutant and cited in ODFW (2004a) suggests that riparian areas may provide important habitat for newly spawned eggs and emerging larvae. If substantiated, this theory could identify a limiting factor in white sturgeon spawning success. Riparian flooding is directly related to hydrograph operation and reservoir level.

Parsley et al (1993) report that young of the year white sturgeon were found at depths of 9-57 m., at water velocities of 0.6 m/s or less, and over substrates of hard clay, mud, silt, sand, gravel and cobble. Fish passage upstream is very limited for white sturgeon.

McCabe and Tracy report that young-of-the-year white sturgeon have been captured less than two months after spawning was estimated to have begun. Young sturgeon grow rapidly during their first summer, reaching a minimum mean total length of 176 mm and weight of 30 g by the end of September (McCabe and Tracy 1993). Juvenile (those over 1 year old) sturgeon were found by Parsley et al (1993) in water depths of 2-58 m., at water velocities of 1.2 m/s or less, and over substrates that consisted of hard clay, mud, silt, sand, gravel, cobble, bounder and bedrock.

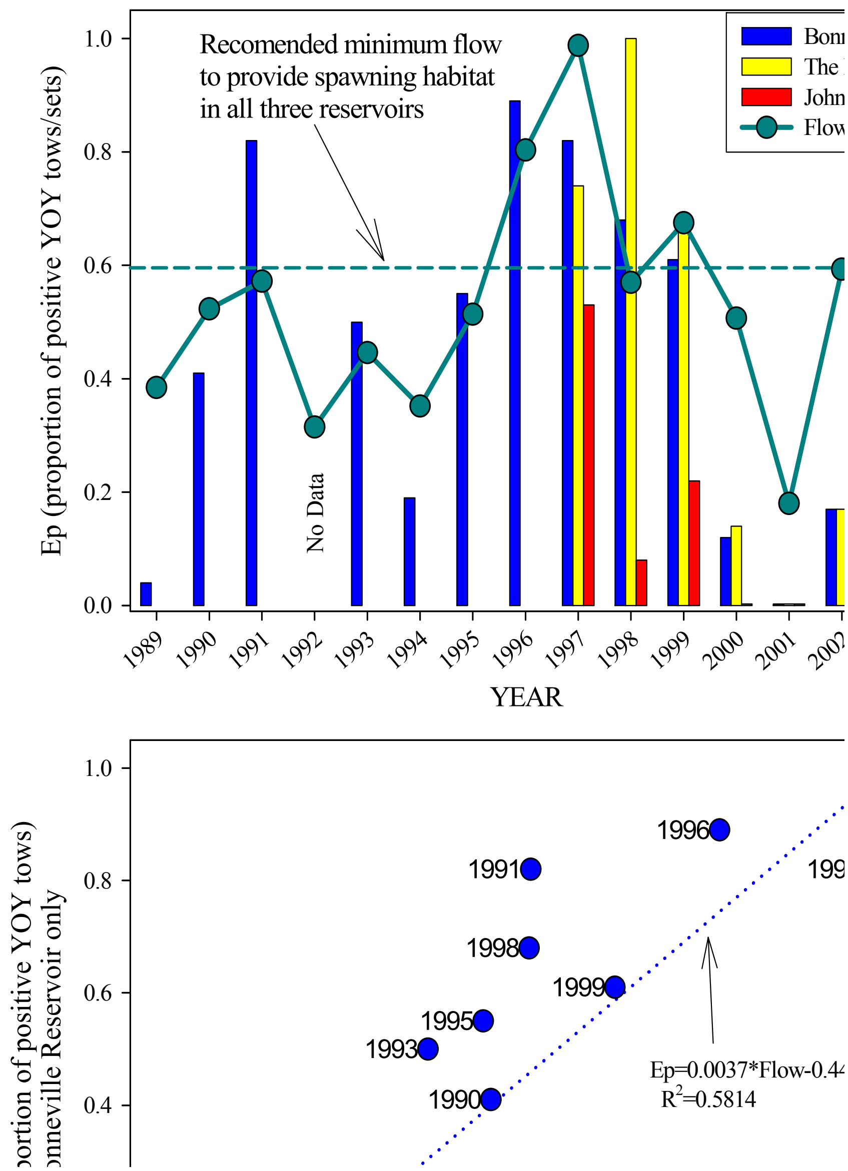


Figure 20 Recruitment index for white sturgeon (proportion of sets capturing one or more young-of-year fish) in Bonneville, The Dalles, and John Day reservoirs, and average daily flow at McNary Dam (April-July)

Note: The Bonneville index is based on standardized trawl efforts 1989-2003. The Dalles and John Day indexes are based on standardized gill-net effort initiated in 1997. All information is preliminary.

Relationship with Other Species

Adult sturgeon in the Columbia River have been reported to feed on clams, crayfish, smelt, suckers, northern pikeminnows, sockeye salmon, and Pacific lamprey, one stomach was reported to contain a house cat (Wydoski and Whitney, 1979). Sturgeon also ingest plant material but researchers believe that they ingest this plant material incidentally (Semakula and Larkin 1968; Cochnauer 1983). Juvenile white sturgeon feed primarily on algae and aquatic insects (PSMFC.Org, 2004). Adult sturgeon in the Columbia River have no natural predators, although, larval, young of the year, and juvenile white sturgeon likely experience predation from a variety of predator species. Predation on larval and juvenile white sturgeon was documented in a laboratory study by Gadomski et al (2001) who determined that size had a greater effect on the number of sturgeon eaten by predators than did turbidity. They determined that prickly sculpins ate white sturgeon up to a mean size of 53 mm total length while channel catfish only ate relatively small sturgeon, about 30 mm total length or less. In contrast, northern pikeminnows reduce their predation on white sturgeon only when they reached a mean total length of 120 mm (Gadomski et al 2001).

Population Delineation and Characterization

White sturgeon are distributed throughout Columbia River reservoirs. Although there is some upstream movement past hydroprojects, white sturgeon do not readily move upstream through fish ladders, it has been theorized that there may be a net downstream movement of white sturgeon past individual hydroelectric projects.

The following quoted text is from ODFW 2004a:

> From 1987 through 2003, 49,000 white sturgeon were tagged in the four lowermost (downstream) Columbia River reservoirs; of these fish, 6,200 (13%) were recaptured by ODFW. During these years, 6,100 (98%) of these fish were recaptured in the reservoir of original capture and tagging, 106 (2%) were recaptured in downstream reservoirs, and 23 (0.4%) were recovered in an adjacent upstream reservoir (Chris Kern, ODFW, from a presentation at the annual meeting of the Oregon Chapter of the American Fisheries Society, February, 2004). To ensure consistency of mark interpretation and reporting, these data do not include creel survey recoveries. White sturgeon marked in the four reservoirs have been recaptured downstream from Bonneville Dam in the unimpounded section of the Columbia River and in coastal tributaries. From 1988 through 1999, 11,755 white sturgeon were tagged in Bonneville Reservoir. Including creel survey recoveries, 1,161 fish were recaptured during this period: 1,127 (97.8%) were recaptured within the reservoir, 33 (2.8%%) were recaptured downstream from Bonneville Dam, and only 1 (0.1%) was caught upstream from The Dalles Dam (Kern et al. 2002).

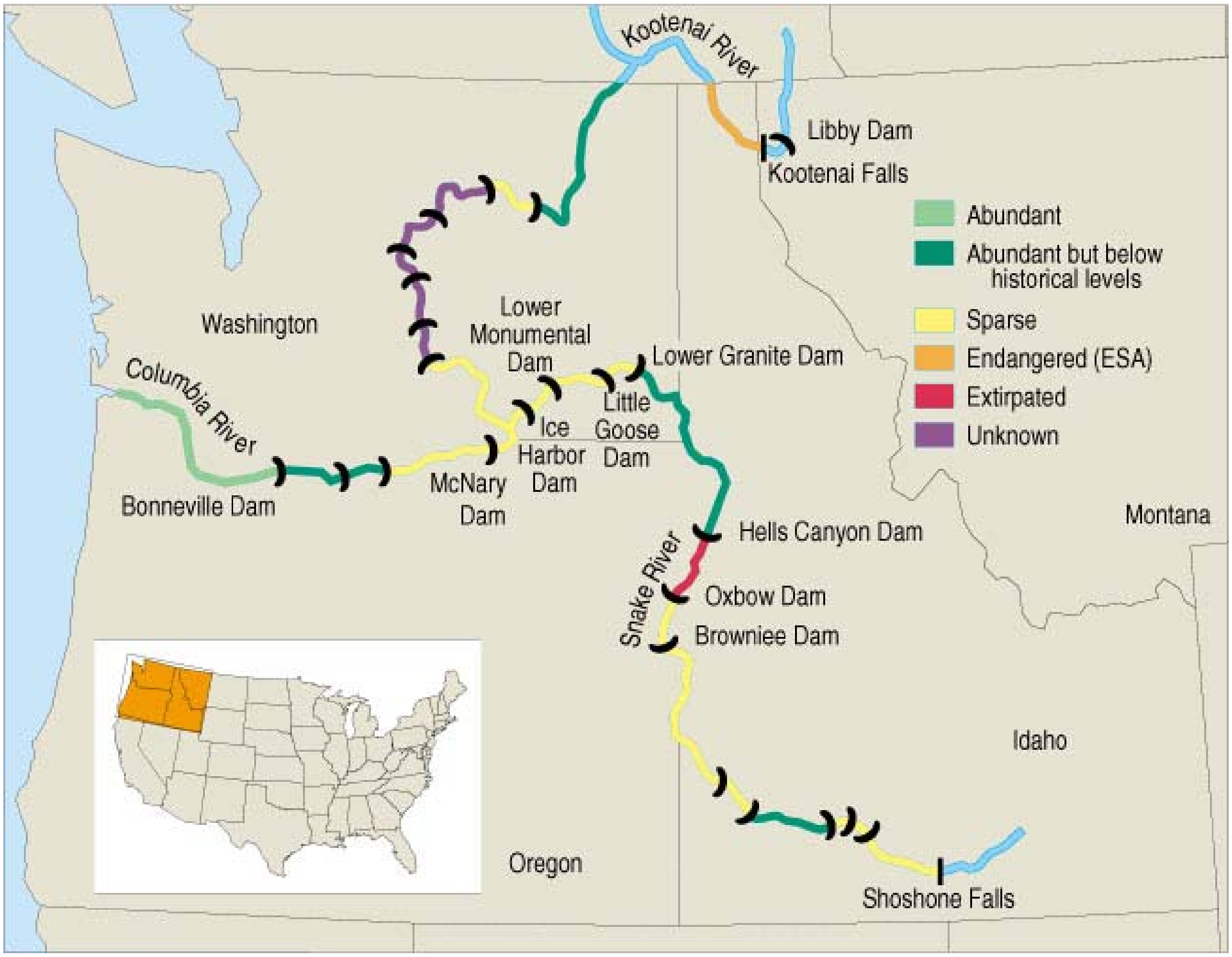


Figure 21 Distribution and status of white sturgeon in the U.S. portion of the Columbia River Basin

Population Status

Miller et al (2004) state in an article located at biology.usgs.gov that the population of sturgeon is "abundant but below historical levels" in The Dalles reservoir but that white sturgeon are relatively scarce in the John Day and McNary reservoirs. The most recent abundance estimate for The Dalles Reservoir was 104,300 fish greater than 24 inches total length in 2002. In John Day there were 30,000 fish greater than 24 inches in 2001. Population numbers have increased in these reservoirs in recent years but most of the increases are in numbers of fish less than 48 in. Abundance of fish in the legal size range (48-60 in.) has fluctuated largely in response to fishery harvest. Estimated abundance of over-legal sized fish has recently increased to levels similar to those estimated prior to 1980 (**Figure 22**, **Figure 23**, **Figure 24**). These white sturgeon populations are less abundant than areas downstream, but still able sustain recreational and tribal commercial fisheries. In 1995, abundance in McNary reservoir and the Hanford Reach was estimated as 8,250 fish greater than 24 in. (**Figure 25**).

Density was higher in McNary Reservoir than in the Hanford Reach. The higher number of white sturgeon in The Dalles reservoir may be a result of more favorable conditions in that reservoir or may be a result of a net downstream movement of sturgeon through the hydrosystem. Further research would be necessary to determine the cause of the varying density in the reservoirs of the Lower Mid-Columbia Mainstem Columbia River.

White sturgeon often experience year-class failures and poor recruitment to young of the year in mainstem reservoirs (Parsley and Beckman 1994). Although recent population estimates in John Day and The Dalles reservoirs (Ward 1998; Ward 1999) are higher than previous estimates (Beamesderfer et al. 1995), larval and juvenile fish have remained relatively scarce. Kern et al (2001) report that sampling of The Dalles, John Day, and McNary reservoirs in 2000 captured young of the year sturgeon only in The Dalles reservoir, an indication of poor spawning success and recruitment in 2000. A possible cause of the poor recruitment in 2000 could be that the peak runoff occurred in April and May, before water temperatures had reached the preferred spawning temperature of white sturgeon. White sturgeon spawning was documented for the first time in Priest Rapids Reservoir in 2000 (Grant PUD, unpublished data).

Total Length	Year				
(inches)	1987	1988	1994	1997	2002
30 - 72	23,600	9,000	9,700	59,800	33,000
(95% CI)	(15,700-33,600)	(7,300-11,000)	(7,500-14,000)	(52,400-68,100)	(26,200-42,000)
24-36	7800	4200	5800	26500	82900
36-48	11,000	4,300	5,700	38,500	13,500
48-60	6,100	1,500	800	8,100	5,900
60-72	1,800	500	<50	200	1,200
72+	1,000	800	300	200	800
24-72+	27,700	11,300	12,600	73,500	104,300

Figure 22 The Dalles Reservoir abundance estimates by total length increment (inches), 1987-2002 (Kern et al. 2004) .

Total Length (inches)	Year 1979	1990	1996	2001
18 - 72	15,971	--	--	--
30 - 72	--	3,900	27,100	19,600
(95% CI)	(13,836-18,651)	(2,300-6,100)	(23,800-30,800)	
24-36	--	16600	5800	14900
36-48	--	1,700	19,700	12,800
48-60	--	400	4,050	1,100
60-72	--	100	350	300
18-36	4,757	--	--	--
36-72	11,214	2,200	24,100	14,200
72+	1,019 [a]	500	700	900
24-72+	16,990	19,300	30,600	30,000

Figure 23 John Day Reservoir abundance estimates by total length increment (inches), 1979 (Macy et al. 1997) and 1990-2001 (Kern et al. 2004).

Note: (a) In 1977 the estimated abundance applied only to fish 18-72 inches and 6% of sampled catch was >72 inches (Macy et al. 1997).

Total Length (inches)	1995
30 - 72	5,234
(95% CI)	(3,782- 9,086)
24-36	900
36-48	2,700
48-72	3,400
72+	1,250
24-72+	8,250

Figure 24 Abundance of white sturgeon between McNary Dam and Priest Rapids Dam by total length increment (Kern et al. 2004)

Population Management Regimes and Activities

Hatchery Effects

Past Management Practices

There is currently one licensed private aquaculture facility downstream from Bonneville Reservoir (Troutdale, OR). This operation is permitted by the State of Oregon to rear progeny of broodstock collected from below Bonneville Dam. Juveniles are sold to the aquarium trade, and some are released into the upper Willamette River as mitigation for the loss of reproduction to the lower Columbia River. Currently, none of these operations directly affect the upstream white sturgeon populations. In recent years the development of more successful hatchery technology has resulted in a growing commercial aquaculture industry in California and the potential for further commercial and enhancement hatcheries in the Columbia River Basin.

The White Sturgeon Management Framework Plan (Fickeisen 1985) identified development of white sturgeon aquaculture as a key action to help restore white sturgeon populations above Bonneville Dam. Beginning in 1999, CRITFC and USFWS biologists began development of a hatchery program to supplement poor recruitment in these reservoirs by hatchery spawning of broodstock collected from the wild. Beginning in 2003, juvenile white sturgeon from these activities were available for release to supplement reservoir populations. Details on the history and achievements of this program can be found in Parker et al. (2004). In 2003, this program produced juvenile white sturgeon for supplementation research. In the same year, funding for the program was eliminated and the project was halted. There are currently no plans to re-establish funding for this program.

Current management Practices

Additionally, there have been efforts to capture, transport, and transplant young of the year white sturgeon from the relatively robust population below Bonneville Dam into The Dalles and John Day reservoirs. This activity has several advantages over other supplementation activities including the elimination of non-natural selection process that may occur in a hatchery environment and will increase the net upstream movement of sturgeon in the Lower Mid-Columbia Mainstem Columbia River. The “trawl and haul” program to transplant sturgeon from below Bonneville Dam to The Dalles and John Day reservoirs was first tested in 1993 and was implemented in 1994 and 1995. Fish transported in these years were all marked with PIT tags, and were all released in The Dalles Reservoir. In 1997, a study was conducted to assess the survival of these releases concurrently with stock assessment activities in The Dalles Reservoir. The results of this study were published in Rien and North (2002). Estimated survival rates from release to recapture in 1997 were 99% for the 1994 release, and 80% for the 1995 release, indicating that survival of transplanted fish was high.

The Trawl and Haul program was fully implemented in 1998. The stated goals of the program are to transplant up to 10,000 juvenile sturgeon (30 – 90 cm fork length or 1 – 6 years old) per year to The Dalles and John Day reservoirs. Because the population density in John Day Reservoir is lower than that in The Dalles Reservoir, about 2/3 of the fish transported annually into John Day Reservoir. As of 2003, about 41,000 juvenile white sturgeon have been transplanted to these reservoirs; 26,000 to John Day, and 15,000 to The Dalles (table 15).

Facilities and Programs

The USFWS, as a part of a cooperative effort funded by BPA, captured wild maturing sturgeon in the Columbia River in 1999 and 2000. They held these fish at Abernathy Creek through the spawning season and released them back to the site of origin. During the 1999 testing, viable gametes were collected from both male and female sturgeon but synchronous spawning did not occur (Holmes 2001). In 2000, lack of oocyte maturation resulted in the collection of no viable gametes. After the 2000 season, it was decided that the 12.5 degree well water that had been used for these experiments was not sufficient to trigger sexual maturation and it was decided to move the program to the U.S. Army Corps of Engineers facility at McNary Dam to provide the adult holding/spawning with water directly from the Columbia River (Holmes 2002).

Effects on Population

At this point, we are unaware of any documentation of the effect of hatchery practices on white sturgeon populations in the Lower Mid-Columbia Mainstem Columbia River.

Table 21 Releases of trawl and haul-transplanted fish, 1994 – 2003

	Release Reservoir		
Year	**The Dalles**	**John Day**	**Total**
1994	2,935	--	2,935
1995	5,611	--	5,611
1998	3,257	5,534	8,791
1999	77	4,171	4,248
2000	1,163	4,019	5,182
2001	1,257	5,195	6,452
2002	941	4,177	5,118
2003	10	2,951	2,961
Total	15,251	26,047	41,298

Hydroelectric Effects

Past Management Practices

The construction of hydroelectric dams on the mainstem of the Columbia River resulted in the fragmentation and inundation of the white sturgeon habitat in the Columbia River and may have created what are believed to be fragmented populations of white sturgeon and reduced spawning habitat. What may have been a continuous population of white sturgeon throughout the Columbia River may potentially be a series of separated populations between mainstem hydropower dams. However, there may be some recruitment into these potentially isolated population through a net downstream movement of white sturgeon past mainstem hydroelectric projects.

Construction and operation of the mainstem Columbia River hydroelectric projects has also affected the spawning habitat of white sturgeon (Parsley and Beckman 1994). White sturgeon spawning and egg incubation usually occur from April through July in the swiftest water available, generally within 8 km of a hydroelectric project (Parsley et al 1993). The amount and quality of spawning habitat is related to total river flow, with the quality and quantity of spawning habitat generally increasing as river flows increase (Parlsey and Beckman 1994). However Ebel et al. (1989) state that the operation of the Columbia River Hydrosystem has reduced the spring and summer flows in the Columbia River. Therefore, in years of relatively low river discharge, the lack of high quality spawning habitat in the Columbia River may preclude successful spawning of white sturgeon.

Parsley and Beckman (1994) state that hydroelectric development in the Columbia River Basin may have resulted in an increase in the amount of rearing habitat suitable for young of the year and juvenile white sturgeon in the impounded reaches of the Columbia River. Impoundment has resulted in increased water depths in the Columbia River reservoirs and, since juvenile sturgeon prefer to use deep water, the total amount of rearing habitat has increased. It is believed that the limited amount of successful spawning and, therefore, recruitment into the population, has resulted in more rearing habitat than the current population can utilize.

Current Management Practices

Work to evaluate and mitigate the effects of the hydropower system on white sturgeon has been systematic and comprehensive. Work commenced in 1983 and between 1983 and 1992 the work concentrated on determining the status and habitat requirements of white sturgeon in the Columbia River. Conclusions from this work led to recommendations for further work including (1) intensified management of fisheries for impounded populations, (2) evaluations of mitigation actions for impounded populations such as transplanting juvenile white sturgeon from below Bonneville Dam and refining and evaluating hatchery technology, and (3) quantifying habitat available and evaluating constraints on enhancement. Work since 1992 has been based on these recommendations. Intensive management of sport and treaty fisheries is ongoing, as are annual transplants of juvenile fish. A broad recommendation for flows that will provide spawning habitat in reservoirs has been developed and final recommendations for operation of the hydropower system is forthcoming. Response of the white sturgeon populations to these actions will be monitored and documented.

The USACE has also recently funded a study conducted by USGS to investigate behavior of white sturgeon near hydroprojects and fishways at The Dalles Dam. Work is scheduled to begin in March 2003 (study code ADS-04-NEW). Objectives are to 1) Describe the distribution, movements, and behavior of white sturgeon immediately downstream from dams including fish ladder entrances and exits, in fishways, navigation locks, and immediate tailrace areas; and 2) Determine routes of passage taken by downstream migrants and if fallback occurs for fish that ascend fishways.

Facilities and Programs (an inventory)

There are three hydropower projects located within the Lower Mid-Columbia Mainstem Columbia River. The Dalles Dam marks the lower end of the Lower Mid-Columbia Mainstem, John Day Dam is located upstream of The Dalles, and McNary Dam is the furthest upstream of the hydroelectric projects located in the Lower Mid-Columbia Mainstem. All of these hydroelectric projects engage in activities designed to mitigate the impact of construction and operation on anadromous fish (primarily salmonids).

From ODFW 2004a:

> Historically, fish lifts that seemed to move white sturgeon effectively were operated at both The Dalles and at Bonneville dams (4,711 fish moved upstream past Bonneville in 12 years). However, these fish lifts are no longer in operation. Fish ladders are less effective at passing white sturgeon upstream than were fish locks, typically when the fish lifts were in operation, less than 30 fish used the ladders at Bonneville annually. Summaries developed by

Warren and Beckman (1993) showed passage at viewing windows at Bonneville, The Dalles, and John Day dams totaled 3,464 fish from 1986-1991. Over 90% (3,181 fish) of these occurred at The Dalles Dam. The east ladder at The Dalles accounted for the vast majority of sturgeon passage at this dam, and by extension, the majority of passage at all three dams as well. The authors noted that counts for other species were also higher at this location than at others. Total length of fish using ladders: appears to range from 1 to 7 feet. Most are around 3 feet and this average size is consistent at all three locations. White sturgeon as long as 11 feet have been reported at The Dalles. One fish counter here noted that extremely large fish turned sideways to negotiate the window orifice. Most passage reported appears to have been upstream in direction. This runs counter to information from tag recoveries that document very few tagged fish recaptured in reservoirs upstream from the tagging location - the majority of fish that are recovered outside the marking reservoir are seen downstream from the reservoir they were marked in. Most white sturgeon passage has been observed from May through November. Peak passage is usually in July and August. Recently USACE has agreed to incorporate white sturgeon counts into their data entry and regular reporting of fish passage numbers.

Effects on Population

Construction and operation of the Columbia River hydrosystem has disrupted the historical migration patterns of white sturgeon and resulted in fragmentation of habitat and populations. Furthermore, the operation of the hydrosystem has affected the productivity of the populations in the impoundments created by the dams, generally reducing the amount and quality of spawning habitat while increasing the amount of rearing habitat.

White sturgeon are not uniformly distributed in The Dalles or John Day reservoirs. Densities (inferred from catch rates) were more than three times greater in the tailrace area immediately below upstream dams than in the rest of the area and densities were lowest in the forebays of downstream dams. White sturgeon of all sizes tended to be distributed more downstream in July than in May, June, July, or September; fish were distributed furthest upstream in September. Fish in The Dalles or John Day reservoirs tended to move more than those in Bonneville Reservoir. Still more than 25% of recaptured white sturgeon had not moved since tagging and over 55% had moved less than 10 km. Catch rates at different depths were significantly different. Using setlines deployed overnight, catch rates in water less than 10 m deep were lowest, fairly uniform from 10 to 30 m, and greatest at sites >30 m deep, however the size-depth interaction was not statistically significant (North et al. 1993).

Harvest Effects

Past Management Practices

A long-lived fish like the sturgeon (life span may exceed 100 years) is susceptible to over harvest. In the 1800s there was a large commercial fishery for white sturgeon that peaked with a total catch of nearly 2,500,000 kg in 1892 and fell to less than 45,000 kg by 1899 (Parsley and Beckman, 1994). Annual harvest was low until the 1940s when the commercial fishery expanded. At this time, a 6-foot maximum size limit was enacted to prevent further population collapse (Miller et al. 2004) The adoption of management practices resulted in recovery of the stocks but yields of sturgeon in the Columbia River did not increase substantially until the 1970s (Parsley and Beckman, 1994).

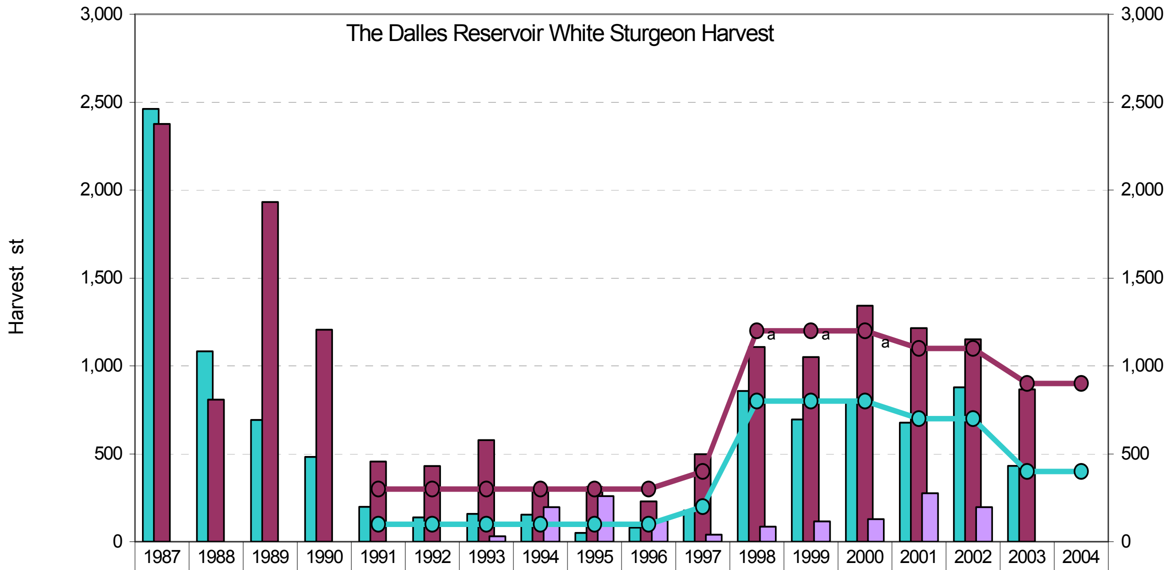
Current Management Practices

Up to 10 sturgeon each year may be caught by anglers, with a daily catch limit of 1 fish and length parameters of 48-60 in (WDFW 2003). In 1990, the sturgeon fishery below Bonneville was estimated to be 17,300 and 5,200 for the recreational and commercial fisheries respectively. From 1983 to 1994, 15 substantial regulations were enacted downstream of McNary Dam to protect white sturgeon from overfishing (Miller et al 2004). Columbia River white sturgeon support an economically important commercial, tribal and recreational fishery that was valued at $10.1 million in 1992.

Harvest estimates are available for white sturgeon in the Lower Mid-Columbia Mainstem Columbia River. Between 1997 and 2003, the recreational fishery in The Dalles reservoir ranged from 178 – 878 fish, for the same time frame, the commercial fishery ranged from 498 – 1,342 fish and the subsistence fishery ranged from 40 – 276 fish (Figure 26). Harvest in the recreational fishery in the John Day reservoir from 1997 – 2003 ranged from 163 – 593 fish, the commercial fishery captured 1,260 – 265 fish, and the subsistence fishery ranged from 24 – 63 fish (Figure 27). There are no estimates of the number of sturgeon harvested from the McNary reservoir (James et al 2001).

Effects on Population

The effects of the historical harvest on white sturgeon were devastating, reducing the population to below commercial harvest levels before the turn of the century. However, current regulations on the fishery and other management practices may have resulted in a white sturgeon population that is capable of sustaining ongoing sport, treaty, and subsistence harvests.

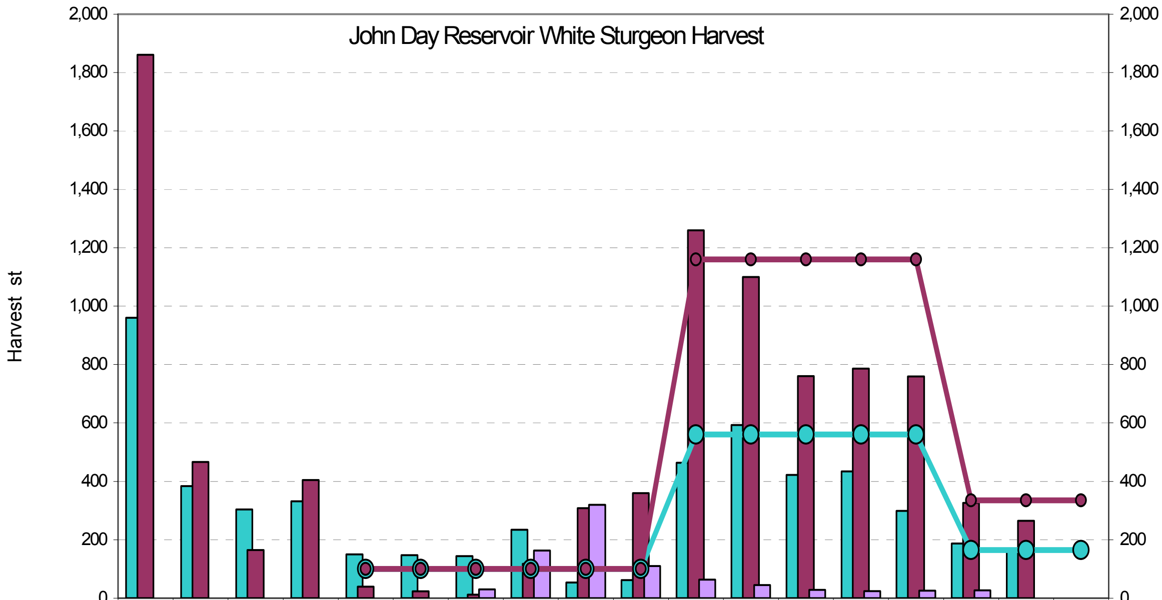


	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Recreational	2,462	1,083	693	482	199	139	158	154	50	80	178	857	695	809	677	878	432	
Commercial	2,376	808	1,932	1,206	457	431	579	309	312	230	498	1,108	1,051	1,342	1,215	1,152	866	
Subsistence							31	197	260	120	40	86	116	128	276	197		
Rec guideline					100	100	100	100	100	100	200	800	800	800	700	700	400	400
Com Guideline					300	300	300	300	300	300	400	1,200	1,200	1,200	1,100	1,100	900	900

Year

Figure 25 White sturgeon harvest in sport (rec), tribal commercial, and tribal subsistence fisheries, The Dalles Reservoir 1987-2004.

Note: (a) During 1998-2000 sport and commercial guidelines were expressed as ranges of 600-800 and 1,000-1,200 respectively (ODFW 2004a)



	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Recreational	960	384	304	331	150	147	144	234	53	62	464	593	422	434	299	187	163	
Commercial	1,861	466	165	405	39	23	12	117	308	360	1,260	1,100	760	786	759	326	265	
Subsistence							30	163	320	110	63	45	28	24	26	27		
Rec guideline					100	100	100	100	100	100	560	560	560	560	560	165	165	165
Com Guideline					100	100	100	100	100	100	1,160	1,160	1,160	1,160	1,160	335	335	335

Year

Figure 26 White sturgeon harvest in sport, tribal commercial, and tribal subsistence fisheries, John Day Reservoir 1987-2004. During 1998-2000

Note: (a) Guidelines were expressed as a range: recreational was 600-800 fish and commercial was 1,000-1,200 (ODFW 2004a)

5.3 Steelhead

Historical Distribution and Abundance

In the LMM subbasin, steelhead (*Oncorhynchus mykiss)* are the second most abundant anadromous fish, fall chinook salmon being the most. Steelhead upstream of The Dalles Dam are summer-run steelhead and are considered to have originated as indigenous species present within the subbasin prior to European settlement (NRIMP 1999). Historically, most of the rivers and streams draining into the lower mid-Columbia mainstem, the John Day, Deschutes, Umatilla, Rock Creek, Fulton Canyon, and Spanish Hollow among others, produced steelhead. In the lower mid-Columbia mainstem, these steelhead stocks mixed with migrating steelhead from numerous stocks upstream of McNary Dam from the Snake River and upper Columbia. Historically steelhead also spawned in the mainstem Columbia, including in the lower mid-Columbia. Presently steelhead stocks in the subbasin are sustained by a mix of hatchery, native, introduced, and wild and/or natural populations (NRIMP 1999).

The Columbia River tribes whose ancestors relied heavily on the lower mid-Columbia stocks, fished for steelhead along with other salmonids in this stretch of river. Prior to Euro-American settlement, steelhead were particularly important to Rock Creek Band members for both sustenance and trade. Steelhead are presumed to have utilized virtually all of the major streams and tributaries of Rock Creek for some aspect of their life history. Historical spawning distribution probably included all accessible portions of the Rock Creek watershed. The highest spawning densities are presumed to have occurred similarly to current practice, in the more complex, braided reaches of the lower mainstem of Rock Creek, as well as in third and fourth order tributaries with moderate (1-4%) gradients.

Life History Forms

Oncorhynchus mykiss, of which steelhead and rainbow trout are members, displays a wide variety of life history strategies. (Rainbow trout are also referred to as Columbia River redband trout.) Anadromy is not obligatory in *O. mykiss* (Rounsefell 1958, Mullan et al. 1992Cpa). Progeny of anadromous steelhead can spend their entire life in freshwater, while progeny of rainbow trout can migrate seaward.

Rainbow trout is not widely distributed within Rock Creek; anecdotal evidence suggests greater historical distribution and population numbers. The rainbow trout co-occur with the anadromous steelhead form of *O. mykiss* within the ESU (Evolutionarily Significant Unit), which includes this subbasin and generally coincides with the Columbia Plateau Province. According NOAA/Fisheries Biological Recovery Team, the two forms may not be reproductively isolated, except where there are barriers (NMFS Tech Memo-27, 1997). Questions also remain about the frequency of residualism within this ESU as well as reproductive isolation. Anadromous steelhead is the focus of interest within Rock Creek. Limited knowledge is available due to a historical lack of resources available for monitoring and evaluation. However, many steelhead have been observed in Rock Creek, warranting greater interest and attention within the Mid-Columbia ESU. (See Current Distribution and Abundance below for more about this Mid-Columbia ESU.)

Steelhead may be classified into two runs (Smith 1960; Withler 1966; Everest 1973; Chilcote et al. 1980). Winter-run fish ascend streams between November and April, while summer-run fish enter rivers between May and October. All steelhead in the Columbia River Basin upstream of The Dalles Dam, with the possible exception of Rock Creek, are summer-run fish (Reisenbichler et al. 1992; Chapman et al. 1994). Although steelhead in the Rock Creek watershed have appeared in some documentation classified as summer-run, there is some evidence that suggests both winter and summer steelhead may utilize Rock Creek. Not all steelhead die after spawning. A small proportion of spawners (known as kelts) may return to the ocean for a short period and repeat the spawning migration. Spawning adults typically range between three and seven years of age.

Two groups of summer-run steelhead migrate through the Columbia River. An early segment known as A group enters the Columbia River in June and July. The B group enters the Columbia River during August and September and is made up of larger fish that are produced primarily in the Clearwater and Salmon river drainages (Chrisp and Bjornn 1978).

A small number of steelhead in Columbia Basin, estimated between 1.6-17%, are able to be repeat spawners (Hatch et al. 2003). Steelhead kelts are those that spawn, survive, and outmigrate again. Researchers are currently investigating ways to reinvigorate kelts to increase their likelihood of survival and successful repeat spawning. See more discussion below in "Population Management."

Current Distribution and Abundance

The hydropower system has eliminated steelhead spawning in the mainstem, with the likely exception of Hanford Reach, which is not in the current planning area of the LMM subbasin. Today steelhead use the mainstem Columbia primarily as a migration corridor and holding area. Steelhead adults stay for extended periods in mainstem reservoirs and near the mouths of major tributaries prior to migrating further upstream. Steelhead in the LMM subbasin are part of the Mid-Columbia Evolutionarily Significant Unit (ESU) and were listed as threatened under the ESA in March of 1999 (NMFS 1999). The Mid-Columbia steelhead ESU, as described by NMFS (now NOAA/Fisheries), occupies the Columbia River Basin from Mosier Creek, Oregon, upstream into the Yakima River subbasin in Washington. In proposing to list this ESU, NMFS cited low returns to the Yakima River, poor abundance estimates for Klickitat River and Fifteenmile Creek winter steelhead, and an overall decline for naturally producing stocks within the ESU (NMFS 1999). (Some populations of Columbia River rainbow trout are on the USFWS Candidate List for proposed listing under the ESA.)

Since NMFS listed steelhead in the Mid-Columbia Evolutionarily Significant Unit (ESU) as threatened, there is evidence that trends in abundance of naturally spawning steelhead are moving upward in the major basins of Mid-Columbia ESU (Cramer 2003).

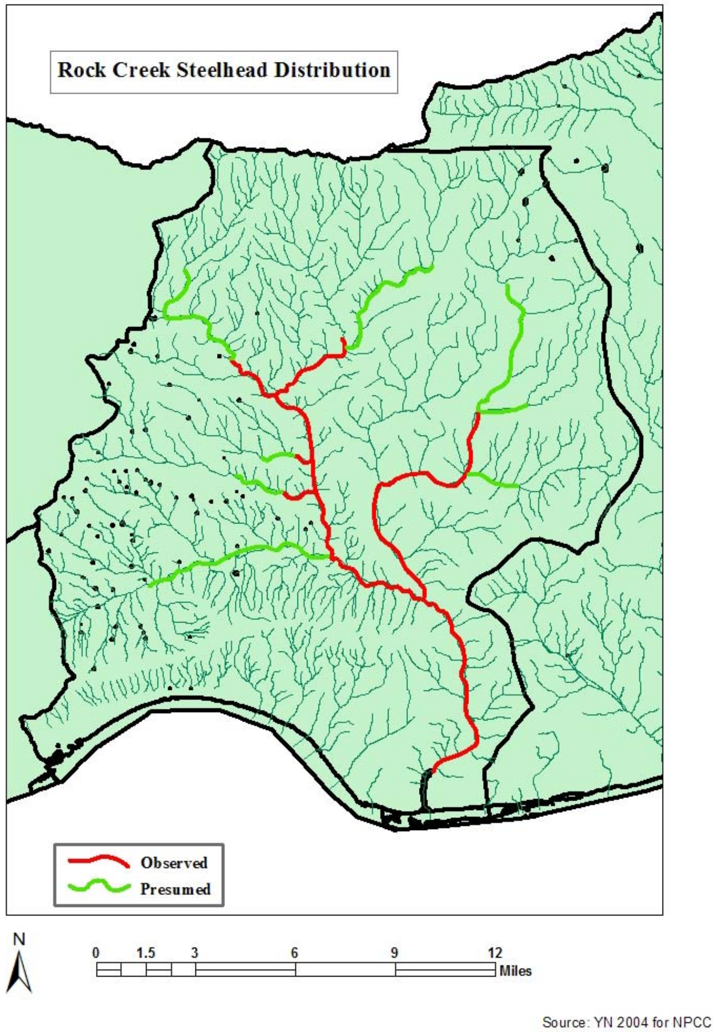


Figure 27 Observed and presumed steelhead distribution in the Rock Creek watershed

The four watersheds in the LMM subbasin (besides the mainstem) that steelhead use include Rock and Pine creeks on the Washington side and Fulton Canyon and Spanish Hollow creeks on the Oregon side. Steelhead use Fulton Canyon and Spanish Hollow Fulton Canyon and Spanish Hollow abundance estimates are unknow, but believed to be low (R. French pers. comm. 2004).

The current range of steelhead in the Rock Creek watershed is presumed to be very similar to historic conditions. However, sections of some streams thought to formerly support spawning and rearing may now be utilized only as migration corridors due to habitat degradation. Estimates of Rock Creek abundance are unavailable. Sporadic redd surveys have been committed by the Yakama Nation in 2002, 2003, and 2004. However, multiple passes have not been able to be done, and only one index reach has been repeated each year (Rock Creek mainstem bottom 3 miles). Spawning is densest in the lower five miles of Rock Creek, with 34-45 redds per mile being observed (YN).

The Columbia tributaries draining directly into the LMM Subbasin that contribute significantly to steelhead populations in the mainstem are: east- and westside tributaries of the Deschutes; Rock Creek; the lower mainstem, the North Fork, Middle Fork, South Fork, and upper mainstem

John Day; and the Umatilla. Other Columbia and Snake river tributaries use the lower mid-Columbia mainstem as a migration corridor for steelhead.

John Day River is the largest producer of naturally spawning steelhead that migrate through the lower mid-Columbia mainstem. The Umatilla and Deschutes rivers produce large numbers of hatchery steelhead. The Upper Columbia and Snake River tributaries above McNary Dam produce both wild and hatchery steelhead.

Steelhead abundance has increased over the past decades. A review of this data illustrates that steelhead abundance was significantly greater in 1999-2003 than in the earlier years of 1992-1997. For the most recent period the recovery targets were met in all five independent population areas. In 1992-1997 the interim targets were met in all of the population areas except the Upper John Day. See **Table 22** for overview of steelhead abundance and trends.

Table 22 Adult steelhead counts at LMM subbasin dams from 1994-2003

	The Dalles Dam		John Day Dam		McNary Dam	
	Steelhead	Wild Steelhead*	Steelhead	Wild Steelhead*	Steelhead	Wild Steelhead*
2003	273,172	85,287	286,176	83,959	230,418	66,554
2002	387,920	116,565	390,300	112,755	286,805	81,439
2001	503,327	125,117	483,409	112,335	389,784	94,384
2000	205,241	53,711	220,325	56,798	130,063	31,072
1999	156,874	41,379	165,314	41,316	84,088	17,711
1998	116,682	22,302	158,567	31,286	99,705	17,859
1997	164,756	20,399	157,088	21,513	129,817	16,707
1996	162,456	23,583	156,002	23,157	124,177	16,733
1995	145,844	19,484	123,240	NA	114,821	NA
1994	112,253	20,263	93,075	17,343	94,427	17,202
10-year averages	222,853	52,809	223,350	55,607 (9 yr. average)	168,411	35,966 (9 yr. average)

*Wild steelheadare a subset of the steelhead count

Life History

Rearing

Young steelhead typically rear in streams for some time prior to migrating to the ocean as smolts. Steelhead smolts have been shown to migrate at ages ranging from 1-5 years, with most populations smolting at ages 2 or 3 (Shapovalov and Taft 1954; Withler; 1966; Hooton et al. 1987; Loch et al. 1988)—usually 2 years in the mid-Columbia (NMFS/BRT Tech Memo 27. 1997).

Steelhead use Rock and Pine creeks as spawning, rearing, and migratory habitat. A few miles of Chapman Creek, near the mouth of Rock Creek, is used for spawning and holding. Some juvenile steelhead appear to rear in the upper Rock Creek watershed for a period of several months between May and October. It is unknown if they undertake a winter migration to positions lower in the basin. Because the lower mainstem goes intermittent from July to September, a number of life strategies must be employed. It appears that upper watershed juveniles remain to rear in the upper watershed. Lower watershed juveniles move out of the system, take advantage of pools (but encounter small mouth bass), and may move higher in the watershed.

Although steelhead may use Fulton Canyon and Spanish Hollow for rearing or spawning, whether they do so in any given season is highly related to environmental conditions, particularly streamflow.

Outmigration

Steelhead outmigration generally peaks in late April and early May. How this variation is expressed by the Rock Creek steelhead is unknown. Some juveniles are presumed to leave the system after emergence in May and June, while juveniles that overwinter are presumed to leave the system in March.

Steelhead grow rapidly after reaching the ocean, where they feed on crustaceans, squid, herring, and other fishes (Wydoski and Whitney 1979; Pauley et al. 1986). The majority of steelhead spend 2 years in the ocean (range 1 - 4) before migrating back to their natal stream (Shapovalov and Taft 1954; Narver 1969; Ward and Slaney 1988).

Adult emigration

Wild steelhead juveniles emigrate during the spring, passing mid-Columbia dams from April through June. Adult steelhead have also been observed entering the mainstem and tributaries in late February to early March. Once in the river, steelhead apparently rarely eat, and grow little, if at all (Maher and Larkin 1954). These various behaviors, in combination, produce fish that range between three and seven years of age at the time of spawning.

Spawning

Observed spawn timing throughout the Rock Creek has some variation. It is likely triggered by a combination of environmental cues including flow and temperature. Spawning begins in the middle of March and reaches its peak in early April. Upper watershed steelhead appear to average later spawn times by about three weeks. There is some uncertainty as to whether the upper watershed steelhead are a distinct run.

For Spanish Hollow, spawning appears to occur within the first approximately 10 downstream miles and during January 1- May 15 (DEQ/EPA 2003). Spawning begins earlier, about October 15, in the first few miles of Fulton Canyon, however, further upstream spawning appears to begin only after January 1 (DEQ/EPA 2003). Steelhead are thought to use both watersheds (not only the mainstems portions) as rearing and migratory areas depending on environmental conditions. See Appendix X for maps that include the Fulton Canyon and Spanish Hollow areas.

Incubation and Emergence

Unlike other species in the *Oncorhynchus* genus, steelhead eggs incubate at the same time temperatures are increasing. In the lower mainstem Rock Creek where densities are highest, fry emerge very rapidly. Densities from electro-shocking suggest approximately 60 days.

Population Management

Hatchery

Over 10 million steelhead smolts are released from hatcheries in Upper Columbia and Snake River tributaries above McNary Dam; a smaller number of wild steelhead smolts are also headed for the lower mid-Columbia on their way to the ocean. By far the most hatchery-reared steelhead are produced in the Snake River basin; most of the production is required mitigation for Snake River dams.

The Irrigon hatchery, near Irrigon, Oregon, one of two hatcheries within the subbasin, produces steelhead for acclimation and release in the Imnaha, Grande Ronde, and Wallowa rivers.

Kelt Reconditioning

Steelhead can express a repeat life history strategy. Because steelhead kelts "have experienced and survived stochastic events and selective forces and reached a life stage that is less prone to mortality factors than any previous stage," Hatch and his co-authors (2003) argue that investing in reinvigorating these steelhead before they make their repeat outmigration is an effective tool in restoration. Kelt reconditioning involves special feeding in a captive environment to encourage growth and redevelopment of mature gonads. To date, these efforts, primarily in the Yakima River, report benefits and support for continued reconditioning efforts, including research, as a means to increase naturally spawning steelhead populations.

Harvest

Table 23 Non-Indian and Indian Columbia River harvest of steelhead above Bonneville Dam

Upriver Steelhead*												
	Upriver A Hatchery			Upriver A Wild			Upriver B Hatchery			Upriver B Wild		
	Columbia River Run	Non-Indian Total	Treaty Indian Total**	Columbia River Run	Non-Indian Total	Treaty Indian Total**	Columbia River Run	Non-Indian Total	Treaty Indian Total**	Columbia River Run	Non-Indian Total	Treaty Indian Total**
2004	NA	NA***	9,400	NA	909	2,790	NA***	NA	5,470	NA	214	1,730
2003	215,850	25,005	14,710	70,870	883	3,690	55,240	6,660	8,550	11,600	203	1,720
2002	238,430	24,225	6,173	87,470	969	1,814	99,040	10,375	3,866	32,460	457	1,908
2001	386,510	43320	17,178	137,940	641	5,509	75,800	1,298	1,260	12,180	4,774	1,388

*Steelhead destined above Bonneville Dam ** Includes ceremonial, subsistence, and commercial. *** Total non-Indian mainstem hatchery A & B was 1,123. Source: OR/WA Joint Staff Report 2004

Hydrosystem

Hydrosystem impacts are discussed in general terms in 3.2.8 Anthropogenic Disturbances on Aquatic and Teresstrial Environments and in 5.7.2 Lower Mid-Columbia Mainstem Assessment Unit.

Relationship with Other Species

Walleye, smallmouth bass, northern pikeminnow, and channel catfish are important predators of all juvenile salmonids in reservoirs, including steelhead. Rieman et al. (1991) estimated 148,000 steelhead were lost to predation in John Day Reservoir (cumulative April – June, 1983-1986). This represented 11-13% of all juvenile steelhead entering the reservoir. Northern pikeminnow were the dominant spring predator. Walleye and smallmouth bass predation rates increased in summer when steelhead outmigration declined, reducing the magnitude of their contribution to steelhead mortality. Steelhead in northern pikeminnow stomachs ranged from 80-210 mm (back-calculated fork length) (Zimmerman et al. 1999).

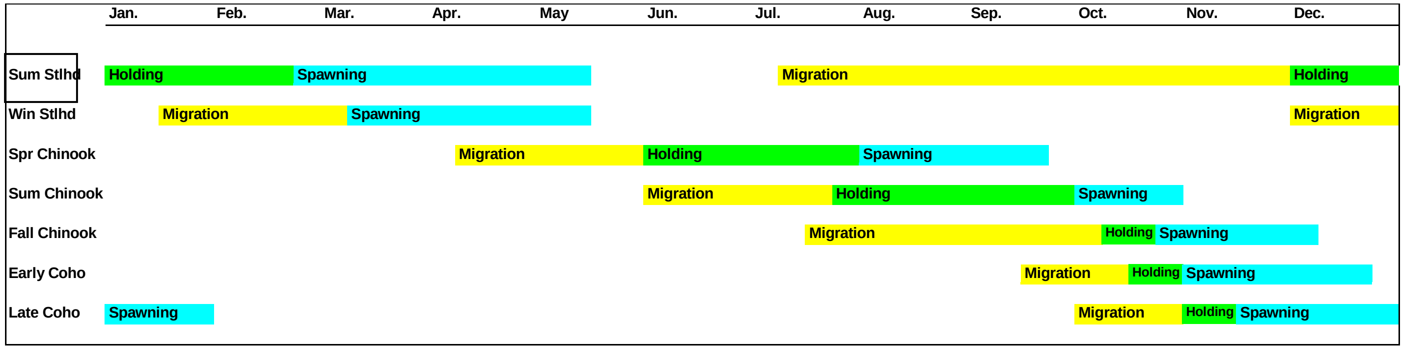


Figure 28 Spawn timing for salmon and steelhead

5.4 Coho

Historical Distribution and Abundance

Coho (Oncrhynchus kisutch) were widespread in the Columbia Basin. Now naturally spawning coho runs are very small. Historically, the Umatilla River, Rock Creek and other watersheds draining into the LMM subbasin produced coho. Endemic stocks of coho in these tributaries were extirpated early in the 20th century. Coho have recently been reintroduced into the Umatilla River. These coho historically mixed in the lower mid-Columbia with migrating coho from numerous stocks upstream of McNary Dam from the Snake River and upper Columbia. A century ago the annual average coho return to the Columbia River a century ago has been estimated at over 600,000 fish.

Key Life History Strategies and Relationship to Habitat

Adults begin entering the Columbia in July and migrate past Bonneville Dam from July through November, with a peak in September. Adults will remain in the mainstem until there are sufficient flows brought about by fall rains, generally, in October or November. Spawning occurs shortly after stream entry, and continues until mid-December. Fry emerge in March and early April, and will rear in available stream habitat through the following winter. Juvenile coho stay in fresh water for a year or longer, making them particularly vulnerable to stream disruptions. Smolting and emigration occurs in April through mid-May. Most coho adults are 3-year-olds, spending about 18 months in fresh water and 18 months in salt water (Shapovalov and Taft 1954; Wright 1970).

Emigrating smolts occupy near-shore habitat in Lake Umatilla at this time. For example, some utilization by juveniles has been noted in the lower portion of Chapman Creek and along the shore of Lake Umatilla. Potential coho habitat has been identified in the lower portion of Glade Creek (Lautz 2000).

There is incidental use associated with upriver migration of adults or downriver migration of juveniles from other Columbia River stocks; this use would generally be restricted to the shore of Lake Umatilla or pool areas near stream mouths. Juvenile coho likely used off-channel areas and tributary mouths for rearing and over-winter habitat (personal communication, Steve Pribyl, ODFW). Coho adult likely use the mainstem for holding as well as migration.

With the exception of spawning habitat, which consists of small streams with stable gravels, summer and winter freshwater habitats most preferred by coho salmon consist of quiet areas with low flow, such as backwater pools, beaver ponds, dam pools, and side channels (Reeves et al. 1989). Habitats used during winter generally have greater water depth than those used in summer, and also have greater amounts of large woody debris. Coho are good indicators of ecological health because they require good water quality and quantity.

Current Distribution and Population Status

In the LMM subbasin, coho currently occupy habitat in the Rock Creek watershed (Figure x) as well as using the lower mid-Columbia mainstem for migration.

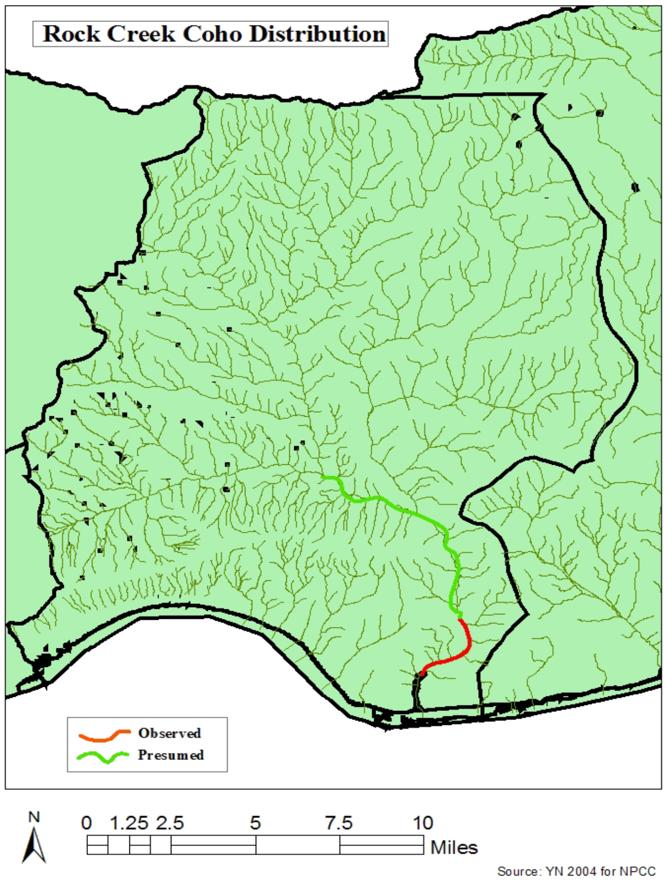


Figure 29 Observed and presumed coho distribution in the Rock Creek watershed

Coho returning to the LMM subbasin and areas above The Dalles Dam are still predominantly hatchery fish, as is the case throughout the Columbia Basin. Most of the Columbia Basin-wide production occurs in Mitchell Act mitigation hatcheries below Bonneville Dam. In recent years, however, more coho are being released in areas above The Dalles Dam, where some are beginning to spawn naturally (Umatilla Subbasin Plan 2004); the majority of these coho returns are hatchery releases from the Yakima, Umatilla, and Clearwater rivers mandated by the *U.S. v. Oregon* Columbia River Fish Management Plan.

Below Bonneville Dam, wild coho from numerous Columbia River tributaries have been been designated as an ESU (Evolutionarily Significant Unit) and are listed under the Endangered Species Act. NMFS (now NOAA/Fisheries) determined that coho stocks upstream of Bonneville Dam were extirpated, in other words, there were virtually no wild coho to list.

The 10-year trend for upriver coho, those returning to spawn upstream of The Dalles, John Day, or McNary dams, is presented in **Table 24**. Hatchery and naturally spawning coho are not differentiated in the dam counts.

Table 24 Adult coho counts at LMM subbasin dams from 1994-2003

	The Dalles Dam	John Day Dam	McNary Dam
2003	42,563	34,453	18,095
2002	9,765	7,669	2,144
2001	62,378	48,870	22,918
2000	24,966	20,560	11,173
1999	13,393	11,901	4,736
1998	8,196	7,646	5,959
1997	4,067	3,518	2,261
1996	3,622	3,289	1,281
1995	2,786	1,913	914
1994	3,786	2,455	1,347
10-year averages	17,552	14,227	7,083

Recently upriver coho counts—after passing Bonneville, salmon stocks, including coho, are considered upriver runs—have been stronger than they were since the early 1970s, with only a few exceptions. The increases are largely attributable to hatchery supplementation projects in the Umatilla, Clearwater, and Yakima subbasins. In fact, coho found in the Rock Creek and adjacent streams are believed to be straying hatchery fish, possibly colonizing or re-colonizing new areas. A small number in Rock Creek also appear to be spawning naturally. No specific life history information exists for coho that utilize subbasin streams; this is inferred from information about Columbia River hatchery stocks (Lautz 2000).

Population Management

Hatchery

The Confederated Tribes of the Umatilla Indian Reservation and ODFW are re-introducing coho in the Umatilla River; the Nez Perce Tribe is re-introducing coho in the Clearwater River, and the Yakama Nation and WDFW are re-introducing coho in Yakima, Little White Salmon and Klickitat subbasins. The Yakama Nation's most recent efforts in the Wenatchee and Methow subbasins have also met with positive results (Rowan 2002; Peven 2003). These releases are not only for harvest augmentation, but also for re-establishing naturally spawning coho stocks in areas above Bonneville Dam.

Harvest

The coho that traverse this portion of the mainstem are harvested by members of the Columbia River treaty tribes and are usually harvested as incidental catches during summer and fall harvest seasons. Fishing regulations as they apply to coho and other species are negotiated as part of the *United States v. Oregon* Columbia River Fish Management Plan. Non-Indian, largely commercial, harvests occur as the adult coho migrate upstream throught the lower Columbia. The following table shows the 2002 and 2003 harvests of upriver coho stocks.

Table 25 Non-Indian and Indian Columbia River harvest of upriver coho above Bonneville Dam

Upriver Coho						
	Ocean Catch/ Mortality	Columbia River Run	Bonneville Dam Passage*	Non-Indian Commercial Total	Sport Total	Treaty Indian Total**
2004	45,359	104,135	72,862	31,273	1,260	NA
2003	30,176	77,195	55,057	22,138	1,260	NA
2002	8,001	32,319***	87,800	43,484***	1,260	1,649
2001	39,299	343,639	259,500	43,580	1,260	NAxs

*Based on Bonneville Dam count ** Includes ceremonial, subsistence, and commercial ***Unknown decrepancy between harvest being more than river run size
Source: OR/WA Joint Staff Report 2004

Hydrosystem

Hydrosystem impacts are discussed in general terms in 3.2.8 Anthropogenic Disturbances on Aquatic and Teresstrial Environments and in 5.7.2 Lower Mid-Columbia Mainstem Assessment Unit.

Relationship with Other Species

Walleye, smallmouth bass, northern pikeminnow, and channel catfish are important predators of all juvenile salmonids in reservoirs, including coho. Rieman et al. (1991) estimated 2,484,000 coho and chinook were lost to predation in John Day Reservoir (cumulative April-August, 1983-1986). This represented 8-61% of all juvenile salmon entering the reservoir. Northern pikeminnow were the dominant spring predator, but walleye and smallmouth bass predation rates increased in summer, which contributed to very high predation rates in August.

5.5 Fall Chinook

Historical Distribution and Abundance

Both distribution and abundance were greater historically than now. Chinook (spring, summer and fall together) were the most abundant salmonids in the Columbia River Basin prior to 1850. Fall chinook run sizes are estimated to have ranged from about 1.5 million to 3.5 million fish annually (NWPCC 1987). Historically fall chinook salmon spawned in the mainstem Columbia River from near The Dalles, Oregon, upstream to the Pend Oreille and Kootenai rivers in Idaho (Fulton 1968) and were along with other salmon species, a staple of the diet of native peoples living in the Columbia Basin. Mainstem spawning still occurs in the Hanford Reach (Dauble and Watson 1997), but fall chinook have also been reported to spawn in the tailraces of Wanapum and McNary dams and a few other mainstem locations. (See below.)

Rock Creek fall chinook are also likely to have diminished in abundance. Although Rock Creek distribution is presumed to have been similar to current distribution, easily accessed areas with historically suitable habitat also would have been Squaw Creek 1 and lower Luna Gulch.

Historical distribution, abundance, and use of Fulton Canyon and Spanish Hollow watersheds by fall chinook is unknown.

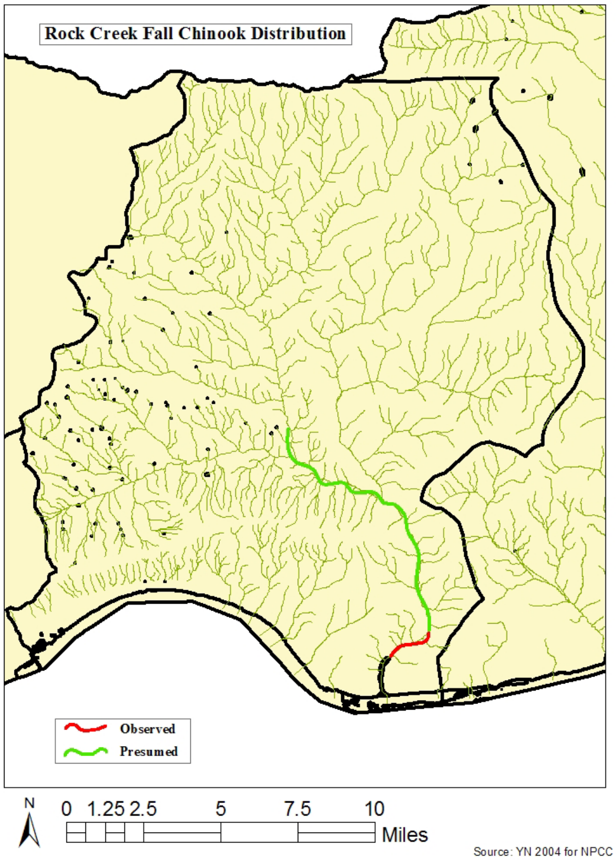


Figure 30 Observed and presumed fall chinook distribution in the Rock Creek watershed

Current Distribution and Abundance

Today fall chinook salmon are the most abundant salmonid in the Columbia River Basin, in large part, because of the naturally spawning stock from Hanford Reach. Hanford Reach, upstream of the active planning area of the LMM subbasin, produces 20 million to 30 million fall chinook salmon fry annually (WDFW, unpublished data). Since 1948 aerial counts of fall chinook salmon redds at Hanford Reach since have provided an index of relative abundance among spawning areas and years. Redd counts during peak spawning were less than 1,000 annually from 1948 to 1961, but they increased to as high as 8,800 in 1989 after construction of several mainstem dams on the Columbia and Snake rivers had inundated more natural fall chinook spawning areas.

The vast majority of the fall chinook migrating through the lower mid-Columbia mainstem is what are referred to as upriver brights or URB stock. (All the fall chinook produced above Bonneville Dam are, in aggregate, the upriver run.) This stock description is quoted from the Joint Staff Report Concerning the 2003 Fall In-River Commercial Harvest of Columbia River Fall Chinook Salmon, Summer Steelhead, Coho Salmon, Chum Salmon, and Sturgeon:

> Most of the upriver brights (URB) are wild fish destined for the Hanford Reach section of the Columbia River. Smaller upriver bright components are destined for the Deschutes, Snake, and Yakima rivers. Snake River wild fall chinook (SRW) are a sub-component of the upriver bright stock. The mid-Columbia brights originated from, and are considered a component of the

> upriver bright stock. The upriver mid-Columbia bright component (Pool Upriver Brights or PUB stock) is comprised of brights that are reared at Bonneville, Little White Salmon, Irrigon, and Klickitat hatcheries and released in areas between Bonneville and McNary dams. Natural production of URB derived from PUB stock is also believed to occur in the mainstem Columbia River below John Day Dam, and in the Wind, White Salmon, Klickitat, and Umatilla rivers.

Juvenile fall chinook likely used off-channel areas and tributary mouths for rearing and over-winter habitat (personal communication, Steve Pribyl, ODFW). Adult fall chinook use the mainstem for migration and holding.

Fall chinook are the dominant salmonid present during spring in nearshore areas of the lower mid-Columbia mainstem Columbia River. Fall chinook salmon also use the upper portions of McNary and John Day reservoirs for rearing, but do not prefer riprap habitats that constitute a large portion of reservoir shorelines (USGS, unpublished data). Releases from Priest Rapids and Ringold hatcheries in June artificially increase the juvenile fall chinook salmon population. Additional fall chinook salmon enter McNary Reservoir from the Snake River and include ESA-listed natural fish produced in Hells Canyon and fish from Lyons Ferry Hatchery.

Rock Creek fall chinook runs, with loss and degradation of habitat within the watershed and the overall reduction in Columbia River populations are presumed to have diminished in abundance. Although Rock Creek distribution is presumed to have been similar to current distribution, easily accessed areas with historically suitable habitat also would have been Squaw Creek 1 and lower Luna Gulch. Rock Creek fall chinook are presumed to be upriver brights, related to the Hanford Reach population.

Current fall chinook utilization of Fulton Canyon and Spanish Hollow watersheds is unknown.

Upriver fall chinook runs have been strong in recent years, often surpassing management goals. The 2003 return of upriver brights (URBs) comprised 42% of the total fall chinook adult return to the Columbia River mouth—the largest since 1987, but below 1987's 420,600 return. The estimated Columbia River return of the ESA-listed Snake River wild chinook was 6,900, two times greater than 2002 (Joint Staff Report 2004). Wild returns to Snake River exceeded the management goal in 2003 and met the goal in 2004 (Joint Staff Report 2003, 2004).

Table 26 Adult fall chinook counts at LMM subbasin dams from 1994-2003

	The Dalles Dam	John Day Dam	McNary Dam
2003	313,697	215,483	178,951
2002	245,928	164,920	141,682
2001	181,316	124,747	110,517
2000	124,967	102, 903	67,572
1999	131.786	78,237	78.356
1998	92,932	86,805	63,791
1997	117,986	88,050	67,192
1996	117,144	68,107	73,929
1995	90,820	86,202	68,186
1994	109,969	59,039	85,932
10-year averages	152,655	107,449	93,611

Life History

Run-Timing

Fall chinook salmon are somewhat unique in that they spend the entire freshwater portion of their life cycle in mainstem habitats. Fall chinook runs generally return to natal streams for spawning September through November.

Adult fall chinook typically return to Rock Creek from the ocean, as 3, 4, or 5 year olds, from October through November. Following spawning, incubation, emergence, and fry growth, outmigration likely extends from May through June. Flow likely dictates run-timing. In Rock Creek the limiting factor is flow. When flows reconnect the lower miles of Rock Creek and provide access, fall chinook enter and distribute themselves upstream. In Rock Creek, timing of the spawning run has consistently been in October and November, when flow allows access.

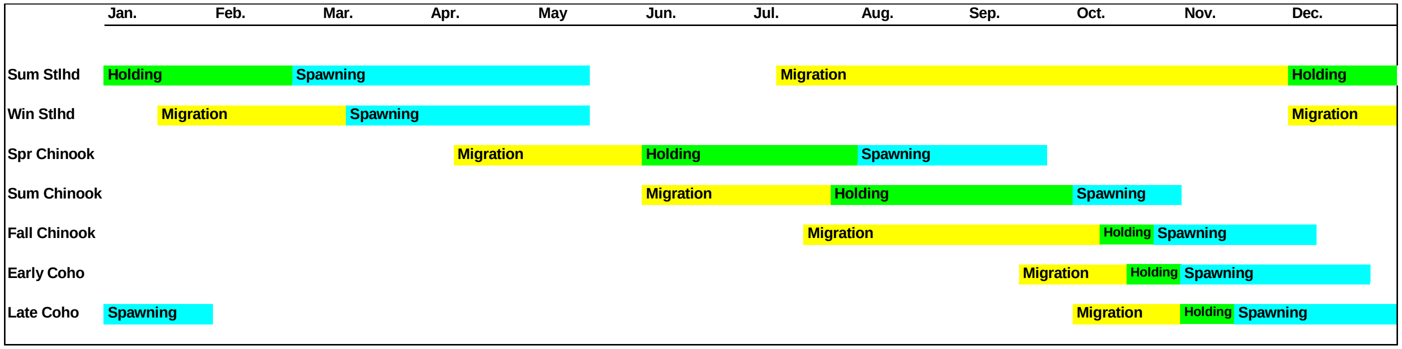


Figure 31 Spawn timing for salmon and steelhead

Spawning

Some spawning occurs in the lower mid-Columbia mainstem outside of the Hanford Reach area. Substantial natural production of brights derived from the mid-Columbia bright component (also called PUB stock) is occurs in the mainstem below John Day Dam (Joint Staff Report 2004). For example, see Figure 32, which shows redd clusters estimated to amount to 1,043 in the John Day tailrace. Similar spawning has not been found below McNary Dam (personal communication, Ron Boyce, ODFW) Lower mid-Columbia mainstem spawning apparently occurs between October and November. Rock Creek fall chinook spawning begins about the middle of October, peaks the first week of November, with water available throughout the spawning window. It is usually complete by the middle of November. It is limited to the lower Rock Creek mainstem and extends as far upstream as is accessible. Spawning may include some fish that spawn much later than the norm. There have been some observations by locals of spawning in late December; however, these are unconfirmed.

Incubation and Emergence

Incubation starts as early as October and can extend as late as late April. There is presumed to be a typical incubation period of 4-5 months, followed by emergence of the fry. Incubation likely extends throughout the winter and spring, followed by the emergence of fry with growth and outmigration in the February to May period. This comparatively short instream development, followed by outmigration to saltwater prior to reaching a full year in age, places fall chinook in the “ocean-type” life history category.

Rearing

There is very little true rearing that occurs in freshwater since smolt outmigration occurs almost immediately after fry colonization. Small, relatively slow swimming juvenile fall chinook are the dominant salmonid during spring in nearshore areas of the lower mid-Columbia mainstem. Fall chinook salmon also use the upper portions of McNary and John Day reservoirs for rearing, but do not prefer riprap habitats that constitute a large portion of reservoir shorelines nearshore areas of the three LMM reservoirs (Ward 2001).

Smolt Outmigration

Outmigration likely occurs in late April and May, followed by the emergence of fry with growth and outmigration in the February to May period. This comparatively short instream development, followed by outmigration to saltwater prior to reaching a full year in age, places fall chinook in the “ocean-type” life history category, including Rock Creek fall chinook.

Figure 32 Video survey of fall chinook redds below John Day Dam

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Population Management

Hatcheries

The lower mid-Columbia bright component includes of brights that are reared at Bonneville, Little White Salmon, Irrigon, and Klickitat hatcheries and released in areas between Bonneville and McNary dams. Releases from Priest Rapids and Ringold hatcheries in June also increase the juvenile fall chinook salmon population. Additional fall chinook salmon enter McNary Reservoir fish produced in Lyons Ferry Hatchery.

Harvest

Chinook, and in recent decades, fall chinook in particular, have become the backbone of tribal subsistence and commercial fisheries. Fishing regulations for fall chinook (and other species) are negotiated as part of the *United States v. Oregon* Columbia River Fish Management Plan. The following table shows recent harvests of upriver fall chinook stocks. Like other Columbia upriver chinook and coho stocks, fall chinook are harvested in the ocean and lower river before they reach spawning upriver fisheries and spawning areas. Columbia River chinook stocks play a significant role during the development of harvest sharing agreements between the United States and Canada.

Table 27 Non-Indian and Indian Columbia River harvest of upriver fall chinook above Bonneville Dam

Upriver Fall Chinook *															
	Ocean Catch and Mortality		**Columbia River Run**		**Bonneville Dam Passage***		**Non-Indian Commercial Total****			**Sport Total**			**Treaty Indian Total*****		
	URB	PUB	URB	PUB	URB	PUB	URB	PUB	SWR	URB	PUB	SWR	URB	PUB	SRW
2004	6,580	1,130	286,980	49,500	264,595	45,684	22,400	3,820	7.80%	1,300	440	0.45%	66,130	13,700	23.04%
2003	9.730	1,640	258,400	43,500	238,250	40,060	20,150	3,430	7.80%	1,170	390	0.45%	59,530	18,250	23.04%
2002	7,400	1,240	276,870	48,120	257,710	45,170	19,350	2,770	6.88%	1,260	40	0.46%	57,250	8,090	20.68%
2001	3,280	470	232,600	33,240	34,920	318,90	12,780	1,350	5,50%	1,020	400	0.44%	34,820	4,410	14.97%

*Fall chinook harvested in Bonneville pool included
**Not including the ocean catch
***Ceremonial, subsistence and commercial harvests included. Source: OR/WA Joint Staff Report 2004

Hydrosystem

Hydrosystem impacts are discussed in general terms in 3.2.8 Anthropogenic Disturbances on Aquatic and Teresstrial Environments and in 5.7.2 Lower Mid-Columbia Mainstem Assessment Unit.

Relationship with Other Species

Walleye, smallmouth bass, northern pikeminnow, and channel catfish are important predators of all juvenile salmonids in reservoirs, including chinook. Rieman et al. (1991) estimated 2,484,000 coho and chinook were lost to predation in John Day Reservoir (cumulative April-August, 1983-1986). This represented 8-61% of all juvenile salmon entering the reservoir. Northern pikeminnow were the dominant spring predator, but walleye and smallmouth bass predation rates increased in summer, which contributed to very high predation rates in August. Chinook in northern pikeminnow stomachs ranged from 40-200 mm (back-calculated fork length). Fewer salmon were found in smallmouth bass and walleye stomachs and the length range was narrower (Zimmerman et al. 1999).

5.6 Lamprey

Historical Distribution and Abundance

Pacific Lamprey (or “eel”) are restricted in North America to the Pacific Coast and coastal islands from the Aleutians to Baja, California. They were once widely distributed throughout the Columbia Basin in Oregon, Washington, and Idaho. Pacific lamprey remain the largest and most abundant of three native lamprey species in the Snake and Columbia River system (Kan 1975; Wydoski and Whitney 1979). A widespread decline in numbers of Pacific lamprey has occurred since the 1960s coincident with completion of the FCRPS. This decline has been attributed to a number of causes, including habitat loss, water pollution, ocean conditions, and dam passage (Close et al., 1995). On January 23, 2003, eleven conservation groups filed a petition to list these three species as endangered or threatened under the Endangered Species Act.

Pacific lamprey are highly regarded as traditional food by Native American tribes. Former lamprey abundance provided both tribal and non-Indian fishing opportunities throughout Columbia River Basin tributaries. Pacific lamprey collection at Willamette Falls for fish food processing in 1913 was documented at 27 tons (CRITFC 1999). Commercial fishermen in the 1940s harvested 40 to 185 tons annually (100,000 to 500,000 adults) at Willamette Falls for use as vitamin oil, protein food for livestock, poultry, and fish meal. Because of declines in abundance, the Willamette River commercial fishery was closed beginning in 2002.

Current Distribution and Abundance

Pacific lamprey are distributed throughout Columbia Basin tributaries upstream to Chief Joseph and Hells Canyon dams. They have been observed as juveniles in smaller tributaries (Viento and Purham creeks; personal communication, T. Murtagh, ODFW). Although tribal accounts recognize historic lamprey in the mainstem of Rock Creek, lower Luna Gulch, and Squaw Creek, no observations of lamprey have been made by Yakama Nation Fisheries personnel during the 2001-2004 period. The current stock status and distribution in Rock Creek is completely unknown.

Although adult lamprey counting at mainstem Columbia and Snake River dams is not standardized, population trends indicate precipitous declines; however, the increases in 2002 and 2003 were much higher than previous years and, according to the Lower Columbia Subbasin Plan, similar to the average for the 1938-1969 period. As of November 1, 2004, an estimated 14,873 lamprey have passed The Dalles Dam.

The Columbia Basin Pacific lamprey work group (CBPLTWG 1999) identified habitat of juvenile and adult life histories as a critical uncertainty. Ongoing projects have focused on evaluating population status in tributaries (Hatch and Parker 1998) and passage requirements at mainstem dams (Mesa et al. 2000; Moursund et al 2000). There have been no studies to assess the relative importance of mainstem habitats on the spawning and rearing of Pacific lampreys.

Table 28 Pacific lamprey counts at LMM subbasin dams from 1997-2003

	The Dalles Dam	John Day Dam	McNary Dam
2003	28,995	20,922	13,325
2002	23,417	26,821	11,282
2001	9,061	4,005	2,539
2000	8,050	5,844	1281
1999	NA	4,005	NA
1998	NA	NA	NA
1997	6,066	9,327	NA

Life History

Spawning

Habitat requirements of Pacific lamprey share several common features with salmonids. Lamprey build nests in gravel in stream riffles and the eggs develop in the substrate. Cool, clean, well-oxygenated water is required.

Lamprey typically reach spawning grounds in mid-summer (Kan 1975; Beamish 1980) and generally spawn the following spring, spending spend approximately 1 year in freshwater.

Spawning generally occurs in small tributary streams. Both sexes construct a crude redd (Scott and Crossman 1973), generally located in the center of the stream near the tailout of a pool in riffles, immediately upstream of shoreline depositional areas (Beamish 1980). Mating is repeated several times in the redd. Each mating is followed by actions that move substrate over newly laid eggs (Kostow 2002).

Water temperatures of 10-15ºC have been measured in Clear Creek, a tributary of the John Day River, during spawning (Kan 1975). After spawning, adults die and provide nutrients to small tributaries where salmon fry rear (Kan 1975), although limited evidence suggests adults can survive to spawn again (Kostow 2002).

Incubation and Emergence

Eggs typically hatch into ammocoetes in less than 2 weeks; these newly hatched larvae, which are filter feeders, then drift downstream and bury themselves in silt, mud, or fine gravel along the margins and backwaters of streams and rivers (Scott and Crossman 1973; Hammond 1979). Ammocoetes generally spend 5-6 years in freshwater (Scott and Crossman 1973). In the fall of their last year, they metamorphose into macrophthalmia, which resemble the adult form. This transformation process is generally completed by early winter.

Run-timing

Downstream migration of macrophthalmia (pre-adult lamprey smolts) appears to be stimulated by and dependent on late winter and early spring floods (Hammond 1979). Because they are not strong swimmers, lamprey appear to be dependent on spring flows to carry them to the ocean (Kan 1975; Beamish 1980). Passage counts at Bonneville Dam showed median passage dates at the end of July. Out-migrating juvenile lampreys have been sampled in abundance at John Day and Bonneville dams. At John Day Dam, two distinct passage peaks appear to be evident. Martinson et al. (2004) report the following for John Day Dam: "An estimated 21,601 lamprey passed the project through the bypass system May 30. The most noteworthy passage peak occurred over a three day period, from 7-9 June when an estimated 67,700 lamprey passed the project. Approximately 98.7% of the juvenile lamprey were smolted (macropthalmia), while the remaining 1.3% were ammocoetes in various stages of metamorphosis. The total estimated lamprey collection for 2003 was 191,876, about 69% of last year's estimate of 279,302."

For Bonneville Dam, Martinson et al. (2004) report: "Pacific lamprey juveniles were found in samples from March through October. Although juvenile lamprey were sampled in every month of the season, there were three distinct peaks; 10 June (6,800), 12 June, (2,500) and 14 June (3,400). These are collection estimates generated from the sample rate and represent the estimated number passing through the bypass system that day. Almost 65% (19,679) of juvenile lamprey passage occurred in June and 97% (30,206) of the run had passed the facility by the end of June. The total collection estimate for the season was 30,333, of which over 99.4% were smolted. This season's (2003) collection estimate is about 135% of last year's total of 22,443."

Habitat Use

Other than upstream and downstream migration, specific habitat use by location, duration, and life stage in mainstem reservoirs is not well known. Current knowledge of habitat use of juvenile Pacific lamprey is mainly limited to tributaries of the Columbia and Snake rivers (Kan 1975; CRITFC 1999.) A recent investigation of substrates in the lower reach of Fifteenmile Creek and its confluence with the Columbia River mainstem identified the presence of larval lamprey at densities up to 117 fish/m2 in depths ranging from 0.5 to 3.2 m (personal communication, J. Smith, InterFluve Company). The fish were well distributed across body lengths, suggesting the presence of multiple year classes.

Changes in temperature clearly dictate both juvenile lamprey outmigration and the timing of spawning migrations by adults. As temperature increases lamprey move more rapidly upstream. However, exceedingly high temperature could be a barrier to lamprey movement. Ocker et al. (2001) reported that significantly fewer lamprey successfully migrated upstream at Bonneville

Dam when temperatures at tagging exceeded 19.5°C. While the effects of high temperature in small streams have not been evaluated, it is possible that lamprey behavior could be altered by thermal barriers.

During both juvenile and adult migrations lamprey may encounter a variety of obstacles to passage. In addition to large hydropower dams discussed below, other less dramatic obstacles to lamprey passage can delay or obstruct adult passage along their migration routes. These include but are not limited to: culverts, irrigation diversion dams, weirs, and other low-head structures (Kostow 2002). The extent to which these structures affect both juvenile and adult movements is not known. However, recent research on lamprey swimming performance and migration behavior at large hydropower dams has provided insights into physical factors that can limit lamprey movements. (See Mesa, Moser, et al. 2004. Passage Considerations for Pacific Lamprey at www.cbfwa.org.)

Population Management

Harvest

Historically Columbia Basin tribes harvested lamprey, which they often call eels, for food, medicine, and trade. Harvested occurred at natural barriers throughout the basin (Wy-Kan-Ush-Mi Wa-Kish Wit 1997). Today, most tribal harvest occurs at Willamette Falls on the Willamette River and at Sherars Falls on the Deschutes River.

Non-Indian harvest lamprey, which does not occur in this subbasin, may be a thing of the past as described above in “Historical Distribution and Abundance.”

In the LMM subbasin there is no significant, if any, harvest of Pacific lamprey.

Hydrosystem

According to the Lower Columbia Subbasin Plan (2004):

> There is substantial evidence indicating that Columbia River dams have had a negative effect on Pacific lamprey populations. Hammond (1979) suggested that construction of the hydroelectric dams have caused a significant decrease in populations. Upstream passage efficiecy of adult lamprey between 1997 and 2000 at Bonneville, The Dalles, and John Day dams have been estimated to be between 38-47%, 50-82%, and 27-55% respectively (Moser et al. 2002).

Research has confirmed that Pacific lamprey are poor swimmers (Mesa et al. 2003; Close et al. 2003). Beamish (1974) showed that the distance (m) sea lampreys could swim declined with an increase in swimming speed between 20-60 cm/s. Swimming speed was positively related to temperature (range 5-15°C).

Mcauley (1996) allowed adult sea lampreys to volitionally swim up a 30-m-long flume at a variety of water velocities and temperatures. At velocities of about 1.5 m/s fish were able to swim for up to 50 s, but at 3 m/s fish could swim for only 2-3 s. Mesa et al. (2003) reported that the mean (+ SD) critical swimming speed of adult Pacific lampreys was 86.2 + 7.5 cm/s at 15°C.

When confronted with rapid current velocities, adult Pacific lamprey use their suctorial disc to hold fast and rest between intervals of burst swimming. They have difficulty navigating fishways at the dams. Swimming over the metal grating in fishway floors and negotiating 90º corners, especially at high velocities are problematic. The sharp edges prevent adult lamprey from staying attached as they move around a corner at the bulkheads adjacent to fish entrances (Moser et al. 2002; W. Kaigle, unpublished data), and instead they fall back down the fish ladder and have to attempt swim up again. Juvenile mortalities, on the other hand, are often the result of turbine entrainment or screen impingement.

Some observations of mainstem habitat use have been made where water surface elevations were rapidly lowered via manipulation of base flows by hydroelectric dams. Several juvenile lamprey were exposed during the test drawdown of Little Goose and Lower Granite dams in March 1992 (Dauble and Geist, 1992).

Hatchery

There are no hatcheries or supplementation programs in the LMM subbasin.

Fish Habitat Conditions

Introduction

The subbasin contains a variety of riverine, riparian, and wetland habitats as well as the rivers and reservoirs themselves. Habitat quality varies, but many habitats have been changed, lost, or degraded by past and present land and water uses such as hydropower development, irrigation and other agricultural activities, fishing, logging, road building, invasion of non-native plants and animals, and other anthropogenic uses.

(Some of the text on the mainstem was taken directly from the Lower Mid-Columbia Mainstem Subbasin Summary produced in 2001 to inform the NPCC's provincial project review process. Principal author of that document was David L. Ward.)

5.6.1 Fish Assessment Methodologies

Ecosystem Diagnosis and Treatment for Rock Creek

This description of the Ecosystem Diagnosis and Treatment (EDT) method is taken from the Draft Wind River Subbasin Plan, authored by the Lower Columbia Fish Recovery Board.

Reach Analysis for fish habitat

Estimation of reach-specific restoration and preservation values is one of several EDT applications. Reach analysis is based on the same fish abundance, productivity, and diversity information derived for population analysis from historic/template and current/patient habitat conditions. Reach analysis provides a greater level of detail as it identifies reaches based on their preservation value and restoration potential.

Preservation value is estimated as the percent decrease in salmon performance if a reach was thoroughly degraded. Reaches with a high preservation value should be protected because of the disproportionately high negative impact on the population that would result from degradation.

Restoration value is estimated as the percent increase in salmon performance if a reach is completely restored. A reach with a high restoration potential would provide a greater benefit to the population than a reach with low restoration potential.

Preservation and restoration are two sides of the same coin. Reaches with excellent habitat conditions have high preservation values but low restoration values. Reaches with poor habitat conditions have high restoration potential but little preservation value. Reach analysis results are specific to each fish species because of the different fish habitat requirements of each. Reach analysis results are typically displayed in a graphical format that is often referred to as a ladder or tornado diagram.

Habitat Factor Analysis

Habitat Factor Analysis is one of several and perhaps the most basic of the EDT applications. Comparing current/patient habitat conditions with optimum conditions in a historic/template baseline identifies key limiting habitat conditions. This analysis illustrates the specific habitat factors that, if restored, would yield the greatest benefit to population abundance. The habitat factor analysis depicts a greater level of detail than the reach analysis in that it looks at the specific habitat factors rather than the aggregate effect of all habitat factors.

EDT analyses are based on condition scores assigned to 46 habitat attributes (level II attributes) for each EDT homogenous stream reach used by the population of interest. Reaches may vary widely in length. This information is organized into a database used as input to the EDT model. The level II attributes are rated for under the current (patient) and historical (template) conditions. The EDT model translates the 46 level II attributes into 17 "habitat survival factors" (level III attributes) that represent hydrologic, stream corridor, water quality, and biological community characteristics. These 17 habitat survival factors described in habitat factor analysis outputs.

Specific level III attributes affect particular life stages of salmonids. The impact to survival of each life stage in individual reaches is combined with information on available habitat area and then integrated across the various life history trajectories of the population in order to derive population productivity (survival) and abundance. The number of different possible life history trajectories that a population exhibits determines an index of diversity.

The standard EDT habitat factor output presents the effect of habitat attributes on life stage survival for each life stage and each reach. These outputs are typically referred to as consumer reports or Report 2. While this level of information is useful for salmon biologists, it is too detailed for the scope of this document. Therefore, the attribute analysis presented here summarizes all life stages within a reach. Stage-specific values were then weighted by the impact that restoration of the reach values would have on overall population abundance. In this way, the degree of impact of a particular habitat factor in a particular reach can be compared to other habitat factors in the same reach as well as to habitat factors in other reaches.

Other Fish Assessment Methodologies

Because empirical data is lacking for the other Washington tributaries and Oregon's Spanish Hollow and Fulton Creek, the habitat assessment is limited and based on the professional judgement of local Yakama Nation, WDFW, ODFW, conservation district, and other agency personnel. The habitat information about the mainstem portion of this subbasin comes from a variety of scientific disciplines and resource agency sources.

5.6.2 Lower Mid-Columbia River Mainstem Assessment Unit

Topography and Climate

The geology of drainage is dominated by extensive basalt flows having a total thickness of up to 5000 feet. The basalt in these flows erupted between 14 and 15.5 million years ago, forming fissures along the Snake River where Washington, Oregon, and Idaho join. The erosion-resistant nature of these flows resulted in the creation of deep (500 to 800 feet) steep-walled canyons with ragged outcrops and in severely constrained floodplain development along substantial portions of the streams within this subbasin (Lautz 2000).

Terrestrial and General Riverine Habitat Conditions

Islands in the Columbia River are of importance to fish. Riverine habitat near islands can provide spawning, rearing, and holding areas for salmonids. In John Day Reservoir, islands occupy approximately 700 ha (USACE 2000).

Embayments, which are shallow water habitats typically connected to the mainstem Columbia River via culverts or small channels, provide special fish values. In most embayments, water fluctuates less than in the river because of the elevation of the culvert or inlet channel. The magnitude of waves is also relatively low in embayments. The reduced water fluctuation and protection from wave action is beneficial to fish directly as potential spawning, rearing and holding habitat, and indirectly, as a result of conditions that promote diverse riparian and wetland vegetative communities that help provide protected areas and food resources.

Abundance of embayments differs among reaches of the Columbia River. McNary Reservoir appeared to have 21 embayments in the mid-1970s (Asherin and Claar 1976). Approximately 17 embayments are connected to John Day Reservoir, with the largest being Paterson Slough in the Umatilla National Wildlife Refuge (approximately 420 ha). The Dalles Pool had 19 embayments in the mid-1970s (Tabor 1976).

River deltas and the usually cooler water occurring at the mouths of the Walla Walla, Deschutes, and most of the other rivers draining into the subbasin’s mainstem provide critical holding habitat for migrating fish, particularly steelhead.

In this portion of the mainstem, some islands are man-made when material from the reservoirs is disposed of material after maintainance dredging. Numerous birds have colonized these islands for nesting, roosting and breeding habitat. Because islands and shallow-water areas attract migrating juvenile salmon, these areas are also often used by predators.

The quantity of riparian and wetland habitat identified in mid-1970s inventories was small (Tabor 1976). An example is John Day Reservoir, where only 230 ha of riparian habitat and 925 ha of wetland habitat remain (USACE 2000). The implications of riparian area degradation and alteration are significant for fish populations that utilize these habitats for rearing and resting (Lautz 2000).

In the Lower Mid-Columbia Mainstem Subbasin, the construction of The Dalles, John Day, and McNary dams and resulting impoundments of the Columbia River have inundated mainstem spawning and rearing areas in the mainstem as well as in the lower reaches of tributaries in this subbasin. Built for hydroelectric power, and variously for navigation, flood control, irrigation and storage, dams (including those constructed upstream of this subbasin) and the resulting impoundments altered water flows. Physical blockages and flow fluctuations caused by large and small dams, tidegates, and warm water limited access to spawning habitat. Dams and impoundments have scoured vegetation and flooded riparian and flatland areas. The river now exhibits steepshore lines and sparse riparian plant communities. The change in the river ecosystem has been systemic.

The dominant shoreline type within the impoundments is usually rip-rap, followed by smaller rock or sand (Hjort et al. 1981). Shoreline gradient in rip-rapped areas is often very steep (>45^o). In the relatively common backwaters, banks are often eroded, and substrate is often smaller than in main reservoirs. There is almost no functioning riparian habitat along the mainstem itself; most of the floodplains that provided favorable hydrologic conditions have been inundated.

Small, relatively slow swimming juvenile salmonids such as fall chinook salmon, may use portions of reservoirs for rearing. Rearing salmonids do not prefer the rip-rap habitats that constitute a high proportion of the shoreline and nearshore areas of all reservoirs in the current planning area of the LMM subbasin (Ward 2001a).

The operation of the hydropower system also has large effects on the spawning habitat of white sturgeon (Parsley and Beckman 1994). Impoundment has increased water depths upstream from the dams; thus, because young sturgeon use the deeper water, the physical rearing habitat has increased. However, during years of reduced river runoff, the lack of high-quality spawning habitat in impounded reaches may preclude successful reproduction by white sturgeon (Ward 2001a). (See 7.3.1 White Sturgeon Key Findings.)

Extant Aquatic Habitats and Aquatic Conditions

In 2004 the multi-agency Northwest Area Committee, a spill response-planning group, identified much of the important remaining aquatic and riparian (and wildlife) habitats in the mid-Columbia mainstem. (The river's general migratory habitat is not described.) The identified aquatic habitats in the LMM subbasin, by reservoir, are in the table below. See Figures x-x for general locations (not all islands are shown). To review the documents, view them or download them from the Internet:

http://www.rrt10nwac.com/files/grp/mid_columbia/dalles-pool-new.pdf

http://www.rrt10nwac.com/files/grp/mid_columbia/johnday-pool-new.pdf

http://www.rrt10nwac.com/files/grp/mid_columbia/johnday-pool-new.pdf

Table 29 Extant aquatic and riparian habitats in the lower mid-Columbia mainstem

Fish Habitat in Mid-Columbia River Mainstem*		
River miles**	**Area**	**Type of Habitat**
The Dalles Pool		
RM 192	The Dalles Dam	Downstream passage resources
RM 193	Lake Celilo pool above The Dalles Dam	Sturgeon spawning area
RM 197.3-197.7	Islands south and SW of Browns Island	Salmonid concentrations and habitat, warm water rearing, fishing
RM 201	NE Celilo, riverbend; Celilo Park (OR) and west of Wishram (WA)	Salmonid concentrations and habitat
RM 205.1	Deschutes River mouth	Salmonid concentrations and habitat
RM 209.3	Spanish Hollow Creek mouth near Biggs Junction (OR)	Riparian habitat
RM 211.25-213.85	West of Rufus (OR)-Oregon side, SE of Maryhill (WA), including three small islands	Salmonid concentrations and habitat, resident warm water fish
John Day Pool		
RM 216.6	John Day Dam (WA side)	Fish ladder
RM 218.7	John Day River mouth (OR)	Salmonid concentrations and habitat, resident warm water fish
RM 230	Rock Creek (WA)	Salmonid concentrations and habitat, resident fish
RM 240.5	Inlet near Roosevelt boat ramp	Salmonid concentrations and habitat, resident fish - warm water rearing, and adult fishery
RM 242.87-243.8	East to west of Roosevelt (WA)	Salmonid concentrations and habitat, resident fish – warm water rearing, and adult fishery
RM 250	Pine Creek (WA)	Salmonid concentrations and habitat
RM 253.5	Willow Creek (OR)	Shallow water habitat-salmonid concentrations and habitat (no tribal fishing zones) resident fish
RM 255.7	Third inlet entrance to Threemile Canyon	Salmonid concentrations and habitat
RM 255.8	Shallow water habitat (WA)	Salmonid concentrations and habitat, resident fish, warm water rearing
RM 255.9	Second inlet entrance to Threemile Canyon	Salmonid concentrations and habitat
RM 256.6	First inlet entrance to Threemile Canyon (OR)	Salmonid concentrations and habitat
RM 258.1	Alder Creek (WA)	Salmonid concentrations and habitat

Fish Habitat in Mid-Columbia River Mainstem*		
River miles**	**Area**	**Type of Habitat**
RM 261.3-263.97	NE, west, east, Crow Island Butte (Crow Butte State Park, WA)	Salmonid concentrations and habitat, prime small mouth fishing west of Crow Butte Island
RM 264.8-265.55	West end of Whitcomb Island (WA) (Umatilla National Wildlife Refuge)	Salmonid concentrations and habitat
RM 272.3	Glade Creek mouth (WA)	Salmonid presence and habitat
RM 273.9	SE point of Sand Island	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 273.95	Between Sand Island and island to the west (WA)	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 274.1	South end of Long Walk Island	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 274.2-275.3	Abandoned railroad trestle, NW of Big Blalock Island	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 275.15-275. 9	Big Blalock Island, NW corner (WA)	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 276.5	First set of small islands east of Long Walk Island (OR)	Salmonid concentrations and habitat, nursery for warm and cool water fish
RM 277.7	Paterson Slough (WA)	Salmonid concentrations and habitat, resident fish in Paterson Slough
RM 278.1-278.18	Washington side, east end of abandoned railroad tracks	Salmonid concentrations and habitat, resident fish in Paterson Slough
RM 282.2-282.3	Washington side, north of Irrigon, Oregon	Island, shallow water habitat
RM 285.8-286.1	Island between Irrigon and Umatilla, east and north entrances	Shallow water habitat
RM 286.2	Second inlet west of Plymouth (WA)	Shallow water habitat
RM 288.6	Near Umatilla River mouth	Salmonid concentrations and habitat, sturgeon spawning, freshwater fish habitat
RM 289.1	Plymouth Park, south side, boat ramp opening (WA)	Island resources
McNary Pool		
RM 291.6	McNary Dam fish ladder (OR)	Adult fish passage
RM 297.6	Inlet at Hat Rock State Park (OR)	Inlet waters
RM 298.3-299.05	The two largest islands east of Hat Rock State Park and passageways between them (OR)	Shallow water habitat
RM 299.4-299.8	First island north of Cold Springs Junction to NE point of peninsula jutting north of Cold Springs Junction	Shallow water habitat

Fish Habitat in Mid-Columbia River Mainstem*		
River miles**	**Area**	**Type of Habitat**
RM 300.05-300.28	Point on south shore opposite Spukshowski Canyon to Point NE of Cold Springs Junction (OR)	Shallow water habitat
RM 304.6	Wetlands area of Juniper Canyon; Corps Habitat Management Area (OR)	Marsh, shallow water, wetland habitat
RM 313.8-314.3	Walla Walla River mouth; near Wallula State Park (OR)	Fish and wildlife resources at the mouth of the Walla Walla River
RM 316.75	Inlet south Hover and Hover Park (WA) across the river from Walla Walla River mouth	Salmonid concentrations and habitat

*General mainstem migratory habitat not described. Not all potentially significant habitat has been identified. ** River miles are based on either the booming or skimming strategies intended to protect riverine resources; in the case of booming strategies, the river miles are slightly upstream of the habitat areas. Where known, some river miles have been adjusted to more closely approximate exact location.

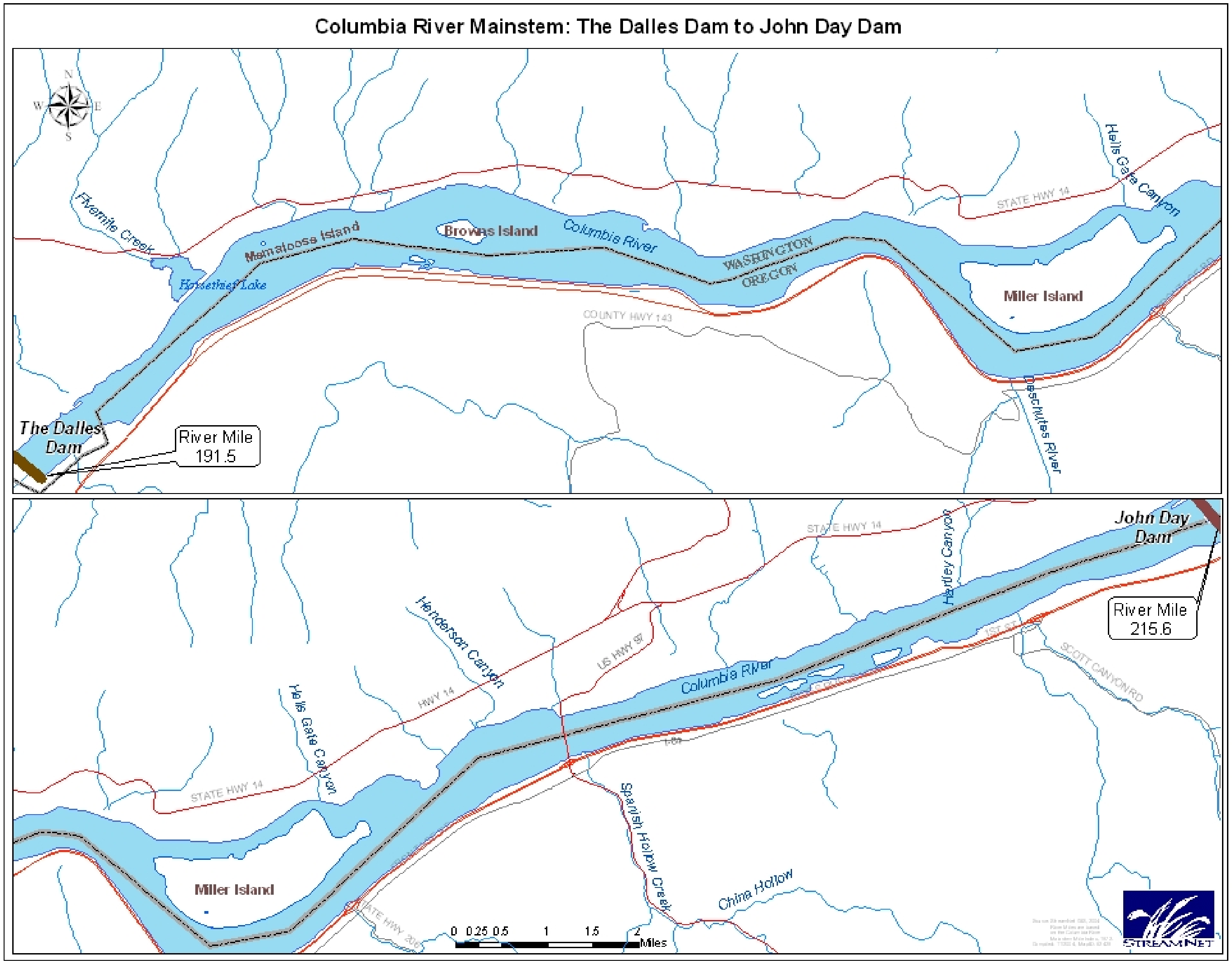


Figure 33 Mainstem Columbia from The Dalles Dam to John Day Dam

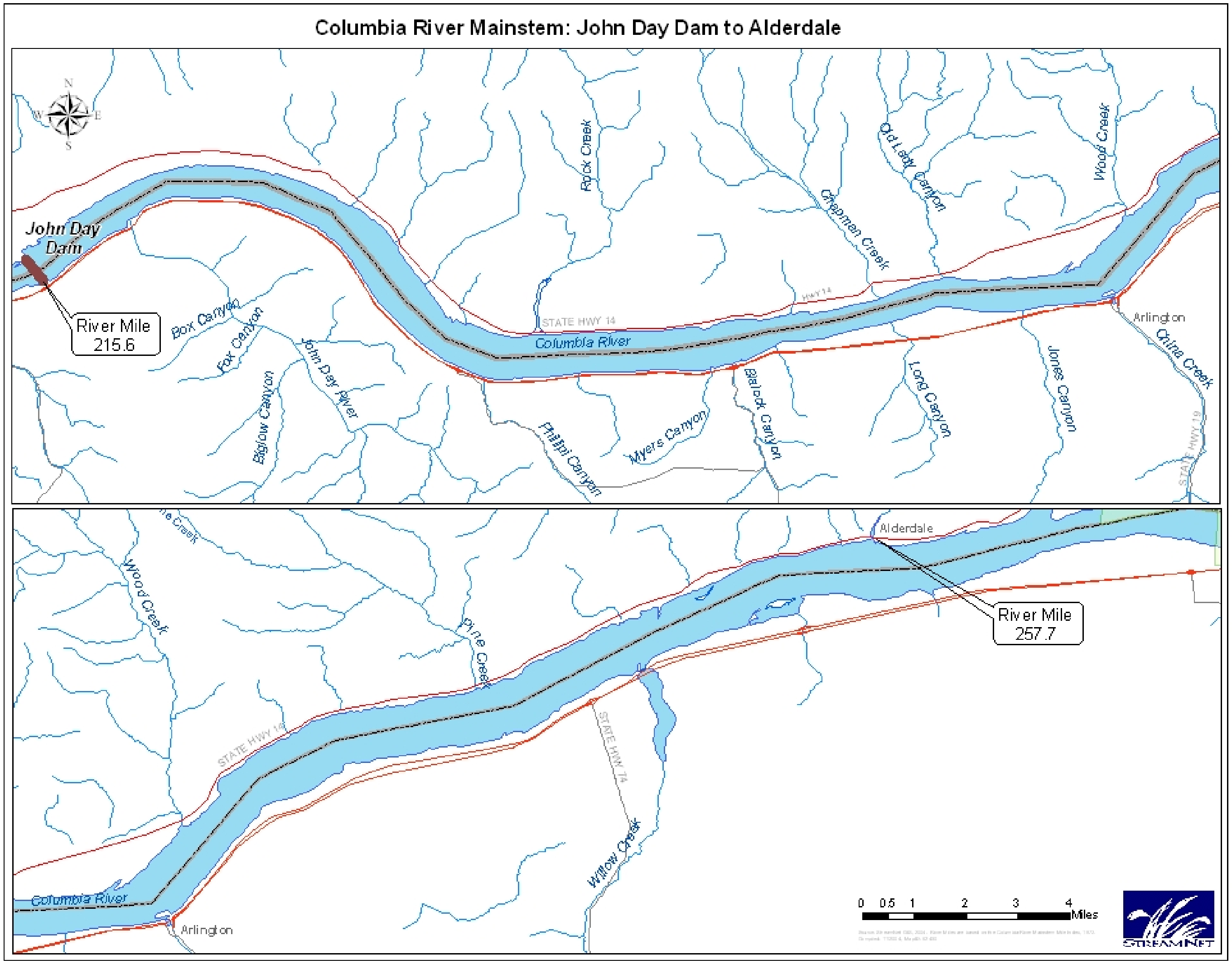


Figure 34 Mainstem Columbia from John Day Dam to Alderdale

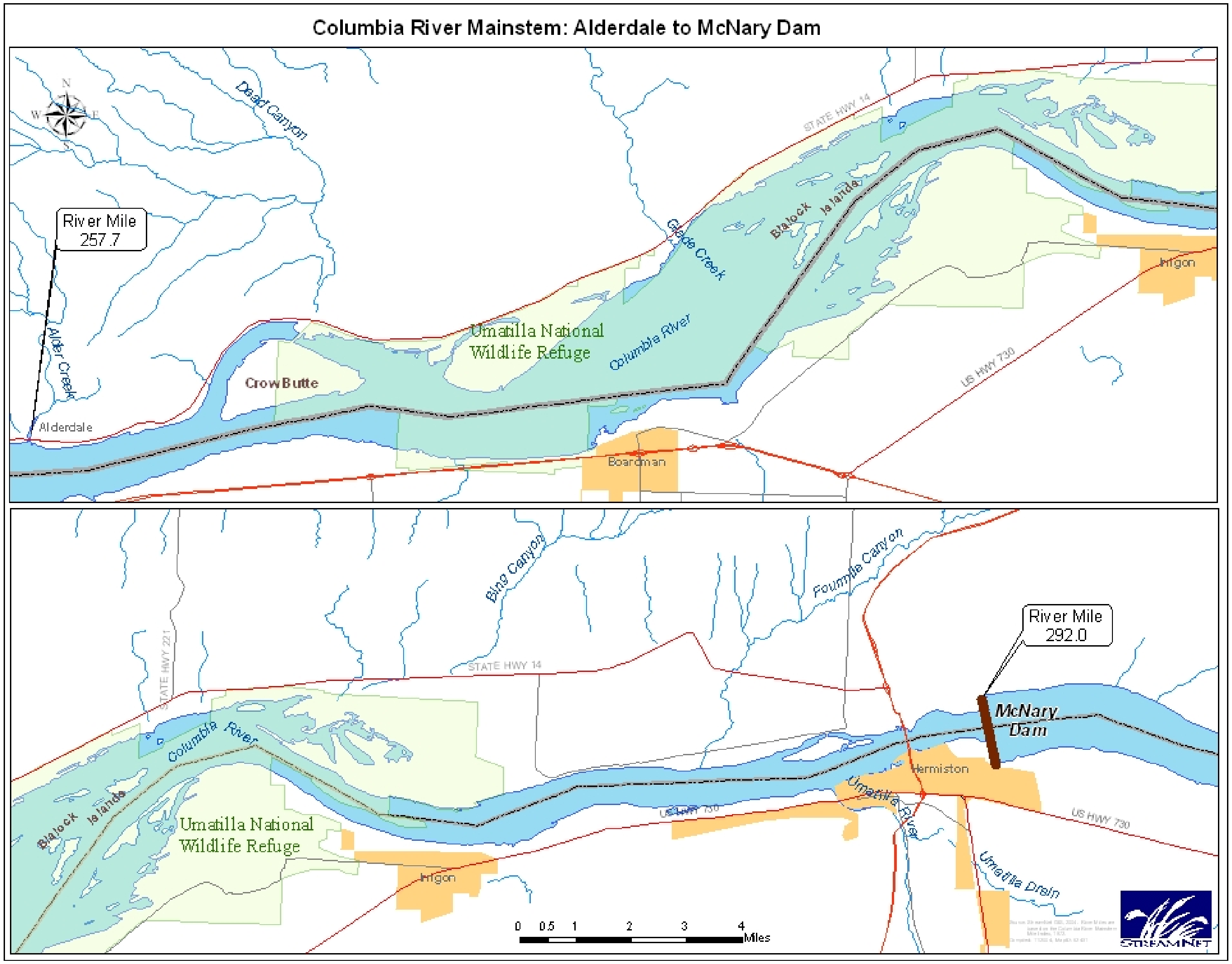


Figure 35 Mainstem Columbia from Alderdale to McNary Dam

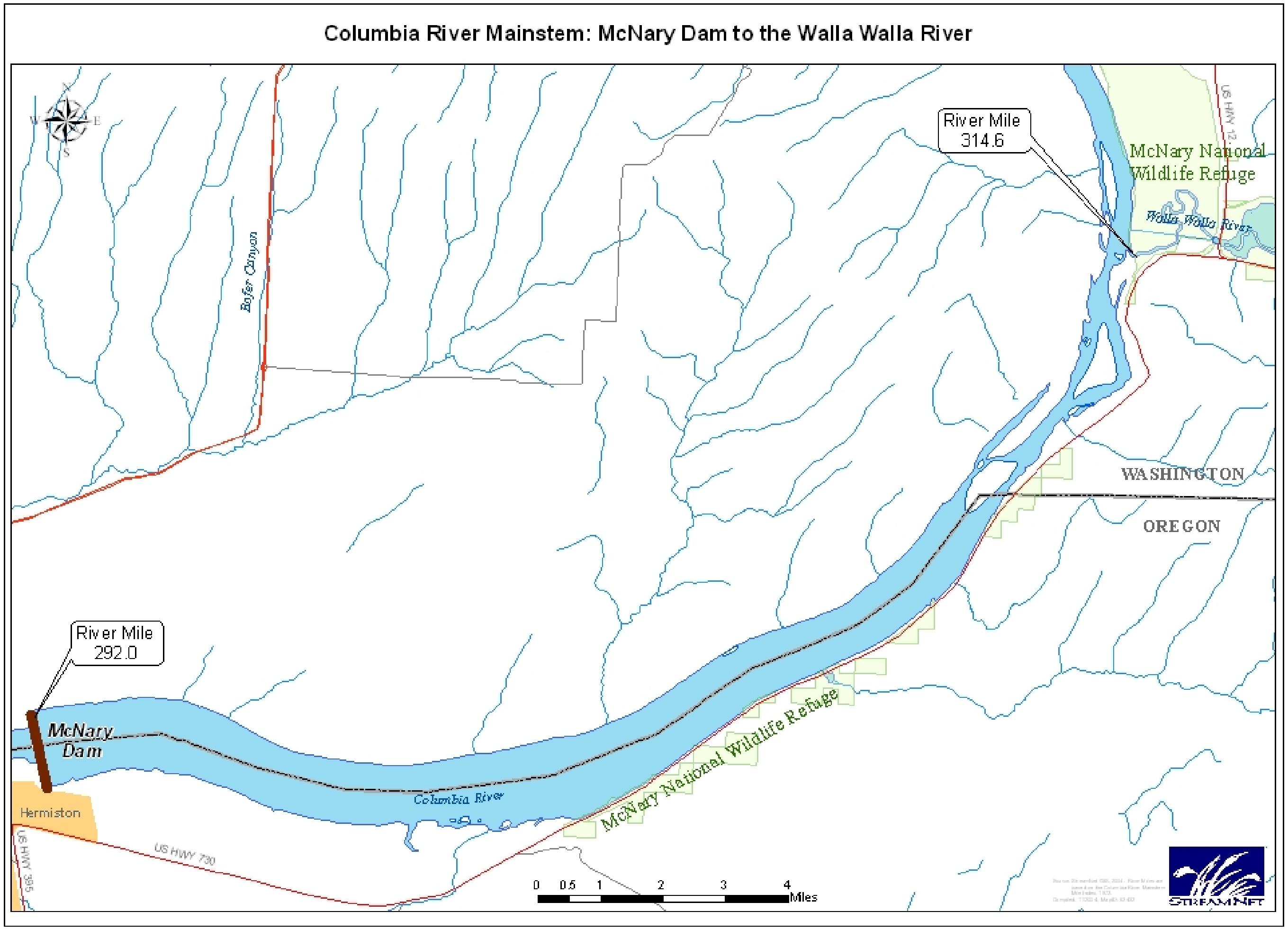


Figure 36 Mainstem Columbia from McNary Dam to the Walla Walla River

Environmental Contaminants

Environmental contaminants enter the lower mid-Columbia mainstem ecosystem through a variety of point and non-point sources. Point sources include outfalls at a variety of agricultural, military, and industrial facilities along the river and major non-point sources including agricultural applications of pesticides, insecticides, and herbicides. Salmonids may uptake contaminants through direct contact or biomagnification through the food chain. The USFWS conducted a study (USFWS 2004d) of environmental contaminants in the Columbia River, with sediment, invertebrate, fish, and egg (piscivorous and non-piscivorous birds) samples collected in the lower Columbia River below Bonneville Dam (four river segments including three NWRs), at Umatilla NWR, above McNary Dam, and in the lower Willamette River near Portland. They found most organochlorine (OC) pesticides were below detection in sediment and biota. However, similar to previous and concurrent studies, the pesticide transformation products DDE and DDD were the most commonly detected and most elevated compounds in biota from both rivers. DDE was detected in all fish samples during both years of the study, and in nearly all samples of bird eggs.

Polychlorinated biphenyls (PCBs) were commonly found in fish and bird egg samples, but were rarely detected in sediment or invertebrates. PCBs and DDE in most fish samples exceeded mean concentrations reported in nationwide comparison studies, and exceeded estimated guidance values for the protection of avian predators.

Mercury was detected in all invertebrates and birds eggs, and in most fish sampled. In invertebrates, mercury was below estimated guidance values for the protection of avian invertebrate predators, but some fish samples exceeded these guidance values. Mercury in eggs of some piscivorous birds in the lower river segments exceeded values associated with impaired reproduction in sensitive individuals.

Most dioxin and furan congeners were near or below detection in sediment and invertebrates, but were commonly detected in fish and bird eggs. Nearly all fish sampled contained 2,3,7,8-tetrachlorodibenzo-pdioxin (TCDD) and 2,3,7,8-tetrachlorodibenzofuran (TCDF) in excess of guideline values derived in this study or other studies for the protection of bald eagles or other avian predators. TCDD and TCDF exceeded estimated NOAELs in eggs of some piscivorous birds.

BMFs derived based on data from Columbia River fish and bald eagle eggs were fairly consistent among river Segments 1 to 3 in the lower river, and the combined BMFs for the three segments were 113 for total PCBs, 75 for DDE, 2.8 for mercury, 16 for TCDD, and 2 for TCDF. The TFC values derived from the BMFs were 0.06 µg/g for total PCBs, 0.04 µg/g for DDE, 0.20 µg/g for mercury, 0.9 pg/g for TCDD, and 7.5 pg/g for TCDF.

Although bioaccumulative contaminants were near or below detection limits in sediment and invertebrates, results document biomagnification of some OC compounds to concentrations likely resulting in adverse impacts to piscivorous birds.

Results did not indicate that individual river segments differed in their contribution to the contaminant concentrations observed in biota. This trend indicates that the river receives contaminants from numerous widespread sources, and that contaminants were evenly distributed in biota.

The extent to which sediments are re-mobilized and transported out of a designated site and their subsequent effects to habitat in areas receiving the sediments is not well understood. USFWS Biological Opinion (1999 predicted contaminants mobilize during the dredging of fine sediments. The USFWS recommends a basin-wide strategy to better control release of bioaccumulative contaminants to the river and minimize impacts to fish-eating birds, to monitor changes in OC contaminants over time, and to better address contaminant uptake from sediment sources.

The lower Umatilla basin is now a Groundwater Management Area. A recent DEQ comprehensive study of the wells within a 352,000-acre portion Umatilla and Morrow counties found elevated levels of nitrate groundwater contamination. Possible source included Umatilla Chemical Depot washout lagoons, confined animal feeding operations, irrigated agriculture, land application of food processing water, and speptic systems. While positive actions have been taken to reduce the contamination, continued work is necessary, according to DEQ (2003).

Lost fishing gear

Commerical gillnets are used in The Dalles and John Day reservoirs. When gear is lost during commercial fishing seasons because of river traffic, vandalism, or water and weather conditions, they sink and sometimes trap fish, including white sturgeon and occasionally salmon. Because a project to retrieve lost gear is relatively new, there are many years worth of the lost synthetic net and buoys to recover (WCT 2003).

Hydrosystem Conditions

Once anadromous fish species and a rugged terrain of fast moving water dominated Columbia River. Since completion of the federal hydrosystem, the lower mid-Columbia River mainstem is dominated by a regulated series of reservoirs and dams, serving multiple and useful purposes. Once the river was important to all stages of the anadromous life cycle; now salmon and other anadromous fish use the mid-Columbia mainstem almost exclusively as a migratory corridor. A migration corridor challenged by juvenile and adult passage through warm, slow moving reservoirs and around/by/through dams by various means.

The focus of mainstem subbasin plans, however, is primarily on habitat rather than system-wide mainstem issues such as passage. Hydropower and storage dams are, of course, major factors in determining the productivity, mortality, and survival of fish in mainstem subbasins. However these issues are intentionally not the focus of subbasin planning and most issues related to passage of anadromous salmonids have been left to be addressed other forums. Major passage and other habitat issues are discussed briefly here and addressed in 8. Management Plan.

Water Quantity

The extent to which hydropower development and flow management practices and their alteration of physical habitat and species assemblages have affected key trophic relationships between species is unknown. It is well established that stream flow quantity and timing are critical components of water supply, water quality, and the ecological integrity of river systems

(Poff et al. 1997). Flow regimes, geology of surrounding landscapes, and longitudinal slope are important controlling variables in salmon habitats and operate at both the watershed and reach scale (Imhof et al. 1996). In the Columbia River, flow regimes are highly regulated by the hydroelectric complex and seasonal discharge is influenced by water storage and water use practices (Ebel et al. 1989). Flow regulation also affects connections among groundwater, floodplains, and surface water (Stanford et al. 1996), or convergence zones (hyporheic habitats) where biodiversity and bioproduction are frequently high (Stanford and Ward 1993). The relative magnitude and frequency of high flow events also acts to modify channel form, but only within constraints of existing geological features. For example, major floods are less frequent because of upstream flood-control projects constructed since the 1940s. This change is significant because rivers that flood frequently maintain different species and food webs from systems that are more ecologically benign (Stanford et al. 1996).

Flows and Flow Augmentation

Dams upstream of this subbasin hold back water for flood control and other uses, interrupting the seasonal river flow patterns. Seasonal releases of water from the dams, called flow augmentation, can aid salmon migration. Flow augmentation for migrating juvenile salmon is called for in the 2000 Biological Opinion. Water is released in spring and summer months to improve flows in the Columbia and Snake rivers. The Corps and the BPA coordinate and plan the flow augmentation with the region through a Technical Management Team for fish.

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Stream flow quantity and timing are critical components of water supply, water quality, the ecological integrity of river systems (Poff et al. 1997) and the ability of anadromous fish to successfully make their timely annual migrations. Flow regimes, geology of surrounding landscapes, and longitudinal slope are important controlling variables in salmon habitats and operate at both the watershed and reach scale (Imhof et al. 1996). Flow regulation also affects connections among groundwater, floodplains, and surface water (Stanford et al. 1996), or convergence zones (hyporheic habitats) where biodiversity and bioproduction are frequently high (Stanford and Ward 1993). The relative magnitude and frequency of high flow events also acts to modify channel form, but only within constraints of existing geological features. For example, major floods are less frequent because of upstream flood-control projects constructed since the 1940s. This change is significant because rivers that flood frequently maintain different species and food webs from systems that are more ecologically benign (Stanford et al. 1996).

The regions fishery agencies have long been working in with the NOAA/Fisheries to ensure that, at a minimum, the flow levels specified in the 2000 Biological Opinion are provided during the juvenile fish migration (State, Federal, and Tribal Fishery Agencies Joint Technical Staff. 2003). These levels of flow were originally selected based on existing data that suggested juvenile survival below these flows would be severely impacted, according to the Joint Technical Staff. Others have recommended alternatives: the Columbia River Inter-Tribal Fish Commission has recommended a normative flow regime that more nearly resembles a natural hydrograph under various runoff conditions, and generally provides spring flows that are significantly greater than the existing targets (2003). (See “Natural Hydrograph and Altered Control” below.)

The preponderance of scientific evidence is that increased flow during migration increases survival of juvenile salmonids by decreasing travel times and that mortality over spillways is lower than mortalities through other routes at dams. Determining the relationship of flow with smolt survival requires, however, more than simply a flow-related variable (DeHart 2003). In a letter of response to the ISAB, DeHart wrote:

> NMFS in published papers has utilized several predictor variables in the regression models. In studies of smolt travel time in the past we have utilized several predictor variables in regression models. In the present application to smolt reach survival, the predictor variables were water transit time, proportion of spill, and water temperature. Because each of these predictor variables are linked to conditions at can influence survival, the model that contained the most predictor variables that each had slope parameter significantly different than zero was chosen as the best model with explanatory capability. Even when spill proportion did not remain in a model in the presence of water transit time, we acknowledged that its influence was still present *because the spillway route is a dam's highest survival route based on past NMFS studies* (emphasis added).
>
> …[A] trend in increasing survival in the lower Columbia River in 2001 was coincident with the increase in spill be provided at dams within the reach. Flows were only moderately changing in 2001 and water temperatures followed the normal course of increasing over time, which links well with increasing predation activity over time. Under these conditions, one would expect reach survival to decrease over the season had spill never been used in the lower Columbia River.
>
> Spill also influences the smolt survival in the reach by providing the route of highest survival ateach dam to the proportion of smolts that utilize that route. Therefore, in every reach survival estimate there are contributions of both spill passage at the dams and flow related variables in the reservoirs to the overall smolt survival estimates. We have been successful in demonstrating that analyses of survival data must include a series of years in order to get a wide enough range of environmental and biotic conditions to show statistically significant relations between smolt survival and a joint set of predictor variables which include a flow-related variable.
>
> The fact that among year flow, water transit time, fish transit time relations can beestablished provides significant reasons to achieve, at a minimum, [2000] Biological Opinion flow objectives in any given year. The proposed NWPPC Program measures would move water from the fish migration period, back to the winter period, affecting flow during the fish migration period. This would be contrary to the intent of the [2000] Biological Opinion. Seasonal flow targets were derived in order to meet minimal hydrosystem survival rates in conjunction with harvest, hatchery and habitat measures, which are required to achieve overall population survival and recovery. Flows should be met throughout the migration period because of differences in passage timing for individual populations. Within populations there are different out migration timing for various lifehistory strategies (e.g. differing overwintering locations within a tributary). The importance of providing protection measures across populations and life-history types has been thoroughly documented, such as ISG *Return to the River* (1996, 2000) and NMFS Viable Salmonid Populations (McElhany et al. 2000). In addition, in river survival

estimates represent only one component of the life cycle, which flows can effect. Other effects of flow include the additional direct mortality that occurs down stream of reach studies and the indirect or delayed mortality that occurs as a result of fish condition, arrival timing and estuary and plume conditions.

The tribes and fish agencies (including NMFS as of 2000), support the flow targets in the unamended 2000 Columbia River Basin Fish and Wildlife Program. At that time in a white paper (2000), NMFS agreed that, especially when base flows are low, continued flow augmentation is consistent with a spread the risk strategy.

Natural Hydrograph and Altered Flood Control

Development of the hydropower system has eliminated most mainstem riverine habitat available for spawning anadromous salmonids and altered the water flows that juvenile anadromous salmonids encounter as they migrate to the ocean. Before construction of the dams, the highest flows occurred in the spring and early summer, and the migration of juvenile salmonids coincided with those high flows (Park 1969). Operation of the hydropower system has resulted in regulated flows that are lower in spring and summer relative to the historic hydrograph (Ebel et al. 1989). Increases in cross-sectional area of the river associated with impoundments further reduced water velocities in spring and summer. The Columbia, once a narrower, fast-moving river, is a now a series of broad, slow-moving reservoirs, effecting wildlife as well as fish (Ward 2001a).

The four Columbia River treaty tribes, who fish and, among others, care for the natural resources in the lower mid-Columbia mainstem, recommend a return to a more natural hydrograph or flow regime. A natural river reservoir operation promotes environmental conditions that are in harmony with the salmon's biological timing (Independent Science Group. 2000. http://www.nwcouncil.org/library/return/2000-12.htm 12.htm

It would require altered flood control and earlier reservoir refill at upstream storage dams. The results, according to the GENESYS model plan, would be more natural river peaks, which would improve salmon survival by increasing turbidity and habitat, decreased travel time, cooler water, less predation, reactivate flood-plain habitats, higher river estuary productivity, and better coincident timing with salmon migration (Martin 2004). Altered flood control uses less reservoir drafts during winter and early spring. More water is shifted from winter to spring, which is more akin to the natural hydrograph than the Corps' current flood contol system.

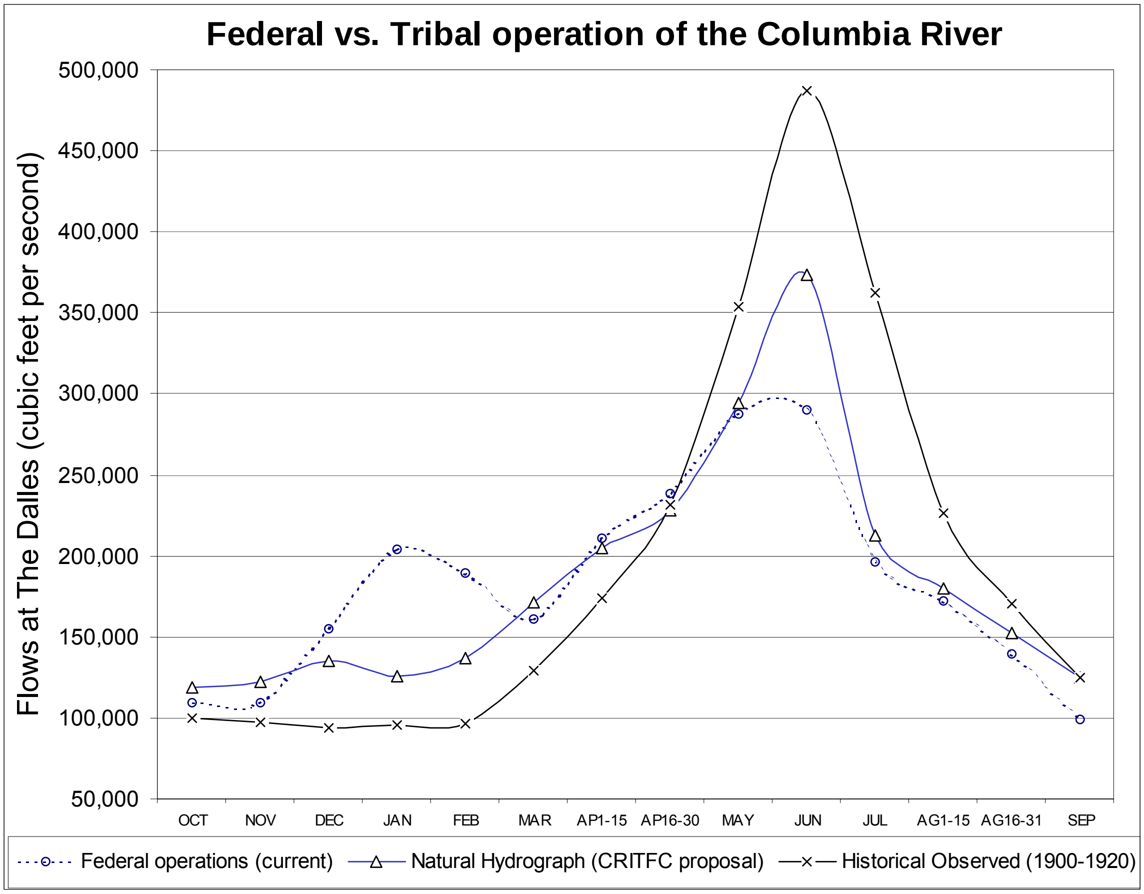


Figure 37 Historical, proposed natural, and current hydrograph

The modeled results shown in the chart above are for the Columbia at The Dalles using the average of 50 water years with the GENESYS hydro model (CRITFC 2001).

Martin makes the case that global warming will reduce winer snow packs, thus reducing the need to store water for spring flood control. New forecast tools, e.g., from the University of Washintgon, CRITFC, and NOAA can reduce premature flood control drafts (2004).

Specific recommendations are proposed for reservoir storage at all the Columbia Basin's major storage dams. Under the proposed scenario generation increases in summer and decreases in winter. Winter demand is offset, in part, by global warming and other non-hydro energy sources (CRITFC 2003) http://www.critfc.org/legal/energy_fin.html

Annual generation from the Federal Columbia River Power System Hydropower would be 162,650 MW or 1,754 MW less than 2000 Biological Opinion annual generation of 162,650 MW.

Note: For other points of view on flow augmentation issues, see Giorig et al. 2002. Giorgi, A., M. Miller, J. Sevenson 2002. Mainstem Passage Strategies in the Columbia River System: Transportation, Spill, and Flow Augmentation. Prepared for the Northwest Power Planning Council, Portland, OR.; and ISAB. 2002. Review of Flow Augmentation: Update and Clarification, Prepared for the Northwest Power Planning Council, Portland, Oregon.

Water fluctuations and rapid flow alterations

Rapid water level fluctuations associated with hydropower peak operations may reduce habitat availability for fish and alter migration patterns. Threats to salmon from altered flows include disruption of natural diurnal and seasonal flow patterns, loss of water-driven access to off-channel habitat, decreased habitat availability for mainstem spawning and rearing stocks, decreased foodweb productivity, altered juvenile migrations and stranding through both direct and indirect effects, and disrupted turbidity patterns (decreased predator avoidance) (LCSSRSP 2004). Rapid changes in flow and spill may also increase problems with upstream passage of adults at dams as fish may have a more difficult time locating the entrances to fishways and may be more likely to fall back after exiting the fish ladder.

Juvenile and adult migration behavior and travel rates are closely related to river flow. Flow fluctuations may stimulate or delay juvenile emigration or adult migration, thereby affecting synchrony of juvenile arrival in the estuary or adult arrival at the spawning grounds. Juvenile and adult salmon have to adjust their habitat distribution and migration timing during these rapid changes in water levels (LCSSRSP 2004).

In response, federal operating agencies have agreed to stabilize daily flow fluctuations from hydropower facilities, including The Dalles, John Day, and McNary dams. Since 1999, the Corps has maintained the John Day reservoir at minimum operating pool year round, with a flow variation within plus or minus one foot, and operate McNary reservoir within the same specifications. Irrigation pumps will be extended in the three reservoirs and will be designed to accommodate spillway crest operation levels as well as minimum operating pools (LCSSRSP 2004). These actions, called for in the regional, federal, and tribal salmon plans, are likely to reduce juvenile travel time, prevent dangerous river conditions for tribal fishers, and may have other habitat benefits.

Peak power flows

Among the reasons for sudden fluctuations and alterations in river flows, is the hydroelectric system responding to peak power demands. The Tribal Energy Vision (Foley and Lothrop 2003), which describes the conflict between peak demand flows and fish among other issues, is the source of most of the following information.

Hydropower is used to serve peak loads because dams can react to demand by quickly putting more or less water through generating turbines. Serving peak loads with hydropower, however, kills millions of juvenile salmon every year. During certain times of the year, so much water is drawn down to generate electricity that salmon redds (gravel nests where salmon lay eggs) are uncovered or dewatered and their eggs die. Juvenile salmon also become stranded in pools or other entrapments and are vulnerable to predation. (This is particularly a problem at Hanford Reach where most of the mainstem spawning is occurring; but also at risk are other potential and documented areas where limited lower mid-Columbia mainstem spawning is occurring or attempted.) There are other adverse flow effects caused by accommodating peak loads. Additionally, the water held behind storage dams for future power generation—for summer air conditioning, for example—would, under natural conditions, be in the river aiding the swift and timely downstream migration of young salmon. Power peaking is an important example of

Columbia River hydrosystem operations that do not provide the natural (or normative) river conditions needed to restore fish to harvestable and sustainable levels.

The tribes envision the development of a more diverse energy resource portfolio to spread the risk between numerous electric power production means. Diverse production sources and other proposals from conservation to major energy effeciencies can be used to make up for losses in power output at federal hydro projects.

Water withdrawals

Flow objectives of NOAA/Fisheries' Biological Opinions for the mainstem Columbia River are rarely met during the summer, especially in moderate to low water years. The summer is a critcal time for migrating salmon, for steelhead and especially fall chinook. Diversion of water for agricultural production, also at its peak during the summer, contributes significantly to this shortage. Low flows, resulting in part from water withdrawals contribute to higher water temperatures and delays in salmon migration, both harmful to fish.

Numerous pumping facilities remove water from the Columbia River mostly for irrigation purposes. Most of the system's water withdrawals are upstream of the John Day Dam, the largest being the Columbia Basin Project in Washington (outside of this subbasin). One of the largest is part of the U.S. Bureau of Reclamation's Umatilla Basin Project. This project includes facilities to pump a maximum of 240 cfs from McNary Reservoir, and to divert an additional 3.9 m3/s from the Oregon-bank fish ladder at McNary Dam to irrigation districts in the Umatilla River subbasin. This project was designed to decrease irrigation withdrawals from the Umatilla River (Ward 2001a).

Another large pumping facility is in John Day Reservoir at the mouth of Willow Creek. A maximum of approximately 449 cfs is withdrawn as part of a permit issued in 1971 by the USACE to irrigate a portion of the land leased originally by the Boeing subsidiary. Various groups have opposed proposed increases to the amount of water withdrawn (Ward 2001a). Most others are small projects. Yet in total large volumes of surface water and groundwater within 1 mile of the Columbia River are being extracted primarily for irrigation (National Research Council 2004; BOR 2002).

Despite efforts to loosen restrictions by the Oregon legislature, it's been very difficult to obtain new water permits in the State of Oregon since 1994, when the state tried to bring its water permitting system in sync with the NPCC's Columbia River Basin Fish and Wildlife Program (Lies 2003). A Bureau of Reclamation study found that water withdrawals from the Columbia and Snake rivers were likely having a significant impact on salmon (BOR 2002). At McNary Dam water diversions take about 20% of the average flow in dry years during the irrigation season which coincides with salmon migations. The study showed that target flows for salmon at McNary were met 74% of the time when there were no withdrawals for irrigation and only 26% with irrigation withdrawals (2002). As of 2003, only two new Oregon water rights were issued since 1994 for Columbia River withdrawals for irrigation (Lies 2003).

In 2004 the National Academy of Sciences, working on behalf of the State of Washington, recently released a report recommending no additional permits be issued for water withdrawals on the Columbia River during the samon critical months of July and August (2004).

Irrigation screening

The irrigation devices used to deflect or pump water from the Columbia River are required by to be screened at the point where water is diverted from the river. The wire mesh screens keep fish from being sucked into the diversion channel or pipe. In 1992 over 44,000 fall chinook salmon in the Umatilla River were killed by a powerful irrigation pump. Then again in 1994, on the same river, 44, 400-88,800 fall chinook were killed when screens failed on a hydroelectric project (BPA 1998).

According to the 1998 BPA report, following a 1993 and a 1994 survey of water intakes on the shores of the Columbia River between Bonneville and McNary Dams, 83% of the Oregon, and 77% of the Washington intakes were out of compliance with screening standards. In 1996 Reynolds, project investigator, did an initial survey of Lower Columbia River (Washington shoreline) water diversion and discovered a noncompliance rate of 62.5%. Reynolds estimated that between 576,000 and 1.1 million juvenile salmon could be lost instantaneously due to inadequately screened water diversions (1998).

The Fisheries Restoration and Irrigation Mitigation Act of 2000 (PL 106-502) created a new federal partnership fish screening and passage program in Idaho, Oregon, Washington and western Montana administered by the U.S. Fish and Wildlife Service. The Congress appropriated $4 million in 2002 to match federal funds with local, state, and tribal water use programs to increase fish survival, reduce entrainment in water distribution systems, and increase access to fish habitats. Since then many irrigation withdrawals have been screened to modern standards. But the authors of this report were unable to locate information regarding the extent of the screening accomplished in the subbasin and how many additional irrigation intakes need to be brought into compliance.

Water Quality

Throughout McNary, John Day, and The Dalles reservoirs, pH, and dissolved oxygen, and conductivity generally meet both Washington and Oregon standards (Ward 2001a). However, standards for dissolved oxygen, sediment bioassay and water temperatures exceed state water quality standards. The Dalles, John Day, and McNary pools are listed as impaired [303(d)] waterways. (See above “Environmental Contaminants” for discussion of sediment problems.)

Tanner, et al. (1996) noted 56 temperature excursions beyond the state criterion out of 170 samples (33%), and the EPA shows 26% of samples collected between 1991 and 1997 have excursions at the John Day Dam forebay. The Corps (1991) also documented numerous temperature excursions at station 814 (below McNary Dam). Numerous TDG excursions were noted at several Corps sites: 25 excursions at the North Pacific Division station JDA in 1993; 14 excursions at the Walla Walla District station MCNTW in 1994; and 33 and 28 excursions at the North Pacific Division station MCN-S in 1993 and 1994, respectively, during times without approved short term modifications to the standards. Sediment levels also exceeded criterion at several locations. Conbere (1994) showed a significant response with sediment bioassay collected Nov. 4, 1993 at 3 locations in the segment and Johnson and Heffner (1994) sediment samples showed substantial toxicity in 10-day Hyelalla bioassays at Badger Island (62%), the Old Outfall (62%), Port Kelly (60%) and Hat Rock (71%) in 1992 (WDE 2000).

Temperature

Impoundments have generally decreased the diversity and quality of habitats. Nearshore and backwater areas, which are more important to the early life history stages of most fish species, suffer from high water temperatures during summer and freezing temperatures during the winter (Hjort et al. 1981). This may preclude year-around use by many species (USFWS 1980). Summer water temperatures often exceed the state and federal standard of 65°F (20° C) that has been established for the Columbia River. EPA is doing work to assess possible PCB releases associated with hydroelectric sources (Ward 2001a).

While construction and operation of dams and reservoirs within the subbasin have not produced a significant change in average water temperature, upstream storage projects have resulted in a temperature phase shift (Jaske and Goebel 1967). Recent studies have hypothesized that the phase shift has resulted in earlier arrival of adult sockeye salmon in the upper Columbia River (Quinn et al. 1997). The migratory and spawning timing of fall chinook salmon returning to the Hanford Reach is also responsive to water temperatures (Dauble and Watson 1997). Historical records indicate that fall chinook salmon returning to the mid-Columbia River may spawn as much as one month later than populations did at the beginning of the nineteenth century (DeVoto 1953). The effects of a later spawning time on the emergence timing and availability of aquatic food web resources is unknown (Ward 2001a).

The upper incipient lethal temperature for juvenile chinook salmon is 24°C (Brett 1952). Temperature affects swimming performance (Brett 1967), growth and energetics (Brett 1952; Elliott 1982), movement behavior (Bjornn 1971), physiological development (Ewing et al. 1979), disease susceptibility (Fryer and Pilcher 1974), and vulnerability of fish to predation (Sylvester 1972; Coutant 1973; Yocom and Edsall 1974; Deacutis 1978). The long-term consequences to fall chinook from chronic exposures to sublethal temperatures that exist in the Columbia River during the summer are unknown, but may be manifested in high mortality at dams due to increased physical stress during passage. This is evidenced by the subyearling chinook salmon kills at McNary Dam in 1994 and 1998, which were temperature related. Studies have also shown that late-migrating juvenile fall chinook salmon exposed to high water temperatures have poorer survival than earlier migrants (Connor et al. 1998; Muir et al. 1998). Considering the life history of fall chinook salmon along with the environmental conditions that exist during their freshwater life cycle, high water temperatures may limit this population by reducing fish performance and long-term survival (Ward 2001a).

Total Dissolved Gas

Because increased flow during migration is thought to increase survival of juvenile salmonids by decreasing travel times, and mortality over spillways is lower than mortalities through other routes at dams, a spill program during juvenile salmonid migration has been specified at Columbia and Snake River dams. Although spill is a relatively safe route to pass dams, it poses risks to fish because it can result in elevated levels of total dissolved gas (TDG) in their bloodstreams. The Environmental Protection Agency’s recommended limit and Oregon and Washington’s criterion is 110% TDG saturation; however, no general agreement exists as to maximum allowable TDG, or to acceptable long-term exposures to levels over 110%. Evaluations of the effects of TDG levels are further confused by the ability of fish to avoid high levels by moving to deeper water. CRITFC and state fish agencies found that because juveniles *are* able to quickly move away from areas of superstatured gas, juvenile exposure to 125% TDG for short periods of time was a better alternative with higher survival rates than moving downstream through generating turbines (Backman and Evans 2002). Nevertheless, fish may be impaired by the sublethal effects of dissolved gas (Ward 2001a).

All reaches making up the Lower-Mid Columbia Mainstem subbasin (the Dalles Dam to John Day Dam, John Day Dam to McNary Dam, and Mcnary Dam to the Washington border) are considered impaired for TDG. Elevated TDG levels are caused by spill events at The Dalles, John Day, and McNary dams. Some spill events, such as those to meet juvenile fish passage goals, are "voluntary." Others are "involuntary" and are caused by lack of powerhouse capacity for river flows. Involuntary spills can result from turbine maintenance or breakdown, lack of power load demand, or high river flows. Elevated TDG levels also enter the TMDL area at the upstream boundary from sources outside the TMDL area. Dams on the Lower Mid-Columbia Mainstem are run-of-the-river dams with very little storage capacity. Therefore, spills are often forced due to operational decisions at upstream storage reservoirs, such as Washington's Grand Coulee Dam or Dworshak Dam (ODEQ and WDE 2002).

Involuntary spills caused by river flows above powerhouse capacity are most likely to occur from late fall to early summer, depending on rainfall or snowmelt in the tributary watersheds. At times of involuntary spill, exceedances above the standard can rise dramatically, peaking above 130% of saturation, and even 140%. These levels do not meet the 110% criterion of either state (ODEQ and WDE 2002).

Adult and Juvenile Passage

Spill

The fish agencies recommend the spill levels in the 2000 Biological Opinion are the minium acceptable levels in most instances for the three mid-Columbia subbasin dams; CRITFC generally recommends more aggressive spill regimes than called for in the Biological Opinion. The dam operators, the Corps and BPA challenged the Bi Op spill plan, arguing that BPA needed to sell more electricity to California, thus saving an extra 10 cents off Northwest ratepayers' bill. Federal Judge James Redden of the Oregon District rejected the power operators' alternative plan on July 28, 2004.

This is from The Biological Benefits of Spill (Heinith and Lothrop 2004):

> The fish agencies and tribes made the case for the federal spill plan: Spill has the lowest rate of direct mortality for juvenile fish passage, ranging generally from 0-2% for spillbays with deflectors, while turbine passage ranges from 2.3-19%. For screen passage, direct morality ranges from 0.4-7.6% (Whitney et al. 1997). Spill has other direct benefits. It reduces passage delay, "speeding juveniles to the ocean" (Heinith and Lothrop 2004). Spill provides higher velocity, decreasing fish delay in dam forbays and trailraces where predator populations are high. (Venditti et al. 2000; Jones et al. 1996; Beamesderfer and Rieman 1991). Spill prevents juveniles from holding in poor quality water conditions in dam passage facilities. (In 1994 an estimated 100,00 fall chinook died because water temperatures were too high.)

In 2003 an estimated 1 million subyearling chinook passed McNary Dam during August. Over the past twelve years the estimated population size at McNary Dam in August has been as high as 2.6 million. The median travel time of subyearling chinook from McNary Dam to Bonneville Dam was estimated to average 8.0 days during August for the years 1997 to 2003. The travel times would likely be longer without spill at John Day and The Dalles and Bonneville dams.

FPC passage data indicates that the average 95% passage date at McNary Dam (1997-2003) of unclipped sub yearling mid-Columbia and Hanford fall chinook marked at Rock Island Dam at McNary is September 16. Long travel time through the John Day pool at summer low flows places these fish in the lower Columbia through September, well beyond the present August 31 end date of BiOp summer spill.

It is estimated that on average, 700,000 and 600,000 subyearling chinook pass John Day and Bonneville dams during August, respectively. The maximum over the past twelve years was 3.5 million and 1.75 million subyearling chinook for John Day and Bonneville dams during the month.

The median travel time of subyearling chinook from McNary Dam to Bonneville Dam was estimated to average 8.0 days during August for the years 1997 to 2003. The travel times would likely be longer without spill at John Day and The Dalles and Bonneville dams.

Survival for many other stocks would be also affected under a no spill operation, including Pacific lamprey. As indicated in radio-telemetry studies by Bjornn and colleagues (2000), spill provides a safer passage route for adult migrants that fallback over dams than turbines or screen systems. Loss of summer spill would select against important stock life history diversity. Tiffan et al. (2000) found that middle and late migraing segments of the Hanford fall chinook were the primary contributors to harvest and to spawning grounds.

The weight of biological evidence indicates that summer spill is critical to the direct and indirect anadromous fish survival, life history diversity and recovery.

The historic passage data demonstrates that a significant proportion of the juvenile and adult summer migration for many diverse stocks is present in the lower Columbia River in late July-August and is benefited by summer spill.

The BiOp August 31 summer spill end date does not provide protection to 95% of the mid-Columbia and Hanford fall chinook passage distribution or adult fallbacks. To protect these migrants, summer spill needs to be extended.

The fish agencies, tribes, environmental and fishing groups argue that barge transportation is not an acceptable substitute for meeting spill and flow targets, because fish mortalities associated with transport can be high. They explain their preference for a spread the risk strategy: use other means, in addition to barging, to aid juvenile fish passage and migration.

Weir Technology

In November 2004 NOAA/ Fisheries announced a revised plan, the 2004 Biological Opinion, which relies heavily on the installation of removable fish weirs at federal Columbia and Snake rivers dams. Fish agencies, tribes, and environmental organizations have criticized the plan saying that it must not be a substitute for other measures called for in the 2000 Biological Opinion. Critics have characterized it as another in a series of federal actions weakening protection for the basin,s salmon. The matter is expected to be taken by Federal District Judge James Redden.

Most Columbia River Basin juvenile anadromous salmon and steelhead tend to stay in the upper 10 to 20 feet of the water column as they migrate downstream to the ocean. However, dam configurations at the Corps, lower Columbia River and Snake River dams cause juvenile fish to dive to depths of 50 to 60 feet to find the passage routes. Engineers and biologists are pursuing new technologies that would provide more surface-oriented, less stressful, passage routes for juvenile fish. Two of these are the removable spillway weir and the Bonneville Dam Second Powerhouse Corner Collector (NOAA/Fisheries 2004).

A prototype removable spillway weir, was installed at Lower Granite Dam on the lower Snake River in 2001. The weir passes juvenile salmon and steelhead over a raised spillway crest (similar to a waterslide), near the water surface, under lower velocities and lower pressures than conventional spill. Juvenile fish are safely and efficiently passed over the weir with less stress and reduced migration delays at the dam. The weir is also designed to be "removable" by controlled descent to the bottom of the dam forebay. This capability permits returning the spillway to original flow capacity during major flood events. The weir has the potential to provide not only fish benefits but also power savings to the region, since less water is used to pass similar numbers of fish, Additional removable spillway weirs are being considered for McNary and John Day dams among others (NOAA/Fisheries 2004).

Adult Fallback and Passage

Spill also provides safer downstream passage for steelhead kelts and adults that fallback over dams than powerhouse routes (Wagner and Hilson 1993). Fallback rates are significant ant range from 5-10% (Henith and Lothrop 2004). Currently, adults that fallback over dams such as John Day and McNary dams can spend extended periods of time in the juvenile system since there is no way to move them from the channel. Several hundred adults are removed each time the fishway system is dewatered. Such dewatering is stressful to adults and has led to mortality. At McNary Dam alone, fallback of steelhead was over 11,000 adults in 1991 (2004). Lamprey are also subject to fallback and impingement on screen bypass systems (Heinith and Lothrop). Adult direct turbine mortality rates are estimated at 22-51% (Wagner and Ingram 1973) and injury rates from screen bypass at 40-50% (Wagner and Hillson 1993).

Adult fish passage criteria for the three lower mid-Columbia dams are established in the Corps' Fish Passage Plan. Fish agency personnel inspect passage facilities at the three dams as they do at other hydroelectric dams on the Columbia and Snake rivers. Since 2001, Basham noted in his 2003 annual inspections report, security conditions prevent unannounced inspections. Although adult fish passage operations and maintainance are routine activities at the dams, some improvements are still needed to meet the established passage critera. Different types of problems from the three dams include: During numerous inspections at The Dalles Dam in 2003, inspectors found fishway traskracks were not being cleared of debris and sticks, which are hazards for salmon trying to swim though the fishways. Gates along the powerhouse collection channel at NcNary need repair as they are at times overtopped with water (2003).The calibrations of gages and other mechical instruments have been an issue of concern at The Dalles and John Day dams. In 1999 the ISAB called for the installation of automated fishway control systems at the dams, which has yet to be accomplished. At John Day a high percentage of fish fall back continues to be a problem: "During the past few seasons, there has been a large fish count differential between The Dalles Dam, John Day Dam, and Mcnary Dam 2003 appears to be no different, with more steelhead counted at John Day thatn The Dalles Dam (+23,000) and about (+58,000) more at John Day than at McNary Dam."

In a positive development, an important modification was made in 2002-03 at John Day Dam in the exit section of the fish ladder. Many lamprey and steelhead tended either to hold or jump in this "serpentine-like" section of the ladder. Biologists observed that the structural modification appeared to have resolved the problem. Despite this success storty, for more than five years, the Fish Passage Center inspection reports, the tribes, and the ISAB have called for a series of more than a dozen recommendations to improve compliance with the adult fishway criteria.

Predation

Primary predators of juvenile salmonids in the Columbia River include northern pikeminnow, smallmouth bass, and walleye. Predator-prey relations have been altered by development of the hydropower system in many ways. Although northern pikeminnow are a native species and have always preyed on juvenile salmonids, development of the hydropower system has increased the level of predation. Dams have slowed water velocity and decreased turbidity, effects that have increased exposure time of juvenile salmonids to predators and increased predation success. Development of the hydropower system has also resulted in extended periods of warm water, and therefore increased predator activity and consumption. Dams concentrate juvenile salmonids in forebays and tailraces, and fish in tailraces are disoriented from passage through or around turbines, spillways, or bypass systems, further increasing their vulnerability to predation. Warm water in the reservoirs have created favorable conditions for exotic warm water species, some of them competing with salmon for food and habitat and preying on juvenile salmon.

Bird predation on juvenile salmonids at the lower mid-Columbia dams is also be a problem. Although estimates for bird predation have been 2% or less of salmonids passing a single dam, it is not known what proportion taken by birds were already dead or seriously or mortally injured (Bayer 2003). In words, it has not been determined what portion of the juveniles would have otherwise survived. Avian predators include Caspian terns, various gull species, double-crested cormorants, American white pelicans among others. While bird predation on juvenile fish is natural part of the food web, dams have made it easier for the birds to select their prey, e.g., by concentrating juvenile salmon at the dams. Some birds have built their nest on the dams; others nest on fish barges and wait for juvenile salmonids to be released en masse from the barges (Collins et al. 2003). After a finding on no significant impact regarding the NMFS 2000 Biological Opinion, the Corps began a new program to deter avian predation at federal dams on the Columbia, including dams in the lower mid-Columbia mainstem. The program is re-evaluating previous deterents strategies, including the wires above the water at tailraces, various forms of lethal and nonlethal harassment as well as studying avain predator behaviors and avain predation mortality numbers.

Environmental/Population Relationships/Limiting Factors

Shallow water habitats can be very productive for fish species. Shallow water habitats comprise approximately 3,600 ha in John Day Reservoir (USACE 2000). The productivity of shallow water habitats, however, is limited in the Columbia River portion of the subbasin because of fluctuating water levels that are caused by power production at the dams.

Islands composed of dredged material have created nesting, roosting and breeding areas for avian predators that prey on juvenile salmon.

Fluctuating water levels along McNary reservoir, the mouth of the Walla Walla River and other areas and river mouths, which provide resting or holding areas for adult salmon, can stress the fish and compromise their upstream migration.

5.6.3 Rock Creek Assessment Unit

Assessment Approach

Available information was summarized on a reach basis. Reaches were delineated using the basic EDT methodology initiating new reaches at each tributary confluence. Great detailed reach breaks may be possible in the future but the time available for planning did not allow an extensive specification based on geomorphology. Generally, the reach breaks are useful and not misleading in the presentation of conditions.

An EDT framework was also used in summarizing the habitat conditions of the reaches. In other words, definitions of ‘pools’, ‘glides’ and other habitat features were considered within the definitions of EDT. Because information on Rock Creek is sparse and sporadic, much of the characterizations are based on best professional judgement. However, orthophotos, field observations, and unpublished Yakama Nation data were incorporated into this summary by reach.

Topography and Climate

Elevations range from 200 feet at the confluence of Rock Creek and the Columbia River to 4,721 feet at Lone Pine Butte. Often the period between volcanic eruptions was long enough to allow development of lakes and streams on the down-warping basalt surface. These bodies of water deposited layers of sand, silt, clay, and volcanic ash forming sedimentary beds between some of the basalt flows. Also present are a variety of forbs indicative of lithic soils (continuous, shallow soils, usually bedrock). Sediment beds form local aquifers and are seen on the hillsides as light colored bands of soil, or bands of trees and brush running along the open grassy slopes.

The drainages in the Rock Creek assessment unit originate in the Simcoe Mountains along Bickleton Ridge, which forms the northern boundary of the subbasin and the southern boundary of the Yakama Indian Reservation. Most of the streams flow in a southerly to southeasterly direction to Lake Umatilla, the portion of the Columbia River impounded by the John Day Lock and Dam. The major streams include Badger Gulch, Harrison, Luna Gulch, Quartz and Squaw creeks as well as Rock Creek. (See Aquatic Habitat Conditions.)

The Rock Creek drainage lies within the eastside Cascades ecological province. Winter conditions in this area tend to be colder with more frequent snow accumulation. Annual precipitation ranges from 20 to 25 inches in the headwaters of Rock Creek to less than 10 inches over most of the eastern half of the subbasin (Lautz 2000).

Vegetation Patterns

The assessment unit lies within a vegetation zone in transition from arid shrub-steppe to the south and forest vegetation to the north. Within the zone, there is a mosaic of meadow-steppe communities and forest communities dominated by Oregon white oak and ponderosa pine (WDNR 1998).

The forest communities are generally found on north-facing slopes and in riparian zones, while the steppe communities populate drier areas. The meadow steppe communities also occupy drier areas in the subbasin. Bluebunch wheatgrass (*Agropyron spicatum*) and Sandberg's bluegrass (*Poa suandbergii*) generally dominate this plant community type (WDNR 1998).

In the headwaters, land cover is primarily coniferous forest. (This area is mostly above known anadromous fish use, although rainbow trout and non-salmonids such as dace use available fish habitat.) Coming off the plateau, land cover is conifer forest or mixed conifer-deciduous forest in the vicinity of streams, transitioning to shrub-steppe in the uplands. Below the canyon reaches, land cover is primarily shrub-steppe in the uplands, with riparian areas transitioning downstream from mixed conifer-deciduous forest to deciduous forest to shrub-grassland.

The riparian zones are made up of primarily the white alder plant community. The subbasin contains some of the few known high-quality occurrences of the white alder community type within Washington, where it is limited to riparian zones in the eastern portion of the state. Most of the riparian zone community has an overstory of Oregon white oak (Quercus garryana), bigleaf maple (Acer macrophyllum), white alder (Alnus rhombifolia), black cottonwood (Populus trichocarpa), and water birch (Betula occidentalis), while shrubs are dense in places and include mock orange (Philadelphus lewisii), ocean spray (Holodiscus discolor), currant (Ribes aureum), and occasionally willow (Salix sp.) (WDNR 1998).

Forested Habitat Function and Process

Oregon White Oak (Quercus garryana)

Oregon white oak (Quercus garryana) is Washington's only native oak. Although limited and declining, oaks and their associated floras comprise distinct woodland ecosystems.

The Rock Creek drainage is the easternmost extent of the largest assemblage of white oak habitat remaining in the state of Washington. Oregon white oak is considered a state priority habitat that is determined to be of significance because it is used by an abundance of mammals, birds, reptiles and amphibians. Many invertebrates, including a variety of moths, butterflies, gall wasps and spiders are found exclusively in association with this oak species. Oak/conifer associations provide contiguous aerial pathways for animals such as the state-threatened western gray squirrel, and they provide important roosting, nesting and feeding habitat for wild turkeys and other birds and mammals. Dead oaks and dead portions of live oaks harbor insect populations and provide nesting cavities. Acorns, oak leaves, fungi and insects provide food. Some birds, such as the Nashville warbler, exhibit unusually high breeding densities in oak. Oaks in Washington may play a critical role in the conservation of neotropical migrant birds that migrate through or nest in Oregon.

Late-successional Forest

Little forestland occurs in the Rock Creek drainage. However logging practices have altered the late successional habitats that do occur within the subbasin. In the past, timber harvest removed important components of older forests, such as large diameter trees, snags, multi-layered canopies and dead, downed wood. Components of these habitats are important to the viability of species such as spotted owls, white-headed woodpeckers, black-backed woodpeckers, pileated woodpeckers, and pine marten. Large, intact tracts of closed canopy and late succession forest habitat are in short supply within the forest stands of the basin.

Deer Winter Range

The Rock Creek drainage lies within the eastside Cascades ecological province. Winter conditions in this area tend to be colder with more frequent snow accumulation. Therefore the importance of low elevation winter range has importance disproportionate to its size. Development of hydropower reduced available big game winter range from historic levels, limiting carrying capacity for big game.

Research has indicated that the low elevation oak woodland and oak/pine mixed forest found in Rock Creek are important wintering habitats, especially where these cover types occur in a mosaic with openings and topographically diverse terrain with abundant south-facing slopes. Such areas are most commonly found associated with the breaks in the upper Rock Creek canyon.

Meadows

Meadow habitats provide for a unique assemblage of plant and wildlife species. Fire suppression has allowed trees to encroach into meadows, resulting in a decrease in size or total loss of meadows. Over-grazing has changed species composition of grasses and herbs, introduced non-native plants that out-compete native vegetation, and reduced species diversity. The construction of roads through meadows has altered water flow patterns, effectively draining them and drastically changing the species composition.

Meadow Steppe

The meadow steppe community is found in the “transition area” between forested uplands and true shrub-steppe. In the subbasin, the meadow steppe community is found in drier areas. Bluebunch wheatgrass and Sandberg's bluegrass generally dominate. Also present are a variety of forbs indicative of lithic soils. In the south central Klickitat area, heavily grazed stands are dominated by cheatgrass, gray rabbitbrush, broom snakeweed, and/or lupines (WDNR 1998).

Areas in the uplands that produce the best herbaceous forage are the riparian habitats that are consequently heavily used by cattle. Bitterbrush (Purshia tridentata) stands on south-facing slopes are heavily browsed by deer and many are decadent and under-productive. Grazing management, particularly in the upper riparian zones and deer winter ranges, is a primary concern.

Conservation Designations

Badger Gulch Natural Area Preserve

The Washington Department of Natural Resources (WDNR) established the 180-acre Badger Gulch Natural Area Preserve in 1982 to protect four important native plant communities and three rare plants. The Natural Area Preserve lies within Klickitat County about 6.8 miles north of the Columbia River and 13 miles east of Goldendale on the Goldendale-Bickleton road. The preserve includes a 2-mile long portion of Badger Gulch, a narrow, steep-walled canyon. Running west to east through the canyon bottom, Badger Creek empties into Rock Creek near river mile 15.

The four protected native plant communities are Idaho fescue-houndstongue hawkweed, Oregon white oak-ponderosa pine, bluebunch wheatgrass-Sandberg's bluegrass and white alder riparian. The three rare plant species are porcupine sedge, shining flatsedge, and beaked cryptantha. These plant communities play an important ecological role in protecting the subbasin's water quality and many vertebrate and invertebrate species.

The Badger Gulch NAP serves as an educational laboratory that provides opportunities for outdoor research and provides baselines for comparison against the effects of human manipulations in similar ecosystems. Additionally, this Natural Area Preserve is valuable as gene pools for native organisms, including species designated as sensitive, threatened or endangered in region.

In 1998 Washington Department of Natural Resources' Southeast Region developed the "Badger Gulch Natural Area Preserve Management Plan." The purpose of the management plan is "to permit natural ecological and physical processes to predominate, while controlling activities that directly or indirectly modify these processes" on the preserve. The plan defines all aspects of management for the site from public use to monitoring and research activities.

Klickitat Oaks Preserve

Adjoining the Badger Gulch NAP is The Nature Conservancy of Washington's Klickitat Oaks Preserve. The currently 414-acre site is preserving native habitats and significant plant and animal species as a functional ecosystem within the upper Rock Creek watershed. This area has been a major conservation site for the Conservancy since the ecological significance of the area was identified in the 1980s. The Conservancy is currently negotiating the purchase of an additional 120-acre plot and, with another private landowner, a 1500-acre limited development conservation easement. Working with federal, state and private adjoining landowners, the Conservancy's purpose is to protect all of the native habitats and significant plant and animal species of the site as a functional ecosystem within the upper Rock Creek watershed.

The Nature Conservancy has developed an initial preserve design and an in-depth Site Conservation Plan for the area. It is a cooperative management strategy for the upper Rock Creek watershed involving a U.S. Bureau of Land Management, WDNR, and resident private landowners. The Nature Conservancy has made a long-term commitment to the site and is currently involved in restoration and management work on the ground, including exotic species control, plant and animal inventory and assessment, and long-term restoration planning.

Physical/Habitat Structure and Composition

Little late successional forest occurs in the Rock Creek drainage and logging practices have altered those that do exist. In the past, timber harvest removed important components of older forests, such as large diameter trees, snags, multi-layered canopies and dead, downed wood. Large, intact tracts of closed canopy and late succession forest habitat are in short supply within the basin.

Forest practices, including logging and roads, have also adversely impacted functional quality of riparian areas in some portions of the headwater and canyon reaches (e.g. upper Rock Creek, Box Canyon, Quartz Creek). Types of impacts include removal of or damage to riparian vegetation, fine sediment delivery from roads and ground disturbance, and compaction and erosion of stream banks and adjacent floodplain areas. Roads and timber harvest may also be elevating the efficiency of storm and snowmelt runoff; thereby affecting peak flows in the drainage. Other timber harvest activities such as skid trails, landings, and tree skidding near streams have caused ground disturbance and erosion.

Development of hydropower reduced available big game winter range from historic levels, limiting carrying capacity for big game.

Vegetative/Habitat Structure and Composition

Riparian hardwood, dominated by white alder, cottonwood, and willow, has an abundance of snags and downed logs that are critical to many cavity birds, mammals, reptiles, and amphibians. Riparian habitats may also contain important subcomponents such as marshes and ponds that provide critical habitat for a number of species (e.g., Virginia rail, sora rail, marsh wren).

The importance of low elevation winter range (for deer) has importance disproportionate to its size. Research has indicated that the low elevation oak woodland and oak/pine mixed forest found in Rock Creek are important wintering habitats, especially where these cover types occur in a mosaic with openings and topographically diverse terrain with abundant south-facing slopes. Such areas are most commonly found associated with the breaks in the upper Rock Creek canyon.

Little forestland occurs in the Rock Creek drainage. However logging practices have altered the late successional habitats that do occur within the subbasin. In the past, timber harvest removed important components of older forests, such as large diameter trees, snags, multi-layered canopies and dead, downed wood. Components of these habitats are important to the viability of species such as spotted owls, white-headed woodpeckers, black-backed woodpeckers, pileated woodpeckers, and pine marten. Large, intact tracts of closed canopy and late succession forest habitat are in short supply within the forest stands of the basin.

Areas of Special Concern

The subbasin contains some of the few known high-quality occurrences of the white alder community type within Washington, where it is limited to riparian zones in the eastern portion of the state. [Please see Vegetation Patterns.]

Oregon white oak (Quercus garryana) is Washington's only native oak. Although limited and declining, oaks and their associated floras comprise distinct woodland ecosystems. The Rock

Creek drainage is the easternmost extent of the largest assemblage of white oak habitat remaining in the state of Washington. [Please see Vegetation Patterns.]

Aquatic Habitat Conditions

Water Quality

Rock Creek was identified as a candidate for the state 303(d) (water quality impaired) list for temperature based on multiple excursions of the standard (18oC/64.4oF) measured in 1990 and 1991 (WDE, 1998).

After further monitoring and stream survey work, Ehinger (1996) concluded that Rock Creek showed "little impact from current forestry or agricultural activities", but also indicated that "impacts from past grazing activity and episodic flood events, including lack of riparian cover and a shallow, braided stream channel" were evident. Ehlinger suggested that high stream temperatures observed in upper Rock Creek "may be natural for a small creek in a hot, sunny summer climate", while temperatures in lower Rock Creek were "affected by the exposed rocky substrate (channel bed) and lack of riparian cover."

Based on this assessment, a memorandum of agreement (Memorandum of Agreement between the Washington State Department of Ecology and Eastern Klickitat Conservation District regarding the delisting of Rock Creek form Section 303(d) list of the Clean Water Act. Signed July 9, 1996) was developed which allowed Rock Creek to be excluded from the 303(d) list subject to the following conditions, to be implemented jointly by the Department of Ecology and Eastern Klickitat Conservation District in cooperation with landowners:

- Identify riparian zones which can be successfully revegetated. Assist landowners to implement Best Management Practices which would enhance canopy cover and encourage channel rehabilitation.
- Monitor grazing and forestry practices.
- Advise landowners in the upper watershed of Best Management Practices for road stability and riparian corridor harvesting.
- Continue water quality monitoring to obtain data for long range planning and for landowners participation with Best Management Practices
- Seek funds to assist with monitoring and rehabilitation efforts.
- Submit a yearly progress report. Implementation of this agreement is ongoing and will continue at least through 2001.

The temperature situation identified in the Rock Creek watershed is likely for all streams in the WRIA; stream monitoring by the Eastern Klickitat Conservation District (1997) has confirmed exceedances of the standard at most of the 27 sites where thermographs have been installed. Based on temperature data through 1997, it appears that exceedances of the standard at higher elevations (plateau and upper canyon reaches) are relatively minor and of short duration; some thermal stressing of juvenile salmonids may occur, but may be avoided if there is access to cool water refuges (areas of spring outflow or groundwater upwelling). In lower canyon and alluvial reaches, exceedances extend well into the sub-lethal or lethal ranges for salmonids and are of long duration. It is unknown to what extent cool water refuges exist in these reaches (Lautz 2000).

Stream-adjacent roads exist along portions of Rock Creek. Generally, the road occurs either along the edge of the floodplain or on a terrace immediately above the floodplain; observed impacts of these roads on floodplain connectivity appears to be minimal. Roads have adversely impacted functional quality of riparian and instream areas in some portions of the headwater, canyon, and alluvial reaches. Types of impacts include removal of or damage to riparian vegetation, fine sediment delivery from roads, ground disturbance, and compaction and erosion of stream banks and adjacent floodplain areas. Roads and timber harvest may also be elevating the efficiency of storm and snowmelt runoff; thereby affecting peak flows in the drainage.

Roads located in the headwaters have also affected instream conditions in the lower Rock Creek. The streams in this subbasin are considered “flashy” (i.e. flows rise and fall rapidly in response to precipitation and/or snowmelt) in the canyon and alluvial reaches. It is likely that road construction in the headwaters has increased drainage density and intensified any natural flashiness. Fish habitat quality in the headwaters is generally considered fair to poor due to the extensive road network.

Further, the construction of roads through meadows has altered water flow patterns, effectively draining them and drastically changing the species composition.

From the mountain headwaters in Rock Creek across the relatively flat basalt plateau, channels are moderately confined to unconfined. As streams enter steep-walled canyons, channels become highly confined. Fish habitat quality is generally fair to poor, due mostly or entirely to the higher stream power in these reaches (Lautz 2000). The subbasin contains a number of springs or seeps including some located in small depressions close to stream channels in the bottom of canyons. In the alluvial valleys below the canyon reaches, channels are moderately confined to unconfined (although there may be locally confined reaches caused by channel incision).

The streams in Rock Creek are considered flashy (i.e. flows rise and fall rapidly in response to precipitation and/or snowmelt) in the canyon and alluvial reaches. It is likely that road construction in the headwaters has increased drainage density and intensified any natural flashiness. Degradation in riparian areas and wetlands has also likely decreased retention capacity. These impacts are most likely to have altered the natural regimen.

Headwaters and Upper Plateau

Grazing, timber harvest near streams and the recent wildfire have also reduced vegetation needed for stream temperature moderation. Loss of riparian vegetation has opened the stream channel to greater summer heating and winter cooling.

Canyon Reaches

Water temperature in the upper canyon reaches is not a significant problem as temperatures exceeding the standard (18° C/64.4°F) are infrequent and of short duration (Lautz 2000). Some thermal stressing of juvenile salmonids may occur, but may be avoided if there is access to cool water refuges (areas of spring outflow or groundwater upwelling).

Alluvial Valley

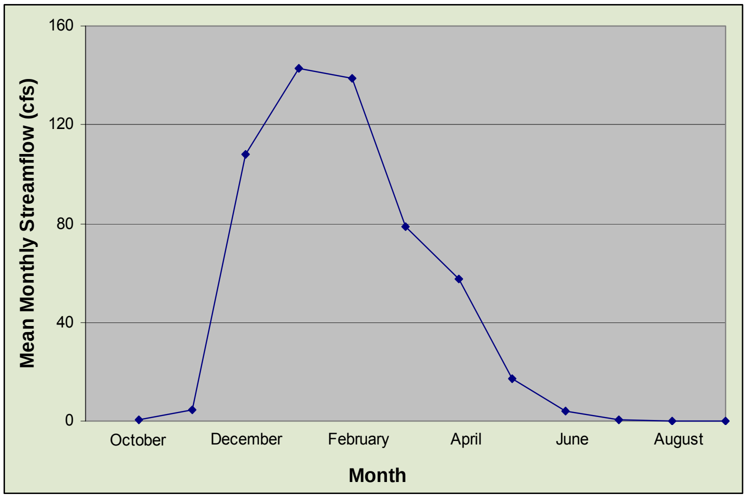
Subbasin streams are classified as Class A streams. Water temperature is, however, a problem affecting habitat quality in the alluvial and lower canyon reaches. In these areas, temperatures above the standard extend well into the sublethal or lethal ranges for salmonids for extended periods. Some springs and seeps exist in these reaches and can provide critical cool water refuges.

The juvenile fall chinook emerge from the gravel from March through May and rear along the shoreline and backwaters for a short period before migrating seaward during the summer (Becker 1973; Key et al. 1994; Key et al. 1996). Fall chinook salmon are the dominant salmonid during spring in nearshore areas of the Lower Mid-Columbia Mainstem Columbia River. Fall chinook salmon also use the upper portions of McNary and John Day reservoirs for rearing, but do not prefer riprap habitats that constitute a large portion of reservoir shorelines (USGS, unpublished data).

Water Quantity

In Rock Creek the limiting factor is flow. When flows reconnect the lower miles of Rock Creek and provide access, fall chinook enter and distribute themselves upstream. In Rock Creek, timing of the spawning run has consistently been in October and November, when flow allows access. Flow likely dictates run-timing in terms of out-migration as well. For Rock Creek, the loss of perennial wetted area in the lower mainstem, loss in overall Columbia River populations, and habitat degradation within the watershed, fall chinook are likely to have diminished in abundance.

Streamflow data is very limited for Rock Creek. The USGS maintained a gage near Roosevelt, WA (Gage # 14036600) for water years (WY; October 1 through September 30) 1963-1968. Mean streamflow over the period of record was 45.8 cfs. The maximum mean annual discharge was 113 cfs and occurred in water year 1965, which encompassed the Christmas floods of 1964 when Rock Creek peaked at 4800 cfs on Dec. 22 and 23. The minimum mean annual flow of 25 cfs occurred during water year 1964. However, annual and even monthly streamflow values do not adequately communicate the seasonally episodic flow distribution pattern. Much of the runoff generally occurred in two or three discreet events.



Major flood events occur when winter rains (or rain-on-snow) falls on frozen soils. Channels and riparian areas were damaged by such flooding early in 1996. Below the plateau, upland soils are thin and rocky; relatively narrow floodplain areas limit storage of runoff during the winter for later release in the summer. These landscape factors, combined with the virtual lack of precipitation from July through September, cause summer flows to go subsurface in some portions of the stream network. This situation is exacerbated in areas where channel widening has occurred, channel downcutting is taking place or flow is distributed over several smaller, shallower channels. Channel dewatering has obvious impacts to fish, including reduction in juvenile mobility, limiting or precluding access for spawning, and mortality due to stranding.

Headwaters and Upper Plateau

Additionally, reductions in vegetation across the watershed may also be increasing peak flow discharges and reducing ground water storage.

Canyon Reaches

Stream flows in the canyons currently rise and fall rapidly in response to precipitation and/or snow. The relatively narrow floodplain in the canyon area limits storage of runoff during the winter for later release in the summer when precipitation is negligible. During normal or drier-than-normal years some areas may go dry during the summer. At the same time, heavy rains and snowmelt can result in extremely high stream flows and flooding conditions. The floods of 1996 further reduced habitat quality in some areas of the watershed.

Alluvial Valley

Dewatering is also a problem [in alluvial valleys], particularly in areas where channel widening has occurred and flow is distributed over several small, shallower channels. Channel dewatering has obvious impacts on fish, including reduction in juvenile mobility, limiting or precluding access for spawning, and mortality due to stranding.

Historical Conditions (Trends)

Historically, peak flows [from the headwaters] may have been somewhat moderated due to greater infiltration and groundwater storage from beaver ponds and vegetation in the headwaters. Further evaluation of historic conditions is needed.

Riparian/Floodplain Condition and Function

There are some areas at the lower end of the Rock Creek canyon reach where flooding and resulting channel widening has damaged or obliterated riparian vegetation over several hundred feet of stream (Lautz 2000).

Headwaters and Upper Plateau

Fish habitat quality in the headwaters is generally considered fair to poor due to effects from past grazing and riparian harvest activities, recent fires on the east side of Rock Creek, and the extensive road network. This area is above currently known anadromous fish use. Rainbow trout and non-salmonids such as dace use the available fish habitat.

Alluvial Valley

Grazing activities, which tend to be concentrated along streams, have degraded riparian habitat (Lautz 2000). These impacts are both direct (browsing, trampling, soil compaction) and indirect (channel incision, bank instability and resulting channel widening). Historically, intensive land uses such as overgrazing adversely altered riparian species composition and habitat characteristics. Continued use of degraded areas in conjunction with greater storm flow intensity is likely impeding natural recovery mechanisms. In incised channels, habitat quality is reduced due to several factors, including high fine sediment levels (associated with bed and bank erosion, runoff from agricultural lands), reduced shade from riparian vegetation, and higher storm flows. In all areas where incision has been reported, grazing is prevalent and is likely a primary accelerating factor.

Steam-adjacent roads exist along portions of Rock Creek. Generally, these roads occur either at the edge of the floodplain, or on a terrace immediately above the floodplain; observed impacts of these roads on floodplain connectivity appears to be minimal (Lautz 2000).

Stream Channel Conditions and Function

The streams in the Rock Creek assessment unit subbasin appear to have similar geomorphic characteristics. Headwater tributaries flow out of the mountains and across the relatively flat basalt plateau at gradients of generally less than 1 %. This area is above known anadromous use.

Coming off the plateau, streams enter steep-walled canyons where gradients increase to 2-4% or more. In steep-walled canyons, substrate is characterized by a mix of cobbles and boulders. Little suitable spawning gravel occurs, and rearing areas (pools) are minimal in extent and quality and are limited to protected areas behind boulders and along stream margins (Lautz 2000).

Below the canyon reaches, streams enter alluvial valleys; gradients range between 1% and 2% near the upper end, diminishing to less than 1% as streams approach the Columbia River (Lautz 2000). Substrate is variable, with particle sizes ranging from cobble to silt.

There are no known natural barriers, such as falls or cascades that block anadromous fish access within the Rock Creek subbasin. Such barriers may exist in unsurveyed canyon reaches of the area.

Geomorphic features of the Rock Creek subbasin have a significant impact on habitat availability and quality. The principal streams of the subbasin share similar features, allowing discussion of three general habitat sub-areas: (1) headwaters and upstream plateau, (2) mid-stream canyons and (3) lower stream alluvial reaches.

Overall [in alluvial valleys], fish habitat quality is highly variable, ranging from poor where degraded riparian zones and channel widening and incision occurs, to excellent where complex habitat elements (deep pools, suitable spawning gravel, large wood debris, riparian cove) exist in the vicinity of spring inflow or groundwater upwelling areas.

There are some areas at the lower end of the Rock Creek canyon reach where flooding and resulting channel widening has damaged or obliterated riparian vegetation. Much of the observed disruption occurred as a result of the 100-year flood event that occurred in 1996. Riparian quality is highly variable in the downstream reaches; the riparian zone is non-existent over significant portions of the alluvial reaches, while elsewhere, it occurs as a strip varying in width from 15 feet to over 150 feet. Continued use of degraded areas in conjunction with greater storm flow intensity is likely impeding natural recovery mechanisms. In incised channels, habitat quality is reduced due to several factors, including high fine sediment levels (associated with bed and bank erosion, runoff from agricultural lands), reduced shade from riparian vegetation, and higher storm flows.

In-channel condition and function

Headwaters and Upper Plateau

In-channel fine sediment is a problem in some areas of Rock Creek, particularly in the headwaters and lower alluvial areas. Primary contributors of fine sediment in the watershed include roads, riparian grazing, timber harvest activities, and recent wildfires.

A number of roads in the headwaters are primarily built of native material with a high fine sediment component. Some of these roads parallel or are in close proximity to streams. Additionally, the roads typically have had infrequent maintenance. Where these roads are poorly maintained and near streams they deliver substantial sediment to the stream system.

Grazing practices in riparian areas have also elevated fine sediment in some areas. Heavy livestock use in springs, seeps and on stream banks has caused erosion and channel downcutting. Loss of vegetation from grazing in these areas has also contributed to bank erosion through a reduction in rooting strength. Other timber harvest activities such as skid trails, landings and tree skidding near streams have caused ground disturbance and erosion. Finally, the recent forest and range fire on the east side of the Rock Creek drainage has removed substantial vegetation and escalated the erosion process.

Canyon Reaches

Fish habitat quality is generally fair due primarily to the higher stream power that can be experienced in these reaches. Spawning gravel and rearing areas are typically associated with boulders and limited woody debris in the canyon reach (Berg 2001).

Alluvial Valleys

Overall, fish habitat quality is highly variable, ranging from poor where degraded riparian zones and channel widening and incision occurs, to excellent where complex habitat elements (deep pools, suitable spawning gravel, large wood debris, riparian cove) exist in the vicinity of spring inflow or groundwater upwelling areas.

Stream channel form and complexity

Headwaters and Upper Plateau

Headwater tributaries flow out of the mountains and across a relatively flat basalt plateau. Channels are moderately confined to unconfined (although there may be locally confined reached caused by channel incision) with gradients generally less than 1% on the plateau. Land cover is primarily coniferous forest.

Loss of riparian vegetation due to grazing, road building, timber harvest and wildfires has limited future recruitment of woody debris to the stream channel. Woody debris is a key element for forming pool habitat, providing overhead cover, sorting spawning gravels, and maintaining channel and bank stability.

Canyon Reaches

Coming off of the plateau, streams enter steep-walled canyons. Channels are highly confined, gradients increase to 2-4%, and substrate is characterized by a mix of cobbles and boulders. Riparian vegetation consists primarily of white alder, willows and water birch. Although limited by the narrow floodplain area, existing riparian vegetation is of relatively good quality and is less effected by grazing and forest management activities as the steep terrain limits accessibility. There are some areas at the lower end of the Rock Creek canyon reach where flooding and resulting channel widening has damaged or obliterated riparian vegetation. Much of the observed disruption occurred as a result of the 100-year flood event that occurred in 1996.

Alluvial Valleys

Below the canyon reaches, streams enter alluvial valleys. Channels are moderately confined to unconfined (although there may be locally confined reaches caused by channel incision), with gradients generally between 1% and 2% near the upper end, diminishing to less than 1% near the Columbia River (Lautz 2000).

Current channel conditions have been significantly impacted by a 100-year flood event, which occurred in early 1996 (Lautz 2000). A number of reaches exhibit extensive bank erosion, migration, widening, deposition, braiding and uprooting of riparian vegetation. While these large flood events are commonly viewed as destructive to habitat, their occasional occurrences can produce long-term habitat benefits through increases in habitat quantity and complexity. Potential benefits can be enhanced if complemented by channel and riparian restoration activities that serve to create habitat, cover, and bank and channel stability against smaller, more frequent flood events.

Ecological Conditions

After further monitoring and stream survey work, Ehinger (1996) concluded that Rock Creek showed “little impact from current forestry or agricultural activities”, but also indicated that “impacts from past grazing activity and episodic flood events, including lack of riparian cover and a shallow, braided stream channel” were evident (Lautz 2000).

Environmental/Population Relationships/Limiting Factors

Human and Natural Factors

The primary limiting factors affecting fish productivity are seasonally low to non-existent stream flows and high summer temperatures. These conditions are most prevalent in the lower portions of the watersheds, but also occur in some sections of the headwaters and canyon reaches. Low or non-existent flows in all streams during the late summer, fall, and early winter will limit or preclude utilization by fall spawning adults (chinook, coho), and limit mobility of juveniles of all species and may result in mortality due to stranding. High stream temperatures during the summer and early fall limit mobility of juveniles of all salmonid species and may result in mortality due to thermal stress. The high stream temperatures can also restrict or delay upstream migration and access for fall spawning fish.

The secondary limiting factors are channel incision and channel widening which have resulted in a reduction in the quality and amount of available fish habitat. In the headwaters and alluvial reaches of the watershed, the combined effects of overgrazing on soils, vegetation and hydrology is the principal contributor to downcutting and channel widening. Channel incision and channel widening may also be causing a reduction or loss of summer base flows. Cattle watering at, or in the vicinity of, spring areas can also have an adverse impact on water quality and riparian function. Spring outflow into fish-bearing waters may provide important cool water refuges for juvenile salmonids during the summer and early fall, even when stream temperatures are high.

Forest practices including logging and roads have also adversely impacted functional quality of riparian areas in some portions of the headwater and canyon reaches (e.g. upper Rock Creek, Box Canyon, Quartz Creek). Types of impacts include removal of or damage to riparian vegetation, fine sediment delivery from roads and ground disturbance, and compaction and erosion of stream banks and adjacent floodplain areas. Roads and timber harvest may also be elevating the efficiency of storm and snowmelt runoff; thereby affecting peak flows in the drainage.

Limiting factors vary for each species of wildlife. However, the degradation and loss of habitat is a common theme for all species. Degradation and loss of habitat has been the result of land use activities such as logging, agriculture, road building, hydropower development, invasion of non-native plants, and expansion of human activities.

Functional Relationship of Assessment Unit with Subbasin

Anadromous fish production within the assessment unit is almost exclusively natural. There are no fish production hatcheries or other facilities located in the subbasin. However, to mitigate for the loss of fall chinook spawning and rearing habitat, the U.S. Fish and Wildlife Service tested net pen rearing of bright fall chinook near the mouth of Rock Creek from 1984 through 1987 (Nelson 1987; Beeman 1994). The program was discontinued because of exposure to infectious hemetopietic necrorsis among the source populations from the Little White Salmon hatchery (Nelson 1987).

Table 30 Rock Creek reach assessments

REACH	DESCRIPTION	Assessment Unit
Rock Creek 1	Columbia River Mainstem to Army Corps of Engineers Park	Rock Creek
FOCAL SPECIES	Steelhead, Coho, Fall Chinook	
PHYSICAL HABITAT CONDITIONS		
decrease in glides increase in pools decrease in pool tailouts loss of backwater pools decrease in woody debris		
WATER QUALITY CONDITIONS		
elevated temperature multiple listings for 303(d) (Columbia River)		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function increased nutrient enrichment increased hatchery outplants increased fish species introduction increased fish community richness increased fish pathology increased harassment decrease in benthic community richness		
COMMENTS		
Reach 1 is a one mile of creek inundated by the John Day Dam. Rock and Columbia River are 303(d) listed for temperature.		

REACH	DESCRIPTION	Assessment Unit
Rock Creek 2	Army Corps of Engineers Park to Squaw Creek	Rock Creek
FOCAL SPECIES	Steelhead, Coho, Fall Chinook	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement increase in embeddedness decrease in glides decrease in pools decrease in pool tailouts loss of backwater pools decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity decrease in temperature spatial variation increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function increased hatchery outplants increased fish species introduction increased fish community richness increased fish pathology increased harassment increased nutrient enrichment decrease in benthic community richness		
COMMENTS		
Army Corps of Engineers park confines new mouth; it buries approximately 40 acres with fill, asphalt, and exotic landscaping. Old Highway 8 bridge and road grade bisect floodplain, confine stream. Riparian cover constitutes less than 5%of channel migration zone. Rock Creek Band has documented declining well depths. Groundwater analysis reveals possible link between upper watershed well water withdrawals and lower watershed surface flows. Small mouth bass observed preying on steelhead fry. Stream 303(d) listed for temperature. Road parallels stream for entire reach. Clipped steelhead morts observed. Extensive invasive species(Himalayan blackberry, walnut, etc). Grazing has impacted channel morphology and has direct impact on steelhead redds/spawning. Steelhead spawning in bottom 5 miles averaged between 36 and 45 redds in 2002 and 2003.		

REACH	DESCRIPTION	Assessment Unit
Rock Creek 3	Squaw Creek to Luna Gulch	Rock Creek
FOCAL species	Steelhead, Coho, Fall Chinook	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement decrease in pools decrease in pool tailouts increase in embeddedness decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity decrease in temperature spatial variation increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function increased fish pathology increased harassment decrease in benthic community richness		
COMMENTS		
Stream has been significantly confined by dikes, channelization, and bridge. Riparian growth is severely limited. Road parallels stream for entire reach. Stream 303(d) listed for temperature. Extensive invasive species (Himalayan blackberry, walnut, etc.). Springs have been impaired by roads and/or grazing.		

<table>
<tr><th>REACH</th><th>DESCRIPTION</th><th>Assessment Unit</th></tr>
<tr><td>Rock Creek 4</td><td>Luna Gulch to Badger Gulch</td><td>Rock Creek</td></tr>
<tr><td>FOCAL SPECIES</td><td colspan="2">Steelhead, Fall Chinook</td></tr>
<tr><td colspan="3">PHYSICAL HABITAT CONDITIONS</td></tr>
<tr><td colspan="3">increase in hydro-confinement
decrease in pools
decrease in pool tailouts
decrease in woody debris</td></tr>
<tr><td colspan="3">WATER QUALITY CONDITIONS</td></tr>
<tr><td colspan="3">increased fine sediment
increase in turbidity
decrease in temperature spatial variation
increase in mean monthly temperature</td></tr>
<tr><td colspan="3">WATER QUANTITY CONDITIONS</td></tr>
<tr><td colspan="3">low flow</td></tr>
<tr><td colspan="3">ECOLOGICAL HABITAT CONDITIONS</td></tr>
<tr><td colspan="3">decrease in benthic community richness
increased fish pathology
increased harassment
decreased riparian function</td></tr>
<tr><td colspan="3">COMMENTS</td></tr>
<tr><td colspan="3">Diking of channel. Lack of any riparian vegetation through half of reach. Road parallels entire reach. Stream is 303(d) listed for temperature. Extensive invasive species (Himalayan blackberry, walnut, etc.). Springs have been impaired by roads.</td></tr>
</table>

REACH	DESCRIPTION	Assessment Unit
Rock Creek 5	Badger Gulch to Quartz Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decrease in benthic community richness decreased riparian function		
COMMENTS		
Mostly naturally confined reach. Most of reach is remote. Loss of stream structure.		

REACH	DESCRIPTION	Assessment Unit
Rock Creek 6	Above Quartz Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decrease presence of beaver ponds decreased riparian function decrease in salmon carcasses		
COMMENTS		
Long reach, two probable low flow barriers. Anecdotal evidence suggests beaver were highly present in past; no beaver observed in past 3 years.		

REACH	DESCRIPTION	Assessment Unit
Squaw Creek 1	Rock Creek to Harrison Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement increase in embeddedness decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decrease in salmon carcasses decrease presence of beaver ponds decreased riparian function decrease in benthic community richness		
COMMENTS		
Rock Creek Road and bridge bisect floodplain. Subwatershed is dominated by agricultural and forest uses. Riparian vegetation is extremely limited.		

REACH	DESCRIPTION	Assessment Unit
Squaw Creek 2	Above Harrison Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity decrease in temperature spatial variation increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function		
COMMENTS		
Lack of riparian cover. Subwatershed is predominantly agricultural and forest.		

REACH	DESCRIPTION	Assessment Unit
Luna Gulch	Above Rock Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
decrease in woody debris		
WATER QUALITY CONDITIONS		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function		
COMMENTS		
Stream is unknown except by orthophoto interpretation and road intersections.		

REACH	DESCRIPTION	Assessment Unit
Badger Gulch	Above Rock Creek	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decrease presence of beaver ponds		
COMMENTS		
Slight road and bridge encroachment in upper watershed. Active channelization observed. No beaver observed. Steelhead observed.		

REACH	DESCRIPTION	Assessment Unit
Quartz Creek 1	Rock Creek to Box Canyon	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decrease in salmon carcasses decrease presence of beaver ponds		
COMMENTS		
Upper watershed dominated by timber harvest and grazing. Roads previously identified as contribution to increase sediment delivery. No beaver observed; anecdotal evidence suggests previous presence; habitat suitable.		

REACH	DESCRIPTION	Assessment Unit
Quartz Creek 2	Above Box Canyon	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
decrease in woody debris		
WATER QUALITY CONDITIONS		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decrease in salmon carcasses decrease presence of beaver ponds decreased riparian function		
COMMENTS		
Upper watershed dominated by timber harvest and grazing. Roads previously identified as contribution to increase sediment delivery. No beaver observed; anecdotal evidence suggests previous presence; habitat suitable. Orthophotos show lack of riparian cover.		

REACH	DESCRIPTION	Assessment Unit
Box Canyon 1	Quartz Creek to Falls	Rock Creek
FOCAL SPECIES	Steelhead	
PHYSICAL HABITAT CONDITIONS		
decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
ECOLOGICAL HABITAT CONDITIONS		
decrease presence of beaver ponds decreased riparian function decrease in salmon carcasses		
COMMENTS		
Short reach(less than 1 mile); 16' waterfall marks end. Lack of large woody debris and opportunity for recruitment. No beaver presence. Upper watershed dominated by timber harvest and grazing. Roads previously identified as contribution to increase sediment delivery.		

REACH	DESCRIPTION	Assessment Unit
Pine Creek	Above Columbia River	Lower Mid-Columbia Mainstem
FOCAL SPECIES	Steelhead, Fall Chinook	
PHYSICAL HABITAT CONDITIONS		
increase in hydro-confinement increase in embeddedness decrease in glides decrease in pools decrease in pool tailouts loss of backwater pools decrease in woody debris		
WATER QUALITY CONDITIONS		
increased fine sediment increase in turbidity decrease in temperature spatial variation increase in mean monthly temperature		
WATER QUANTITY CONDITIONS		
low flow		
ECOLOGICAL HABITAT CONDITIONS		
decreased riparian function increased fish species introduction increased fish community richness increased fish pathology increased harassment decrease in benthic community richness		
COMMENTS		
Steelhead and Fall Chinook have been observed spawning in limited numbers. State highway and railroad create difficult barrier to passage. How fish pass is unknown; some reports of sunken culvert(now buried). Anecdotal information suggests greater populations historically, better habitat. Habitat has been simplified. Upper watershed is primarily in agriculture. Stream needs more study and passage solution.		

5.6.4 Washington Tributaries Other Than Rock Creek Assessment Unit

Vegetation Patterns

Less than 10% of the WRIA is forested, primarily in the headwaters of Rock Creek and Pine Creek; much of the forested land also has active grazing allotments (Lautz 2000).

Environmental/Population Relationships/Limiting Factors

Access

Barrier culverts at SR 14 on Pine Creek preclude access to potential steelhead habitat.

Low or non-existent flows in all streams during the late summer, fall, and early winter will limit or preclude utilization by fall spawning adults (chinook, coho), and limit mobility of juveniles of all species.

High stream temperatures in the lower portions of all streams during the summer and early fall will limit mobility of juveniles of all salmonid species (Lautz 2000).

Floodplains/Wetlands/Riparian Areas

Grazing and trampling by cattle in and near stream banks has caused accelerated channel incision (entrenchment, downcutting) and resulted in a reduction in the quality and amount of available existing or potential fish habitat; continued grazing activity in these areas may delay recovery where functional floodplains and riparian areas are becoming reestablished (Lautz 2000).

Channel widening and obliteration of riparian zones caused by a 75 to 100 yearflood event in 1996 has resulted in locally poor habitat quality and riparian condition. While there may be long term benefits (LWD recruitment, creation of complex habitat) as a result of this event, there may be opportunity to accelerate habitat recovery and improve stability against smaller, more frequent floods through channel and riparian restoration activities (Lautz 2000).

Cattle watering at, or in the vicinity of, spring areas may have adverse impacts on water quality. Spring outflow into fish-bearing waters may provide important cool water refuges for juvenile salmonids during the summer and early fall (Lautz 2000).

Functional quality of riparian areas has been adversely impacted by grazing and forest practices in many locations throughout the watershed. Types of impacts include removal of or damage to riparian vegetation and compaction and erosion of stream banks and adjacent floodplain areas (Lautz 2000).

Water Quantity and Quality

Low or non-existent flows in all streams during the late summer, fall, and early winter will limit or preclude utilization by fall spawning adults (chinook, coho), limit mobility of juveniles of all species, and may result in mortality due to stranding (Lautz 2000).

High stream temperatures in the lower portions of all streams during the summer and early fall will limit mobility of juveniles of all salmonid species, and may result in mortality due to thermal stress (Lautz 2000).

Information Gaps

The limiting factors described above were identified based upon a very limited amount of information that was available for this WRIA. More detailed information should be collected to more precisely define these factors, and to identify specific areas where restoration activities will best redress them. The information to be collected includes the following:

- Further investigstion of fish utilization and habitat availability and quality, to be conducted on all accessible or potentially accessible streams.
- Further investigation of potential barriers should be conducted on all fish bearing streams, using an approved assessment and inventory protocol.
- More detailed evaluations of the condition of channels, floodplains, wetlands, and riparian areas.
- Identification of sediment sources, sinks, and sediment related impacts to habitat.
- A stream temperature study to provide a better understanding of the causative factors of high stream temperatures.

A watershed assessment, funded by the Columbia River Basin Fish and Wildlife Authority and administered by the Yakama Nation, will be initiated in the next year. It is anticipated that most, if not all, of the information needs described above will be accounted for as part of this assessment (Lautz 2000).

Aquatic Habitat Conditions

Water Quality

All streams in this assessment unit are classified as Class A streams (excellent water quality). Identified water quality problems include high water temperatures recorded during the summer. Alder Creek, Six Prong Creek, Wood Gulch, Pine Creek were found to exceed the WDE standard (18oC/64.4oF) (BLM 1986, EKCD 1997, Lautz 2000).

The temperature situation identified in the Rock Creek watershed is likely for all streams in the subbasin. Stream monitoring by the Eastern Klickitat Conservation District (1997) has confirmed exceedances of the standard at most of the 27 sites where thermographs have been installed. Based on temperature data through 1997, it appears that exceedances of the standard at higher elevations (plateau and upper canyon reaches) are relatively minor and of short duration; some thermal stressing of juvenile salmonids may occur, but may be avoided if there is access to cool water refuges (areas of spring outflow or groundwater upwelling). In lower canyon and alluvial reaches, exceedances extend well into the sub-lethal or lethal ranges for salmonids and are of long duration. It is unknown to what extent cool water refuges exist in these reaches (Lautz 2000).

Riparian/Floodplain Condition and Function

Riparian areas have been extensively impacted within the Columbia basin such that undisturbed riparian systems are rare (Knutson and Naef 1997). Impacts have been greatest at low elevations and in valleys where agricultural conversion, altered stream channel morphology, water impoundment, and water withdrawal have played significant roles in changing the character of streams and associated riparian areas. Losses in lower elevations include large areas once dominated by cottonwoods that contributed considerable structure to riparian habitats (Lautz 2000).

Steam-adjacent roads exist along portions of Wood Gulch, Chapman Creek, and Glade Creek. Generally, these roads occur either at the edge of the floodplain, or on a terrace immediately above the floodplain; observed impacts of these roads on floodplain connectivity appears to be minimal (Lautz 2000).

Stream Channel Conditions and Function

No systematic, evaluation of sediment sources and impacts has been conducted in the subbasin. Generally speaking, land-use related sediment sources in this watershed occur as a result of forest practices (e.g. streamside harvesting and construction and use of gravel and native surface roads and skid trails), grazing practices (e.g. streamside grazing), and from stream-adjacent county and private roads not associated with forest practices. Informal assessments suggest that in-channel fine sediment is not a problem, except in the upper reaches of Pine Creek (Lautz 2000).

Areas of Special Concern

WDFW has identified potential coho habitat in the lower portion of Glade Creek (LaRiviere, pers. comm.; Lautz 2000).

Environmental/Population Relationships/Limiting Factors

The barrier culverts at SR 14 on Pine Creek preclude access to potential steelhead habitat. This barrier occurs at the mouth of Pine Creek, and consists of a single 120” concrete-encased corrugated metal pipe located on line with the creek, and three 120” concrete-encased corrugated metal pipes offset approximately 150 feet to the east of the creek. All culverts are perched approximately 6 feet relative to the creek bed at the upstream end. Flow (and fish passage) in the culverts occurs only when high flows in Pine Creek create a backwater, or when the John Day pool in the Columbia River rises above the inlet elevation of the culverts; at other times, flow in either direction passes through the roadbed, effectively precluding passage. These culverts have been identified by WDFW as a total barrier to all anadromous species. Approximately three miles of potential steelhead habitat have been surveyed above this culvert (Lautz 2000).

Functional Relationship of Assessment Unit with Subbasin

Pine and Glade creeks do not have confirmed anadromous fish use, but have been identified as having potential use because of available habitat (Lautz 2000).

5.6.5 Oregon Tributaries Assessment Unit

The two streams with anadromy in this subbasin are Frank Fulton Canyon and Spanish Hollow creeks. East of these two watersheds are small intermittent streams such as Helm, Blalock, Long, and Jones canyons, which are near but not part of the John Day River Subbasin. Neither ODFW or Sherman County SWCD have habitat surveys of Spanish Hollow or Fulton Canyon Creek watersheds or the other canyon areas, and they do not know of any that have been conducted.

A 2003 map produced by StreamNet apparently with data from DEQ and EPA shows salmonid use of Spanish Hollow and Fulton Canyon watersheds. (See Appendix E Figures 160A&B in LMM Appendices folder.)

Aquatic Habitat Conditions

Water Quality and Quantity

Low flows throughout these watershed during the late summer, fall will limit or preclude utilization by fall spawning adults (chinook, coho), limit mobility of juveniles of all species, and may result in mortality due to stranding (French 2004). Groundwater withdrawals are likely to have lowered base flows decreasing perennial flow area (NOAA/Fisheries 2004).

Temperatures near and above lethal limits for salmonids for much longer duration than during pre-settlement times due to reduction in summer low flow (French 2004). High stream temperatures in the lower portions of all streams during the summer and early fall will limit mobility of juveniles of all salmonid species, and may result in mortality due to thermal stress.

Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces is occurring and can severely decrease egg incubation survival, decrease interstitial space affecting inactive rearing stages of juveniles and or entomb juveniles (NOAA/Fisheries). The NOAA/Fisheries recommendation is to decrease sources of fine sediment from erosion, especially on sloping soils, where cover crops and residue are lacking.

Riparian/Floodplain Condition and Function

Altered hydrology and removal of vegetation from landscape and riparian areas, uncontrolled grazing, and mechanized agriculture have resulted in soil erosion and reduced infiltration capacity of the soils, and increased peak or flashier runoff is also likely to be occurring (NOAA/Fisheries 2004).

Stream Channel Conditions and Function

In general, habitat conditions in Fulton Canyon and Spanish Hollow streams are confined by roads and are affected by sedimentation likely from agricultural practices and, in some places, from livestock grazing (French, pers. comm. 2004; Stradley, pers. comm. 2004). Both sediment and temperature limit fish production in these two streams (French, pers. comm. 2004).

Environmental/Population Relationships/Limiting Factors

Lower mid-Columbia River and other mainstem dams have reduced anadromous fish numbers, including potential spawners in Fulton Canyon and Spanish Hollow Poor passage and migratory conditions (including temperature) for anadromous fish have reduced abundance, productivity, and spatial diversity. Summer/early fall habitat availability diminished in comparison with pre-settlement environment.

Functional Relationship of Assessment Unit with Subbasin

Columbia River dams have reduced anadromous fish numbers, including potential spawners in Fulton Canyon and Spanish Hollow Poor passage and migratory conditions (including temperature) for anadromous fish have reduced abundance, productivity, and spatial diversity. Spanish Hollow and Fulton Canyon watersheds are used by steelhead (French 2004), but whether other anadromous species use the watershed and the extent of that use is unknown.

5.7 Key Findings

5.7.1 Mainstem: Steelhead, Coho, Fall Chinook

Table 31 Mainstem key findings and working hypotheses: steelhead, fall chinook, coho

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Confidence Level in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Hydropower system has altered the historic hydrograph, which has a negative impact on juvenile salmon, including steelhead, coho, and fall chinook.	For juvenile salmon, migration time is greatly extended and has decreased juvenile and subsequent adult survival	High	High	High	Restore normative hydrograph	Employ alternative flood control strategies to help recapture to historical timing of flows Augment flows
	Increased water velocities will reduce travel time and improve juvenile and subsequent survival of adult returns	High	High	High	Improve juvenile passage conditions in the subbain's mainstem	Augment flows to increase water velocities. Provide spill beyond August 31, which is the 2000 BiOp rule
Downsteam passage conditions at dams can result in high mortalities	Increased spill diverts fish from turbines and increases survival	High	High	High	Improve juvenile passage conditions in the subbain's mainstem	Provide appropriately timed and sufficient spill at The Dalles, John Day, and McNary Dams
Peak flows and frequent water fluctations have a deleterious and sometimes fatal effect on juvenile salmon	More uniform flow will keep more juveniles away from turbines and improve travel time.	High	Medium	Medium	Improve juvenile passage conditions in the subbain's mainstem	Operate hydrosystem to minimize peak demand flows and develop new appropriate energy sources to minimize peak flows to meet peak demand

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Confidence Level in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Weir technology is new and has been installed only at Lower Granite Dam. Not all dams and reservoirs have the same passage conditions.	New weir technology directs fish to safer passage routes; hower, technology must be tested before it is presumed to be effective for juvenile salmon survival.	Medium	Medium	Unknown	Improve juvenile passage conditions at The Dalles, John Day, and McNary Dams.	Investigate the efficacy of the planned installation of removable spillway weirs to aid in directing migrants to safer passage routes
Fluctuations in flow can delay adult salmon migration	Adult salmon migration is imperiled by alterated hydrology.	High	High	Medium	Restore features of the normative hydrograph to improve migration conditions.	Minimize flow fluctuations and continue investigation of adult migration patterns.
Prolonged exposure to elevated water temperatures is stressful for upstream migrants and can delay migration. Steelhead seek cold water refuges, including tributary mouths.	Adult salmon migration is imperiled by alterated hydrology and subsequent high water temperatures can be lethal.	High	High	Medium	Reduce exposure to elevated water temperatures.	Develop a temperature TMDL for the subbasin and implement specific actions (to reduce exposure to elevated water temperatures).
When monitored, adult fish passage perfomance criteria are not often in compliance.	Compliance with fish passage criteria will improve upstream adult returns.	Medium	Medium	Low	Improve adult migration conditions	Monitor fishways regularly at the dams for compliance with adult fish passage criteria.
Adult steelhead fallback is occurring at the dams.	Hydro operations alter flow patterns, creating various conditions conducive to fall back.	Medium	High	Medium	Improve adult migration	Identify and correct adult steelhead fallback conditions at eacn dams.

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Confidence Level in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Construction of the hydrosystem reduced the survival of steelhead kelts. (BPA, CRITFC)	Collecting and reconditioning the kelts improves the chances of repeat spawning.	High	High	High	Improve chances of return migration to the ocean and to spawning areas.	Continue research on kelt reconditioning to identify conditions that improve survival.
Contaminants input from upstream land-use activities are often trapped in the reservoirs behind dams. Dredging suspends contaminants accumulated in sediments.	Dredging can lead to direct mortalities of juveniles (and adults).	Medium	Medium	Medium	Improve water quality	Reduce exposure to contaminants.
Same as above	Same as above		Medium	Medium	Improve water quality	Eliminate dredging.
Same as above	Same as above		Medium	Unknown	Improve water quality	Identify contaminants in the sediment and water and the effects of the contaminants on salmon migrants.
Same as above	Same as above		Medium	Unknonw	Improve water quality	Develop TMDLs for contaminants, including identifying remedial actions.
Rapid changes in reservoir levels occur frequently, e.g., levels in The Dalles Pool can change several feet in one day.	Rapid changes in reservoir levels can isolate or dewater rearing areas and lead to juvenile mortalities.	Medium	Low	Unknonw	Minimize juvenile stranding	Identify flow conditions creating areas vulnerable to stranding.

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Confidence Level in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Juveniles can be entrained into irrigation pumps.	Screening irrigation pumps will prevent entrainment.	High	Medium	Medium	Protect rearing habitat	Screen all irrigation pumps.
Irrigation withdrawals contribute to stranding of rearing juveniles.	Irrigation withdrawals can affect water quantity and create conditions that can result in stranded juveniles.	Medium	Medium	Unknown	Protect rearing habitat	Enact a moratorium on additional mainstem water withdrawals and quantify the effects of irrigation withdrawals.
Commercial and recreational fisheries occur in the subbasin. Commercial gillnets used in The Dalles and John Day pools may break free and get lost.	Under certain conditions the lost fishing gear will continue to trap fish.	High	Medium	Low	Protect migrating adult salmon.	Identify locations of lost gear and remove. Quantify the impact of lost fishing gear on salmon.
Juvenile salmon are being harvested by bird and fish predators at higher rates than prior to hydro operations.	Controlling avian and piscivorous predators will increase juvenile salmon survival.	HIgh	High	High	Protect juvenile salmon migrants.	Remove exotic species and control native predators.

5.7.2 Mainstem: Sturgeon

Table 32 Mainstem key findings and working hypotheses: white sturgeon

Key Finding	Cause/Working Hypothesis	Confidence Effect Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain
Spawning occurs in the mainstem but can be limited by hydrograph and water temperatures	Modification of the historic hydrograph due to dam operation can result in peak flows that do not coincide with optimal spawning temperatures and can result in year class failure	High	High	High	Increase spawning success of white sturgeon in the LMM Columbia River	Operate hydrosystem so that peak flows occur when water temperature is suitable for white sturgeon spawning
Impounded WS populations incur periodic year-class failures	Inadequate spawning ground water velocities, lack of multi-day uniformity in flow, turbulence, and turbidity produce year class failures	High	High	High	Increase first-year survival of naturally spawned WS in the LMM Columbia River	Operate hydrosystem for multi-day uniform peak flow (no excessive hourly or daily variation) when water temperature is suitable for white sturgeon spawning
Egg, larval stage, and YOY WS are susceptible to predation	Indigenous and introduced predators cause mortality in pre-juvenile white sturgeon	High	High	High	Reduce predation in LMM Columbia River, especially on egg and larval stage WS, but also sub-yearling WS	Develop predator control studies for the LMM Columbia River. Identify predator population densities and dynamics. Develop experimental predator removal programs. Establish predator removal M&E including predator population exploitation, WS egg, larvae, and YOY consumption rates, and pre-yearling WS survival rates.

Key Finding	Cause/Working Hypothesis	Confidence Effect Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain
Impounded WS populations are less productive than the unimpounded lower Columbia River population	Construction and operation of Mainstem hydroelectric dams has reduced WS population productivity especially in The Dalles and John Day pools	High	High	High	Restore LMM Columbia River population abundance and productivity	Supplement less productive impounded WS populations through capture of juvenile WS from below Bonneville Dam and transporting them into The Dalles and John Day reservoirs to compensate for year class failures.
The health of WS populations show up in density, condition factor, reproductive potential, age structure, and fish growth rates	Construction and operation of Mainstem hydroelectric dams has reduced or eliminated WS population productivity resulting in reduced or negated sustainable WS harvest	High	High	High	Restore LMM Columbia River population abundance and productivity to levels that can sustain reasonable harvest	Identify the need for and evaluate the success of LMM WS population recovery activities. Sustainable tribal and sport harvest is dependent upon periodic population status updates. Expand the periodic stock assessment program into McNary pool, the Hanford Reach, and into Priest Rapids Pool.

Key Finding	Cause/Working Hypothesis	Confidence Effect Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain
Reservoir specific intensive harvest management can influence WS abundance levels	Population over harvest has been mitigated by WDFW, ODFW, and CRITFC through many years of adapted reservoir specific harvest management involving in-season harvest monitoring linked to periodic population assessment and harvest regulation modeling	Medium	Medium	Medium	Increase LMM Columbia River WS populations to levels supporting reasonable harvest opportunities	Continue to monitor harvest levels and adjust fishing regulations as necessary between Bonneville and McNary Dams. Expand annual angler survey program to McNary pool, the Hanford Reach, and eventually to Priest Rapids Pool.

5.7.3 Mainstem: Pacific Lamprey

Table 33 Mainstem key findings and working hypotheses: Pacific lamprey

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate Improve/Maintain or Mitigate
Recent counts of Pacific lamprey at The Dalles, John Day and McNary dams indicate a serious decline in abundance. Pacific lamprey serve an important role in the ecological function of the area by contributing to nutrient budgets and transporting marine nutrients to freshwater systems. Pacific lamprey are important part of the natural food web. Pacific lamprey are an important tribal cultural food source. Low abundances preclude fishing opportunities in upstream tributaries.	Populations are below historical levels because of anthropogenic activities, including hydropower operations.	High	High	HIgh	Restore Pacific lamprey populations. Attain self-sustaining natural production of Pacific lamprey that provides for fishing opportunities at traditional locations.	

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate Improve/Maintain or Mitigate
Adult fishways are difficult for lamprey to negotiate. Research indicates that rounding corners and alternative substrates improve passage efficiency.	Changes in fishways will improve passage.	HIgh	High	High		Improve adult passage at dams.
Same as above and, in addition, alternative passage routes may be more effective.	Auxiliary passage systems will increase survival.	HIgh	Medium	Medium	Investigate auxiliary passage systems, similar to those being researched at Bonneville Dam.	
Juvenile lamprey suffer from high impingement rates on bypass screens because they are relatively poor swimmers. John Day Dam, in particular, impinges large numbers of lamprey.	Modifications to and avoidance of screens will increase survival.	HIgh	HIgh	Medium	Identify areas for passage improvements.	Make improvements in juvenile passage that do not conflict with salmonid passage needs.

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate Improve/Maintain or Mitigate
Contaminants input from upstream land-use activities are often trapped in the reservoirs behind dams. Dredging suspends contaminants accumulated in sediments. Dredging can also lead to direct mortalities. Dredging should be minimized and limited to periods outside of the active migration period.	Eliminating dredging will reduce exposure to contaminants and reduce mortalities.	Medium	Low	Low		Identify contaminants and the effects on lamprey
Same as above	Same as above	Medium	Medium	Low	Reduce exposure to contaminants.	
Rapid changes in reservoir levels can isolate or dewater rearing areas and lead to mortalities of juveniles. Reservoir levels in The Dalles Pool can change several feet in one day.	Change in flow fluctuations minimizes stranding	Medium	Medium	Low	Minimize stranding.	
Data gap. To remediate it is important to know where stranding occurs.	Identifying habitat usage will indicate where actions need to take place.	Low	Unknown	Unknown		Identify areas vulnerable to stranding.

Key Findings	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate Improve/Maintain or Mitigate
Data gap. Essential for efforts to restore Pacific lamprey.	Acquiring basic information about species will increase likelihood of developing successful restoration strategies.	High	Unknown	Unknown		Determine abundance, distribution, and habitat use of rearing juveniles

5.7.4 Rock Creek

Table 34 Rock Creek key findings and working hypotheses

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Altered thermal regimes have affected fish life histories (such as natural spawn timing, incubation, rearing etc), decreased quantity of suitable habitat	Management activities affecting riparian areas and channel morphology have produced greater summer maxima, and lower winter minima	High	High	High	Increase winter minima temperature and decrease summer maxima temperatures	Restore riparian conditions and channel morphology.	

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Juveniles redistribute themselves downstream in the summer and fall after emergence, with highest densities in fall being found well below the major spawning areas	Natural expression of some life histories	High	High	High			
	Decreased areas of perennial flow in tributaries	Medium	Medium	Medium	Increase extent and distribution of perennial habitat	Restore riparian conditions and channel morphology. Increase floodplain connectivity. Improve upland management practices to mimic natural runoff and sediment production.	
Steelhead populations have been dramatically reduced from pre-settlement abundance levels	Habitat loss and alteration and changes in the biotic community have reduced habitat suitability, which in turn has reduced productivity, abundance, and spatial distribution of the species.	High	High	High	Restore steelhead population abundance, productivity and spatial distribution to viable, harvestable and sustainable levels over the next 30 years.	Coordinated management of populations and habitat improvements including: Ongoing research, Habitat restoration, Population management activities such as harvest management and hatchery supplementation	

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Population levels of Lamprey have been dramatically reduced from pre-settlement levels.	Poor passage for anadromous forms through the mainstem Columbia River (and possibly in the Subbasin) have severed life history pathways and reduced population abundance, productivity and spatial diversity.	High	High	Medium			
	Changes in habitat conditions and reduction in salmon populations within the subbasin have reduced habitat suitability and reduced abundance, productivity and life history diversity. Improvement in habitat conditions for salmonids will improve lamprey populations as well.	Medium	Medium	Medium	Study specific habitat relationships for lamprey. Implement habitat restoration actions under Subbasin Plan.		

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Tributary Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment	Temperatures near and above lethal limits for salmonids for much longer duration than during pre-settlement times due to reduction in summer low flow.	High	High	High	Reduce Temp to near pre-settlement conditions	Increase flows to satisfy depth thresholds, Reconnect Side Channels; improve Riparian Zone; investigate areas of groundwater connection; improve floodplain connectivity	
Loss of Habitat Diversity/ thermal refugia by loss of off-channel habitat	Numerous examples of confinement by roads, bridges, dikes.	Med	High	High	Reconnect 100% of floodplain side channels in this Assessment Unit	Relocate infrastructure where possible to allow natural processes to operate. Re-establish native vegetation on floodplain.	Reconnect side channels. Artificially confined reaches limit side channel habitat, more importantly though, removal of rd and rip rap may reduce bed shear and increase margin habitat complexity

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Hydrology has been altered to increase peak flows; loss of storage	Groundwater withdrawals may lower base flows decreasing perennial flow area	Medium	Medium	Medium		Study and monitor groundwater withdrawals in area	
	Increased peak runoff	High	Medium	Medium	Restore historical hydrologic regime	Compare to 1860s GLO maps, restore physical and riparian characteristics	
Tributary Lack of Habitat diversity (pools with cover)/Lack of Large Woody Debris(Decreased Abundance of LWD)	Logging practices, general agricultural/forest and floodplain developments increased peak flows	Medium	Low to Medium	High	Implement sustainable agricultural and forest practices, improve road management. Improve watershed management	Implement practices which leave sources of LWD to naturally enter system	
	Lack of LWD Recruitment Due to riparian harvest, stream cleaning, and Change in upstream Riparian Zone	High	High	Medium	Restore viable P. Pine populations to upstream Riparian Zones over the next 20 years (upper forest)	Implement practices to naturally supply sources of LWD	Artificially introduce LWD

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Food web in lower river has been altered/reduced.	Fluctuations in water quality parameters (Temp, DO, Nutrients) and toxics have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity	Low	High	High		Study/Characterize productivity. Characterize within framework of Sediment load. Restore riparian conditions and channel morphology. Increase floodplain connectivity. Improve upland management practices to mimic natural runoff and sediment production.	
Predation Risk to salmonids from native fish (northern pike minnow) is high in vicinity of Rock Creek Mouth-	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation.	High	High	Medium	Increase abundance of salmonid populations to reduce proportion of predation due to native sp	1) Implement Subbasin planning and other habitat and population restoration programs	Bounty Programs, creation of artificial off-channel habitats.
	Increased habitat for native predators in Col. Mainstem leads to increased pops in lower tribs.	High	High	Medium	Reduce population levels in Mainstem Col	Further control and actions on predator populations in mainstem reservoirs	
Predation risk to salmonids from non- native fish (walleye, Smallmouth bass etc) is high	Increased Temps in lower river increase habitat for non-native predators, temps also trigger increase in feeding levels	High	High	Medium	Reduced non-native predators	Reduce Habitat suitability	Bounty and increased harvest measures on non-native predators

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Predation risk to salmonids from bird populations is elevated	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation	Med	Low	High	Increase abundance of salmonid populations to reduce proportion of predation due to native sp.	Improve flow, cover, available habitat, and habitat diversity to reduce potential for predation by native birds.	
Survival of steelhead kelts (mature spawned out fish with the potential to spawn again) migrating out of the Rock Creek Subbasin and through the mainstem Columbia to the ocean is believed to be at or near zero.	Lack of facilities for downstream passage through the dams for large bodied adults, habitat conditions in the mainstem Columbia.	Med	High	High	Increased adult survival at mainstem Columbia dams for repeat spawners.	Support Corps studies of fish passage at mainstem Columbia dams. Evaluate habitat conditions for survival in the mainstem Columbia habitat.	Implement Kelt Reconditioning. Implement improved passage at Mainstem Columbia dams.
Hatchery Fish compete with Natural Origin fish for space and food resources	Clipped fish morts have been observed in lower river; competition with natural origin fish,	Low	Low	High	Evaluate genetics of Rock Creek steelhead		

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Tributary High Temperatures have resulted in increased susceptibility of native salmonids to pathogens.	Increased temperature stresses the fish and increases chances of initial infection Where current or Historic fish stocking exists	Low	High	Medium	Reduce Summer High Temperatures	Study presence of pathogens in juveniles and adults during high temperatures. Restore riparian conditions and channel morphology.	
Loss of Habitat Diversity/ thermal refugia by loss of off-channel habitat	Rock Creek Road and other infrastructure in watershed have altered floodplain negatively, confined river and tributaries	Med	High	High	Reconnect 100% of floodplain side channels in this Assessment Unit	Relocate infrastructure where possible to allow natural processes to operate. Re-establish native vegetation on floodplain.	Reconnect side channels. Artificially confined reaches limit side channel habitat, more importantly though, removal of rd and rip rap may reduce bed shear and increase margin habitat complexity

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Population and ecological effect of Beavers have been significantly reduced and altered	Reduction of habitat, conflict with water infrastructure results in removal of dams and beavers, current trapping and historic population reduction and fragmentation. Other effects: Loss of fine sediment storage capacity, beaver dams also created grade control structures which resulted in off channel habitat and increased channel stability and maintained channel planform	High	High	High	Increase available habitat in mainstem floodplains, especially urbanized floodplains. Reduce conflicts with infrastructure, set population targets based on desired functions and population connectivity.	Restore “unmanaged” or natural floodplain habitats. Encourage beaver colonization of these areas. Inventory existing and potential habitat, include reintroduction of beaver into restoration actions.	

Key Findings	Cause/Working Hypothesis	Confidence that Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain	Strategy to Mitigate Effect
Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces	Can severely decrease egg incubation survival, decrease interstitial space affecting inactive rearing stages of Juveniles and or entomb juveniles				Decrease sources of fine sediment	Employ road management actions that reduce fine sediment inputs. Study fine sediment inputs. Characterize. Restore riparian conditions and channel morphology. Increase floodplain connectivity. Improve upland management practices to mimic natural runoff and sediment production.	

5.7.5 Fulton Canyon and Spanish Hollow

Table 35 Fulton Canyon and Spanish Hollow key findings and working hypotheses

Key Finding – Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Altered hydrology	Removal of vegetation from landscape and riparian areas, uncontrolled grazing, and mechanized agriculture resulted in soil erosion and reduced infiltration capacity of the soils	High	Undetermined	Unknown		Implement Dry Cropland or Range and Pastureland Resource Management Systems (RMS) in Gilliam and Sherman counties in conjunction with the Natural Resources Conservation Service (NRCS) as per the April 2004 Biological Opinion
	Increased peak or flashier runoff is occurring	High	Undetermined	Unknown	Restore historical hydrologic regime	Same as above Restore physical and riparian characteristics
	Groundwater withdrawals lower base flows decreasing perennial flow area	High	Undetermined	Unknown	Restore historical hydrologic regime and Increase extent and distribution of perennial habitat	Implement dry cropland or range and pastureland RMS plans in conjunction with NRCS, specifically, study and monitor groundwater withdrawals in area

Key Finding – Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Columbia River dams have reduced anadromous fish numbers, including potential spawners in Fulton Canyon and Spanish Hollow	Poor passage and migratory conditions (including temperature) for anadromous fish have reduced abundance, productivity, and spatial diversity.	High	Undetermined	Unknown	Improve passage rates	Support efforts to improve passage survival rates
Summer/early fall habitat availability diminished in comparison with pre-settlement environment	Temperatures near and above lethal limits for salmonids for much longer duration than during pre-settlement times due to reduction in summer low flow	High	Undetermined	Unknown	Reduce temperatures to near pre-settlement conditions	Implement dry cropland or range and pastureland RMS plans in conjunction with NRCS, specifically: Increase flows to satisfy depth thresholds Reconnect side channels Improve riparian zone Investigate areas of groundwater connection Improve floodplain connectivity

Key Finding – Observed Effect or Phenomenon	Cause/Working Hypothesis	Confidence Effect Is Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate, Improve/Maintain or Mitigate
Increased percentages of fine sediment from background levels in spawning gravels and interstitial spaces	Can severely decrease egg incubation survival, decrease interstitial space affecting inactive rearing stages of juveniles and or entomb juveniles	High	HIgh	Unknown	Decrease sources of fine sediment from erosion, especially on sloping soils, where cover crops and residue are lacking	Implement dry cropland or range and pastureland RMS plans in conjunction with NRCS, specifically: Study and characterize fine sediment inputs. Improve agricultural management practices to mimic natural runoff and sediment production Restore riparian conditions and channel morphology. Increase floodplain connectivity. Employ road management actions that reduce fine sediment inputs.
Basic hydrological, habitat, and population information is lacking	Scientific information and analysis is the foundation of natural system and species conservation and restoration	—	High	—	Restore ecological functioning and biological integrity to these two watersheds	Use funds available from a variety of sources, including federal and ratepayer sources

6 Inventory

6.1 Introduction, Purpose, and Scope

The inventory attempts to summarize the fish and wildlife protection, restoration, and artificial production projects and programs that have occurred over the past five years or are about to be implemented. The inventory identifies existing legal protections, management plans, management programs, and projects that target fish and wildlife or otherwise provide substantial benefit to fish and wildlife. The timeframe of this inventory is the last five years and where possible, such activities that are about to be implemented.

Compilation of this information helps demonstrate the current management directions, existing and imminent protections, and current strategies implemented through specific projects. The inventory information illustrates current effort. This alone is not the purpose of an inventory of fish and wildlife programs and projects in the Lower Mid-Columbia Mainstem Subbasin. The Council's "Technical Guide for Subbasin Planners" (Council Document 2001-02), states that the inventory will have its greatest value when it is reviewed in conjunction with the limiting factors resulting from the assessment. Such a project review helps to identify gaps between: 1) what is actually happening and 2) what needs to happen to achieve the Council's vision and the subbasin's vision. However, such a gap analysis for the Lower Mid-Columbia Mainstem Subbasin is only partially constructed in this 2004 draft. Elements of a gap analysis are in:

- 4. Wildlife Assessment/4.3.4 - 4.5.3 Key Findings
- 5. Fish Assessment/5.8 Key Fish Findings
- 7. Synthesis and Interpretation
- 8. Management Plan/Wildlife 8.2.1 - 8.2.6 and Fish 8.3.1 - 8.3.5

The inventory information gathered for this subbasin was derived from interviews, fish and wildlife project managers, Internet websites, and databases. The Yakama Indian Nation, WDFW, ODFW, the Department of Ecology, and Klickitat, Sherman, and Gilliam counties provided information used in this plan. Also, the Eastern Klickitat Conservation District is actively pursuing bridge replacement, riparian restoration and channel stabilization projects, which have been identified, but not yet funded. Yet it is still incomplete. Summaries of existing legal protections, management plans, management programs, and conservation and restoration projects are compiled in the following tables: **Table 36**, **Table 37**, **Table 38**, **Table 39**.

6.1.1 Existing Legal Protection

Table 36 Summary of existing legal protections

Federal	Endangered Species Act
	Clean Water Act
	Fish and Wildlife Coordination Act
	Magnuson-Stevens Fishery Conservation and Management Act
	Migratory Bird Treaty Act
	Columbia River Gorge National Scenic Area Act
	Rivers and Harbors Act
	Bald Eagle Protection Act
	Federal Non-indigenous Aquatic Nuisance Prevention and Control Act
	National Invasive Species Act
State (Oregon/Washington)	Oregon Forest Practices Act
	Washington Forest Practices Act
	Oregon Removal-Fill Law
	Fishing and Harvest Regulations
	Washington Growth Management Act
	Washington Shoreline Management Act
	Washington Bald Eagle Habitat Buffer Rule
	Washington Fish and Wildlife Commission 1986 Bald Eagle Habitat Protection Rule
	Oregon Water Resource Protections
	Oregon Department of Fish and Wildlife Integrity Rules
	Washington Salmon Recovery Planning Act
	Washington Wild Stock Restoration Initiative
	Washington Watershed Management Act
Local	Klickitat County Zoning Ordinances
	Washington Critical Area Ordinances

Federal

Endangered Species Act – The 1973 Endangered Species Act provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered in the U.S. or elsewhere. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The Act outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species, and contains exceptions and exemptions. The Endangered Species Act also is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora, commonly known as CITES. Criminal and civil penalties are provided for violations of the Act and the Convention.

Clean Water Act - The Clean Water Act established the basic structure for regulating discharges of pollutants into the waters of the United States. It gave the Environmental Protection Agency the authority to implement pollution control programs such as setting wastewater standards for industry. The Clean Water Act also continued requirements to set water quality standards for all contaminants in surface waters. The Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. It also funded the construction of sewage treatment plants under the construction grants program and recognized the need for planning to address the critical problems posed by nonpoint source pollution.

Section 404 of the Act regulates the discharge of dredged or fill material into all waters of the United States, including wetlands, both adjacent and isolated. The USACE presides over permitting, mitigation, and enforcement of Section 404.

Fish and Wildlife Coordination Act - The Act provides that whenever the waters or channel of a body of water are modified by a department or agency of the U.S., the department or agency first shall consult with the U.S. Fish and Wildlife Service and with the head of the agency exercising administration over the wildlife resources of the state where construction will occur, with a view to the conservation of wildlife resources. The Act provides that land, water and interests may be acquired by federal construction agencies for wildlife conservation and development. In addition, real property under jurisdiction or control of a federal agency and no longer required by that agency can be utilized for wildlife conservation by the state agency exercising administration over wildlife resources upon that property.

Magnuson-Stevens Fishery Conservation and Management Act – The U.S. Congress passed the Magnuson-Stevens Fishery Conservation and Management Act in 1976. It created a 200-mile limit of U.S. control over waters once heavily fished by foreign fleets. It also set up a federal management system for fishing between three and 200 nautical miles. States continue to manage fishing out to three miles but now they must coordinate what they do with federal management. The Sustainable Fisheries Act amended the Magnuson-Stevens Act in 1996. The Sustainable Fisheries Act is a landmark piece of legislation containing strict new mandates to stop overfishing, rebuild all overfished stocks, minimize bycatch, and protect essential fish habitat.

The Magnuson Act involves power-sharing arrangements between regional management councils and the U.S. Department of Commerce. The councils write and revise fishery management plans (FMPs) and also make decisions as required by those FMPs. NOAA Fisheries provides scientific advice and reviews the plans to make sure that they meet the legal obligations of the Act. The Department of Commerce has the final say on plan approval. Approved plans are implemented by NOAA Fisheries and enforced by the U.S. Coast Guard. Congress oversees the process by regular reauthorization of the Magnuson Act and designating funding for the Councils, NOAA Fisheries, and the Coast Guard.

Migratory Bird Treaty Act - The Migratory Bird Treaty Act implements various treaties and conventions between the U.S. and Canada, Japan, Mexico and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing or possessing migratory birds is unlawful.

Columbia River Gorge National Scenic Area Act - The Columbia River Gorge National Scenic Area was created on November 17, 1986 when President Reagan signed into effect Public Law 99-663. One of the purposes of the Act is to protect and enhance natural resources including fish and wildlife. The entire Columbia Gorge Subbasin is within the Scenic Area and proposed land use is subject to review by the Forest Service to ensure consistency with the Scenic Area Management Plan.

Rivers and Harbors Act – Section 10 of the Rivers and Harbors Act requires authorization for the construction of any structure in or over any navigable water of the United States. This law applies to any dredging or disposal of dredged materials, excavation, filling, rechannelization, or any other modification of navigable water of the United States, and applies to all structures. The USACE presides over permitting, mitigation, and enforcement of Sections 10 and 13 of the Act.

Bald Eagle Protection Act - Prohibits the taking or possession of and commerce in bald and golden eagles, with limited exceptions.

Federal Non-indigenous Aquatic Nuisance Prevention and Control Act - The Non-indigenous Aquatic Nuisance Prevention and Control Act was passed on November 29, 1990, and subsequently amended by the National Invasive Species Act of 1996 (P.L. 101-646, 11/29/90, as amended through 10/26/96). It established a broad new Federal program to prevent introduction of, and to control the spread of, introduced aquatic nuisance species (Zebra mussels, mitten crab, brown mussel, ruffe, Eurasian watermilfoil, and hydrilla) and the brown tree snake. The purposes of the Nonindigenous Aquatic Nuisance Prevention and Control Act are to (ANS Task Force 1990, USFWS 1990):

- prevent unintentional introduction and dispersal of nonindigenous species into waters of the United States through ballast water management and other requirements;
- coordinate federally conducted, funded or authorized research, prevention control, information dissemination, and other activities regarding the zebra mussel and other aquatic nuisance species;
- develop and carry out environmentally sound control methods to prevent, monitor and control unintentional introductions of nonindigenous species from pathways other than ballast water exchange;
- understand and minimize economic and ecological impacts of nonindigenous aquatic nuisance species that become established, including the zebra mussel; and
- establish a program of research and technology development and assistance to States in the management and removal of zebra mussels.

The U.S. Fish and Wildlife Service, the U.S. Coast Guard, the Environmental Protection Agency, the Army Corps of Engineers, and the National Oceanic and Atmospheric Administration all were assigned major, new responsibilities, including membership on an Aquatic Nuisance Species Task Force established to develop and implement a program of prevention, monitoring, control, and study to prevent the introduction and dispersal of nonindigenous species in waters of the U.S.

National Invasive Species Act (P.L. 104-332) - This 1996 Act reauthorizes and amends the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (P.L. 101-646) (NMI 2001). The purposes of the Act are to:

- reauthorize the Great Lakes ballast management program and expands applicability to vessels with ballast tanks (as opposed to vessels which carry ballast water);
- direct vessels that enter U.S. waters after operating beyond the exclusive economic zone to undertake ballast exchange in the high seas;
- conduct ecological and ballast discharge surveys in waters highly susceptible to invasion or requiring further study and determine effectiveness of ballast management;
- consult and negotiate with foreign governments, examine ballast discharge and types of ballast practices, develop guidelines in abating invasions, and test compliance with and effectiveness of the guidelines;
- develop and maintain a clearinghouse of national data on ballasting practices, compliance with the national ballast management guidelines, and other information and to report data collected to the Task Force and Congress on a biannual basis;
- issue guidelines developed by the Task Force to control the spread of zebra mussels and other aquatic nuisance species via recreational activities, such as boating and fishing;
- implement a ballast water management program for seagoing vessels of the Department of Defense and Coast Guard;
- undertake a demonstration of technologies and practices which may prevent introduction and spread of nonindigenous species through ballast discharge;
- provide research grants to fund research on aquatic nuisance species prevention and control; and
- encourage the formation of regional panels to participate in activities to control introduction of aquatic nuisance species and to encourage and fund the development and implementation of state, interstate, or tribal invasive species management plans.

State

Oregon Forest Practices Act - The Oregon Department of Forestry enforces the Oregon Forest Practices Act (OAR 629-Division 600 to 680 and ORS 527) regulating commercial timber production and harvest on state and private lands. The Act contains guidelines to protect forests and streams in forest management activities including road maintenance, road construction, chemical application, slash burning, timber harvest, and reforestation.

Washington Forest Practices Act – The Forest Practices Act defines a plan to protect public resources while assuring that Washington continues to be a productive timber growing area. The Act regulates activities related to growing, harvesting, or processing timber on all local government, state, and private forestlands. The Act provides for a riparian space program that includes acquisition and conservation easement on lands within unconfined avulsing channel migration zones.

Oregon Removal-Fill Law - Oregon Division of State Lands, under Removal-Fill Law (ORS 196.795-990) and the U.S. Army Corps of Engineers, under Section 404 of the Clean Water Act, regulate the removal and filling of materials in wetlands and waterways. Under state law, permits are required for projects involving 50 or more cubic yards of material in wetlands and streams. Permit applications are reviewed by ODFW and may be modified or denied based on project impacts to fish. Projects that may affect ESA-listed species require consultation with NOAA Fisheries or the U.S. Fish and Wildlife Service to insure compliance with the Endangered Species Act. The Oregon Removal-Fill Law requires a permit for most removal and fill activities in areas designated by the state as essential indigenous salmonid habitat. Essential salmonid habitat is defined as the habitat necessary to prevent the depletion of native salmon and trout species during their life history stages of spawning and rearing. The designation applies to species listed as Sensitive, Threatened or Endangered by a state or federal authority.

Fishing and Harvest Regulations – Commercial fishing seasons in the mainstem Columbia River (concurrent jurisdictional waters) are established by the Columbia River Compact while Select Area commercial fishing seasons occurring in state waters are established by the regulating state. The Columbia treaty tribes regulate treaty Indian Ceremonial and Subsistence fisheries in the mainstem Columbia and tributaries. Recreational fishing regulations for the Columbia River are established separately by the management agencies of Washington and Oregon. Recreational regulations set by each state in the concurrent Columbia River waters are usually identical. All fisheries of the Columbia River are established within the guidelines and constraints of the Columbia River Fish Management Plan (CRFMP), the Endangered Species Act (ESA), and management agreements negotiated between the Parties to U.S. v. Oregon. The Columbia River Inter-Tribal Fisheries Enforcement (CRITFE) monitors tribal fisheries and enforces fishing regulations in the Columbia River between Bonneville and McNary Dams, including closures around the mouth of the Hood River.

Washington Growth Management Act – The Growth Management Act requires cities and counties to plan for growth and development through a comprehensive, coordinated, and proactive land use planning approach. The Act is adopted and implemented at the local government level.

Washington Shoreline Management Act - Provides for some tree retention within 61 m (200 ft) of the shorelines of rivers and marine waters.

Washington Bald Eagle Habitat Buffer Rule - State Legislature's 1984 RCW 77.12.655: Habitat buffer zones for bald eagles.

Washington Fish and Wildlife Commission 1986 Bald Eagle Habitat Protection Rule - (WAC 232-12-292) provides for development of a Site Management Plan whenever activities that alter habitat are proposed near a verified nest territory or communal roost.

Oregon Water Resource Protections

- allocation of conserved water program ORS 537.470
- delivery and use of water under water exchange ORS 540.541-543

- delivery of stored water ORS 540.410
- regulation of water by watermaster ORS 540.045 to protect existing rights including instream water rights
- lease of water rights instream ORS 537.348
- transfer of water rights instream ORS 540.510;
- transfer of a surface water point of diversion to a ground water well ORS 540.53.
- public interest standards for new water withdrawals from the Columbia River under OAR Chapter 690, Division 33

Oregon Department of Fish and Wildlife Integrity Rules - Nonnative, introduced species (sometimes called "exotics"), which are brought into Oregon for a variety of reasons (e.g. commercial, recreational, domestication), are a major concern of the ODFW because of negative impacts to native fish and wildlife: competition, diseases, destruction of habitat, interbreeding, and mortality. Under state law #ORS 496.012, which prevents the serious depletion of any indigenous species, ODFW drafted rules (Oregon Administrative Rules, Division 056) to protect the integrity of Oregon's native wildlife. These rules regulate the importation, purchase, sale, exchange, transportation, holding, and confinement of prohibited and controlled nonnative wildlife (ODFW 2004f).

Washington Salmon Recovery Planning Act (SRPA, ESHB 2496) -The SRPA provides the framework for developing restoration projects. It requires a limiting factors analysis and establishes a funding program for local habitat restoration projects. It also creates the Governor's Salmon Recovery Office. As a result of this bill, an Independent Scientific Panel was created to provide scientific review for salmon recovery projects.

Washington Wild Stock Restoration Initiative (WSRI), ESHB 1309 - In 1993, Washington State adopted the WSRI and initiated a commitment to salmonid protection and recovery that has led to more recent salmon recovery legislation. Recently enacted state legislation (1998-1999) designed to guide salmon recovery in the state of Washington includes the SRPA (ESHB 2496), Watershed Planning Act (ESHB 2514), and Salmon Recovery Funding Act (2E2SSB 5595). Stock inventories were the initial commitment of state and tribal fishery managers to the WSRI that complemented and strengthened ongoing programs to protect salmonid stocks and habitats. The Salmon and Steelhead Inventory and Assessment Program (SSHIAP), an integral part of WSRI, is a partnership-based information system that characterizes freshwater and estuary habitat conditions and distribution of salmonid stocks in Washington. SSHIAP is designed to support regulatory, conservation, and analysis efforts such as Washington State Watershed Analysis, State Salmon Recovery, Habitat Conservation Planning, and EDT.

Watershed Management Act (WMA, ESHB 2514) - The 1998 Washington State Legislature passed the WMA (Chapter 90.82 RCW) to provide a framework for local citizens, interest groups, and government organizations to collaboratively identify and solve water-related issues in each of the 62 Water Resource Inventory Areas (WRIAs) in the state. The WMA enables local groups called "Planning Units" to form for the purpose of conducting watershed planning. Under the law, citizens, local governments, tribes, and other members of the Planning Unit must assess water resources and needs and recommend management strategies for the watershed. The

Planning Unit may also assess habitat, water quality and instream flow requirements. Ecology oversees the WMA (Kaputa and Woodward 2002).

Local

Klickitat County Zoning- Klickitat County zoning is guided by Ordinance No. 62678, which includes the Klickitat County Shoreline Master Plan and the Flood Plain Management Ordinance. http://www.klickitatcounty.org/Planning

Washington Critical Area Ordinances – As part of the Growth Management Act, cities and counties are required to adopt policies and regulations that protect critical areas, such as fish and wildlife habitat conservation areas, wetlands, frequently flooded areas, aquifer recharge areas, and geologically hazardous areas.

6.1.2 Existing Management Plans

Table 37 Summary of existing managment plans

Tribal	Wy-Kan-Ush-Mi Wa-Kish-Wit
Tribal/Federal/State	*U.S. v. Oregon* Columbia River Fish Management Plan
Federal	Columbia Gorge Scenic Area Management Plan
	Columbia River Basin Fish and Wildlife Plan (NPPC) (See NPCC below)
	Endangered Species Act Implementation Plan for the FCRPS
	FCRPS Biological Opinion and the Basinwide Salmon Recovery Strategy
	ESA Resource Management Systems for Dry Cropland and Range and Pastureland in Gilliam, Sherman and Wasco Counties, Oregon
	U.S. Fish and Wildlife Service 1986 Pacific States Bald Eagle Recovery Plan
State (Oregon/Washington)	Oregon Plan for Salmon and Watersheds
	Washington Statewide Strategy to Recover Salmon
	Washington Department of Fish & Wildlife's Priority Habitat and Species Management Recommendations, Volume IV: Birds
	Oregon Wildlife Diversity Plan
	Western Pond Turtle Recovery Plan
	Washington Aquatic Nuisance Species Management Plan
	Oregon Aquatic Nuisance Species Management Plan
	Oregon Invasive Species Action Plan
	Oregon Noxious Weed Strategic Plan
	Middle Columbia River Dalles Pool Area Geographic Response Plan (GRP)
	Middle Columbia River John Day Pool Area Geographic Response Plan (GRP)
	Middle Columbia River McNary Pool Area Geographic Response Plan (GRP)

Local	Gilliam County Comprehensive Plans
	Sherman County Comprehensive Plans
	Lower Deschutes Agricultural Water Quality Management Area Plan
	Klickitat County Shoreline Master Plan (see Klickitat County Zoning above)

Tribal Plans

This is the Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes (CRITFC 1996). This plan includes adult return targets for each subbasin in the Columbia Basin. Wy-Kan-Ush-Mi Wa-Kish-Wit recommends habitat restoration actions that focus on limiting, restricting, or eliminating land uses and enhancing populations with implementation of new broodstock, release and production programs. The plan was published in 1996, and habitat restoration projects emphasizing implementation of forest, range, and agricultural best management practices have been initiated in priority watersheds since 1997 through the Council's program.

Tribal/Federal/State Plans

Columbia River Fish Management Plan - The Columbia River Fish Management Plan (CRFMP) is an agreement resulting from the U.S. District Court case of U.S. V. Oregon (Case No. 68-513). This agreement between federal agencies, Indian tribes and state agencies (except Idaho) set guidelines for the management, harvest, hatchery production, and rebuilding of Columbia River Basin salmonid stocks. Appropriate harvest levels and methods were established for various levels of attainment of interim population goals for spring chinook, summer chinook, sockeye, fall chinook, summer steelhead, and coho salmon. The plan guaranteed the treaty Indian fisheries a minimum of 10,000 spring and summer chinook annually, not dependent on run size.

Federal Plans

Columbia Gorge Scenic Area Management Plan – The western portion of the Lower Mid-Columbia Mainstem subbasin is within the Scenic Area boundary. Say where boundaries are in LMM. The Federal Act establishing the Columbia River Gorge National Scenic Area mandated that each county within the Scenic Area either adopt regulations to implement the Management Plan for their portions of the Scenic Area or relinquish control of land development within the Scenic Area to the Columbia River Gorge Commission. The Columbia River Gorge National Scenic Area Management Plan (Columbia River Gorge Commission and USDA Forest Service, 1992) is implemented by the USFS and the Columbia Gorge Commission to insure that land use is consistent with the Scenic Area Act. In the Columbia Gorge Subbasin, the Scenic Area Management Plan is implemented primarily by Hood River, Wasco, Skamania, and Klickitat counties, with oversight by the Columbia Gorge Commission.

Endangered Species Act Implementation Plan for the FCRPS - The three action agencies have prepared the implementation plan in acknowledgement of responsibilities for fish protection under the Northwest Power Act and water quality protection under the Clean Water Act, and their obligations to Indian tribes under law, treaty, and Executive Order. The plan responds to the December 2000 Biological Opinions issued by the U.S. Fish and Wildlife Service and the NOAA Fisheries on the effects to listed species from operations of the Columbia River hydropower system. The plan is a five-year blueprint that organizes collective fish recovery actions by the three agencies. The plan looks at the full cycle of the fish, also known as "gravel to gravel" management or an "All-H" approach (hydro, habitat, hatcheries, and harvest). However, it describes only commitments connected to the FCRPS, not the obligations of other federal agencies, states, or private parties. The plan describes the three agencies' goals; the performance standards to gauge results over time; strategies and priorities for each H; detailed five-year action tables for each H; research, monitoring, and evaluation plan (RM&E); and expectations for regional coordination.

Biological Opinion and the Basinwide Salmon Recovery Strategy - NOAA Fisheries has recently developed several documents and initiatives for the recovery of Endangered Species Act listed Snake River steelhead, chinook and sockeye. The Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp) and the Basinwide Salmon Recovery Strategy issued at the end of 2000 contain actions and strategies for habitat restoration and protection for the Columbia River Basin. Action agencies are identified that will lead fast-start efforts in specific aspects of restoration on nonfederal lands. Federal land management will be implemented by current programs that protect important aquatic habitats (PACFISH, ICBEMP). Actions within the FCRPS BiOp are intended to be consistent with or complement the Council's amended Fish and Wildlife Program and state and local watershed planning efforts.

NOAA Fisheries has also initiated recovery planning with the establishment of a Technical Recovery Team for the Interior Columbia, which includes Snake River stocks. The Technical Recovery Team will identify delisting criteria and viability criteria for populations within ESUs, identify factors that limit recovery, and identify early actions for recovery among other things. A stakeholder-based forum will develop a formal recovery plan from these products.

For federally listed resident species (bull trout in the Columbia Gorge mainstem subbasin) impacted by the FCRPS, USFWS is working with State and Tribal agencies to develop the Draft Bull Trout Recovery Plan. The goal of the recovery plan is describe actions needed to achieve the recovery of bull trout and ensure their long term persistence. Specific recovery objectives include maintaining or increasing the present distribution within core areas; maintaining stable or increasing trends in abundance; restoring and maintaining habitat conditions that are suitable for bull trout across all life history stages and strategies; and conserving genetic diversity and providing opportunity for genetic exchange.

Under the 2000 FCRPS BiOp, NOAA Fisheries expects the Bonneville Power Administration, the Corps of Engineers, and the Bureau of Reclamation to meet their ESA obligations in part through offsite mitigation. Subbasin plans will become local recovery plans or will become a substantial component of NOAA Fisheries recovery planning. The BiOp relies on subbasin plans to identify and prioritize specific actions needed to recover listed salmon and steelhead in tributary habitats. NOAA Fisheries expects subbasin plans to include implementation of the BiOp's offsite mitigation actions in the Reasonable and Prudent Alternative (RPA). Specifically, subbasin planning should provide for RPA habitat actions 149 through 163 and harvest and hatchery RPA actions 164 through 178 that pertain to and require local planning and management. NOAA Fisheries also expects subbasin plans to incorporate the research, monitoring, and effective strategies and actions, particularly those described in RPA action 179, 180, and 183.

ESA Resource Management Systems for Dry Cropland and Range and Pastureland in Gilliam, Sherman and Wasco Counties, Oregon –Under the Endangered Species Act Section

7 Formal Consultation and the Magnuson-Stevens Fishery and Conservation Management Act Essential Fish Habitat Consultation, the Natural Resources Conservation Service (NRCS), in cooperation with local Soil and Water Conservation Districts (SWCDs) and individual farm and ranch operators, proposes to develop Resource Management Systems (RMS) that will guide the completion of individual farm and ranch conservation plans for Dry Cropland and Range and Pastureland agriculture in Gilliam, Sherman, and Wasco Counties, Oregon. The objective of the consultation is to determine whether the proposed RMS plans within the Tri-County Region, Oregonz—two counties, Sherman and Gilliam are part of the Lower Mid-Columbia Mainstem—are likely to jeopardize the continued existence of 12 listed Columbia Basin salmonids or cause the destruction or adverse modification of their designated critical habitats.

The NRCS proposes to assume program responsibility for each conservation plan by providing engineering designs or other final project specifications and/or pay for all or part of the conservation practices (CPs) necessary to carry out each plan.

As part of the consultation process, NOAA Fisheries, the NRCS, and the farmers and ranch operators agreed to the characteristics that constitute the salmon quality criteria and indicators applicable to the riparian and aquatic habitats within the action area. The salmon quality criteria and indicators and their use in designing, evaluating, installing, and employing of the conservation practices that will make up each farm and ranch conservation plan are the subjects of this consultation.

Over the next five years, the NRCS proposes to develop and complete RMS plans for potentially 853,853 of the 1,141,636 acres of dry land crop and rangeland acres in Gilliam and Sherman counties. The NRCS will help to carry out these plans with technical assistance from the local SWCDs and U.S. Department of Agriculture (USDA) farm program funding. In Oregon, completion of RMS-level planning is a requirement for participation in funding from various USDA farm programs (NRCS 2002).

The salmon quality criteria are based on assessment elements used in the NRCS Stream Visual Assessment Protocol (SVAP) (USDA NRCS 1998), and range from physical habitat conditions to biotic (features of a natural, living system) indicators. While these criteria and indicators represent the health of underlying processes and, taken together, are intended to represent the full suite of minimum habitat functions necessary to conserve the ESA-listed salmon and steelhead analyzed in the Biological Opinion. Use of these criteria will also serve as an important cross-check on the potential adverse effects of management actions, under the control of farm and ranch operators, that can prevent or delay the recovery of desired aquatic habitat conditions so those actions will be modified or excluded as necessary.

The typical Dry Cropland RMS plans involves growing small grains (i.e., soft white wheat, feed barley), usually every other year on a given piece of land. Undesirable vegetation that grows into the fallowed cropland is controlled with mechanical tillage. Supporting long-term CPs such as Diversions (CP362), Terraces (CP600) or Water and Sediment Control Basins (CP638) are constructed as needed in the fields during the fallow period and/or after harvest. The long-term practices are constructed once, and then maintained for their 10 to 20 year life span. Other CPs, including Contour Buffer Strips, Conservation Cover, and Filter Strips or Grassed Waterways (CP393, 327, 393, 412, respectively), Upland Wildlife Habitat Enhancement practices (CP645, 648), including watering facilities, may be installed throughout the year.

A typical RMS plan on rangeland and pastureland in the region consists of prescribed grazing management that incorporates a deferred or rest-rotation type of animal movement to make optimal use of available forage. Prescribed grazing manages animal movements to control the timing, intensity, frequency, and duration of grazing.

Native or established vegetation on rangelands provides livestock food needs, except in winter when snow covers available forage and supplemental feeds may be necessary. Distribution of grazing across the landscape to prevent livestock from overusing stream courses and to decrease plant damage is encouraged through strategic water development and distribution.

Fencing assists in better distribution of livestock for more even use of forages, while excluding livestock (CP472) from sensitive areas such as riparian zones, newly seeded acres, or program restricted areas facilitates vegetation growth and recovery. Animal Trails and Walkways (CP575) can provide easier access to watering areas, livestock movement for rotation. Consideration for existing wildlife in forage allocations is a critical component of the final RMS plan. Seeding mixtures for range planting include species compatible with wildlife habitat needs (CP645).

The salmon quality criteria are based on these essential elements of critical salmonid habitat: (1) Substrate; (2) water quality; (3) water quantity; (4) water temperature; (5) water velocity; (6) cover/shelter; (7) food (juvenile only); (8) riparian vegetation; (9) space; and (10) safe passage conditions (50 CFR 226). Based on migratory and other life history timing, it is, likely that adult and juvenile life stages of these 12 ESA-listed salmon and steelhead would be present downstream of the Tri-County Region in the Columbia River mainstem, estuary, and plume when activities authorized by the proposed actions would be carried out. The MCR steelhead, in particular, migrates, spawns and rears throughout the Tri-County Region including the lower John Day River and lower Deschutes River.

U.S. Fish and Wildlife Service 1986 Pacific States Bald Eagle Recovery Plan - The U.S. Fish and Wildlife Service Pacific Bald Eagle Recovery Plan (1986) includes recommendations for managing habitat and human disturbance and applies to the states of California, Idaho, Montana, Nevada, Oregon, Washington, and Wyoming. Federal permits for projects that may affect bald eagle habitat must be reviewed by the U.S. Fish and Wildlife Service.

State Plans

Oregon Plan for Salmon and Watersheds - Approved by the Oregon legislature in 1997, Oregon Plan for Salmon and Watersheds and the 1998 Steelhead Supplement outlines a statewide approach to ESA concerns based on watershed restoration, ecosystem management, coordination among state agencies, and local solutions to protect and improve salmon and steelhead habitat. The Oregon Watershed Enhancement Board provides grant funds and technical support for watershed groups and others to help implement the Oregon Plan locally.

Washington Statewide Strategy to Recover Salmon – Created by the Washington Governor's Salmon Recovery Office and Joint Natural Resources Cabinet, this plan describes how Washington's state agencies and local governments can work together to address habitat, harvest, hatcheries, and hydropower issues as they relate to recovery of listed species.

Washington Department of Fish & Wildlife's Priority Habitat and Species Management Recommendations, Volume IV: Birds - In Washington, landowners who are pursuing land-use changes (e.g., tree-cutting, construction activities) in the vicinity of bald eagle nesting or roosting areas may be required to obtain management plans in order to ensure their new land-use activities comply with bald eagle protection laws. This document contains a description of bald eagle management plans, and the basic elements they address (Watson and Rodrick 2001).

Oregon Wildlife Diversity Plan - The Oregon Fish and Wildlife Commission adopted the Oregon Wildlife Diversity Plan in November 1993 and updated it in January 1999. This plan sets forth the Goal, Objectives, Strategies, Sub-strategies, and Program Priorities for the Oregon Department of Fish and Wildlife's Wildlife Diversity (formerly Nongame) Program. Although the focus of this plan is on nongame species, it addresses all fish and wildlife species, both game and nongame.

In addition to being a policy document to guide the actions of the Oregon Department of Fish and Wildlife, the Oregon Wildlife Diversity Plan is also a reference document containing: history of Oregon's non-game program and accomplishments; biological information on all fish and wildlife species in the state; habitat information, organized by Oregon's 10 physiographic provinces; summaries of state and federal laws and programs affecting fish and wildlife and their habitats; lists of endangered, threatened, and sensitive species; economic considerations; and the official Oregon list of Neotropical Migratory Birds (ODFW 1993).

Western Pond Turtle Recovery Plan - The recovery plan identifies WDFW recovery goals for three populations of western pond turtle in the Bonneville Pool. Each of the three populations must reach at least 200 animals and meet conservation targets for age structure, reproduction, and habitat security.

Washington Aquatic Nuisance Species Management Plan - The development of a state management plan is called for in Section 1204 of the National Invasive Species Act of 1996 (Appendix A), which provides an opportunity for federal cost–share support for the implementation of state plans approved by the National Aquatic Nuisance Species Task Force. The Washington State Plan was published in 1998 and is revised periodically. The Washington ANS Management Plan is focused on the identification of feasible, cost effective management practices to be implemented in partnership with tribes, private, and public interests for the environmentally sound prevention and control of ANS. The management actions outlined in the 1998 plan concentrated on stopping the spread of ANS already present, and minimizing the risk of further ANS introductions (i.e. both accidental and intentional introductions) into Washington waters through all known pathways, particularly animal species. This revision (WDFW 2001) identifies new and ongoing actions and broadens the focus to address more species.

Oregon Aquatic Nuisance Species Management Plan - The federal Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 amended by the National Invasive Species Act of 1996 calls for the development of state and regional management plans to control aquatic nuisance species. The Oregon management plan addresses specific aquatic nuisance species, provides a management framework, and sets objectives and actions to prevent and reduce the impact of aquatic nuisance species in Oregon. The goal of the Plan is to: Minimize the harmful ecological, economic, and social impact of ANS through prevention and management of introduction, population growth, and dispersal of ANS into, within, and from Oregon. The Plan includes a system to classify all nonindigenous species in Oregon, identifies the proper management for each class, details current authorities and programs, and sets objectives that will lead to the accomplishment of the Plan goal. These objectives include the establishment of a management structure that coordinates ANS activities, a strong prevention program, a monitoring program that allows for the early detection and eradication of pioneering ANS, a control program aimed at established species, education, and research (Hanson and Sytsma 2001).

Oregon Invasive Species Action Plan – This Plan was developed by the Oregon Invasive Species Council in response to a directive from the Oregon Legislature (ORS 561.685). The Plan is designed to improve Oregon's defenses against invasive species (e.g. Micro-Organisms, Aquatic and Land Plants, Aquatic and Land Invertebrates, Fish, Birds, and Mammals). It includes a detailed description of the impact of invasive species in Oregon, lists the most dangerous invaders, potential economic impacts, and provides information on the Oregon Invasive Species Council (OISC 2003).

Oregon Department of Agriculture - Oregon Noxious Weed Strategic Plan - In response to the 1999 House Bill #2118, this document provides a framework and overall strategy for cooperators in noxious weed management. It assesses the magnitude of the problem, highlights the importance of current weed control activities, and offers recommendations. Implementation of this strategic plan will build and expand strong coordinated programs for the future to protect Oregon's agricultural economy and natural resources. Priority activities recommended by this plan are the following: Establish strong statewide, county, and local weed control programs; identify new invaders and potential threats to the state; implement early detection and eradication programs and effective containment projects; develop cooperation and partnerships; provide and implement biological control; prioritize and implement effective projects; and provide leadership, quality inventory and mapping information, funding, assistance to public and private land managers, and education (increasing awareness) to public and private sectors; develop cooperation and partnerships (ODA 2001).

Middle Columbia River Dalles Pool Area Geographic Response Plan (GRP) – This GRP identifies and ranks oil spill protection strategies for sensitive natural resources within the Dalles Pool area of the Columbia River and allows for immediate and proper action. The strategies provide instructions for deployment of a protective boom (a floating barrier to the oil) and collection to contain or collect spilled oil. The GRP prioritizes public natural resources to be protected and allows for immediate and proper action (Northwest Area Committee 2004a).

Middle Columbia River John Day Pool Area Geographic Response Plan (GRP) – This GRP identifies and ranks oil spill protection strategies for sensitive natural resources within the John Day Pool area of the Columbia River and allows for immediate and proper action. The strategies provide instructions for deployment of a protective boom (a floating barrier to the oil) and collection to contain or collect spilled oil. The GRP prioritizes public natural resources to be protected and allows for immediate and proper action (Northwest Area Committee 2004b).

Middle Columbia River McNary Pool Area Geographic Response Plan (GRP) – This GRP identifies and ranks oil spill protection strategies for sensitive natural resources within the McNary Pool area of the Columbia River and allows for immediate and proper action. The strategies provide instructions for deployment of a protective boom (a floating barrier to the oil) and collection to contain or collect spilled oil. The GRP prioritizes public natural resources to be protected and allows for immediate and proper action (Northwest Area Committee 2004c).

Other Plans

Gilliam and Sherman County Comprehensive Land Use Plans – Gilliam 1969-[ongoing], Sherman 1968-1994 – These series of reports document the development and revision of plans for the use of lands within the Sherman and Gilliam counties. They include plans for transportation, energy, housing, population and economics, public facilities and services, urbanization, natural resources, greenways, recreation, agricultural and forest lands, land capability, resource quality, floodplains, landmarks, historic property, rural community center designation, and natural areas. Each plan includes background information about the subject; supporting documentation such as maps, charts, and diagrams; and a narrative description of each aspect of the plan and how it is to be implemented. Reports may also include overall "comprehensive plans" for Sherman and Gilliam counties, which contain both historical and current looks at county land practices and define goals and policies adhered to during the creation and implementation of the plans (OSA 004).

Lower Deschutes Agricultural Water Quality Management Area Plan - This June 2000 plan covers the Spanish Hollow drainage and was developed by the Lower Deschutes Local Advisory Committee with assistance from Oregon Department of Agriculture and Wasco County Soil and Water Conservation District. This area plan applies to agricultural activities on all non-federal and non-tribal agricultural, rural and forest lands in the Lower Deschutes Agricultural Water Quality Management Area. This Management Area consists of 1) all lands drained by the Deschutes River and its tributaries downstream but not inclusive of the Trout Creek drainage and 2) all streams flowing into the Columbia between the Hood River drainage and the John Day Basin

6.1.3 Existing Management Programs

Table 38 Summary of existing management programs

Tribal	Confederated Tribes of the Umatilla Indian Nation
	Confederated Tribes of the Warm Springs Reservation of Oregon
	Nez Perce Tribe
	Yakama Indian Nation
	Columbia River Inter-Tribal Fish Commission
Federal	National Oceanic Atmospheric Administration Fisheries
	National Marine Fisheries Service
	U.S. Fish and Wildlife Service
	U. S. Environmental Protection Agency
	U.S. Army Corps of Engineers
	Northwest Power and Conservation Council
	Bonneville Power Administration
	Bureau of Land Management
	Natural Resource Conservation Service
	Conservation Innovation Grants (CIG)
	Conservation Reserve Program (CRP)
	Continuous Conservation Reserve Program (CCRP)
	Environmental Quality Incentives Program (EQIP)
	Public Law 566 Small Watershed Program (PL 566)
	Wetlands Reserve Program (WRP)
	Wildlife Habitat Incentive Program (WHIP)
State (Oregon/Washington)	Oregon Department of Environmental Quality
	Washington Department of Ecology
	Columbia River Initiative
	Washington Water Resources Inventory Areas
	Oregon Department of Fish and Wildlife
	Oregon Watershed Enhancement Board
	Washington Department of Fish and Wildlife
	Washington Salmon Recovery Funding Board
	Oregon Department of Forestry
	Oregon Department of Transportation

	Washington Department of Transportation
	Oregon Division of State Lands
	Washington Department of Natural Resources
	Oregon Department of Agriculture
	Washington Department of Agriculture
	Washington Conservation Commission
	Enforcement of Hunting and Fishing Regulations
	Land Conservation and Development Commission
	Oregon Invasive Species Council
Local	Gilliam Soil and Water Conservation District, Oregon
	Sherman County Soil and Water Conservation District, Oregon
	North Sherman County Watershed Council, Oregon
	Fulton and Gordon Canyons Watershed Council, Sherman County, Oregon
	Klickitat County, Washington, Citizens Review Committee, Lead Entity for Salmon Recovery

Tribal Programs

The Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Indian Nation are the only tribes in the Columbia Basin to have reserved rights to anadromous fish in 1855 treaties with the United States. Each of the four tribes is a co-manager of state fisheries resources along with Oregon Department of Fish and Wildlife and the Washington Department of Fish and Wildlife. The Four Tribes coordinate participation in fisheries management through the Columbia River Inter-Tribal Fish Commission.

Federal Programs

National Oceanic Atmospheric Administration Fisheries - The National Oceanic Atmospheric Administration (NOAA) Fisheries administers the federal Endangered Species Act as it pertains to anadromous fish. Under section seven of the ESA, federal agencies are required to consult with NOAA Fisheries regarding any actions they fund, authorize, or conduct that may affect listed salmon and steelhead. NOAA Fisheries reviews and comments on fill/removal permit applications on streams with anadromous salmonids and on any hydroelectric project proceedings where anadromous fish are involved.

National Marine Fisheries Service - NMFS provides management, research, and other federal services for protection and use of marine resources and administers the ESA as it pertains to anadromous fish. Two listed ESUs migrate through the Columbia River: upper Columbia River spring Chinook salmon and upper Columbia River steelhead.

Under Sections 7 and 10 of the ESA, “take” of listed species is prohibited and permits are required for handling. Recovery actions for listed species also require Fisheries Management and Evaluation Plans.

U.S. Fish and Wildlife Service - The U.S. Fish and Wildlife Service is the principal Federal agency responsible for conserving, protecting and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the American people. The Service manages the National Wildlife Refuge System, National Fish Hatchery System, fishery resource offices, and ecological services field stations. The Service enforces Federal wildlife laws, administers the Endangered species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign governments with their conservation efforts. It also oversees the Federal Aid program that distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies.

The U. S. Fish and Wildlife Service also implements the Environmental Contaminants Program, which applies to all watersheds within the Columbia River Basin. The Environmental Contaminants program conducts studies that help reveal the health of terrestrial and aquatic ecosystems. Wildlife and fish populations are assessed for the health of their habitats, populations and individual organisms. The purpose is to identify and prevent the harmful effects of contaminants on fish and wildlife, and to restore resources degraded by contamination.

U. S. Environmental Protection Agency - The mission of the Environmental Protection Agency is to protect human health and the environment. Primary EPA activities include developing and enforcing regulations, performing environmental research, and further environmental education.

U.S. Army Corps of Engineers - The U.S. Army Corps of Engineers operates and maintains Bonneville and The Dalles locks and dams for hydropower production, fish and wildlife protection, recreation and navigation. The USACE is the lead agency for operation of fishways and monitoring fish passage.

Northwest Power and Conservation Council - The Northwest Power and Conservation Council develops and maintains a regional power plan and a Columbia River Basin Fish and Wildlife Program to balance the Northwest's environment and energy needs. The Council is responsible for developing a 20-year electric power plan that guarantees adequate and reliable energy at the lowest economic and environmental cost to the Northwest, developing a program to protect and rebuild fish and wildlife populations affected by hydropower development in the Columbia River Basin, and educating and involving the public in the Council's decision-making process. The Council works to protect, mitigate, and enhance fish and wildlife of the Columbia River and guides Bonneville Power Administration's funding of projects to implement the Fish and Wildlife program.

Bonneville Power Administration - The BPA is a federal agency established to market power produced by the federal dams in the Columbia River Basin. The BPA provides funding for fish and wildlife protection and enhancement to mitigate for the loss of habitat resulting from hydroelectric construction and operations.

Bureau of Land Management - The Bureau of Land Management (BLM) manages lands in the Lower Mid-Columbia Mainstem subbasin. The lands are managed for multiple uses including habitat for native wildlife.

The BLM continues to protect and manage riparian habitat in the Subbasin to enhance riparian habitat and water quality from season-long livestock grazing. Protection allows for proper functioning of healthy riparian systems including silt and sediment entrapment, aquifer recharge, erosion abatement, and fish and wildlife habitat.

The BLM also acquires and manages shrubsteppe habitat for shrubsteppe obligate species including Washington ground squirrel and sage grouse. This project is meant to improve the condition of shrubsteppe habitat and restore degraded and converted cropland. Restoration and management activities include improving grazing management practices through rotational grazing and reduced stocking rates; controlling weeds through spraying and vehicle management (road closures); collecting native grass seeds to create commercially available seed sources; and developing and testing land treatment methods (e.g., mowing, herbicide application, plowing, seeding) to establish native shrubsteppe plant communities on degraded and converted lands.

Natural Resources Conservation Service - One of the purposes of the NRCS is to provide consistent technical assistance to private land users, tribes, communities, government agencies, and conservation districts. The NRCS assists in developing conservation plans, provides technical field-based assistance including project design, and encourages the implementation of conservation practices to improve water quality and fisheries habitat. Programs include the CRP, River Basin Studies, Forestry Incentive Program, Wildlife Habitat Improvement Program, the Environmental Quality Incentives Program, and Wetlands Reserve Program. The USDA Farm Services Administration (FSA) and the NRCS administer and implement the federal CRP and Continuous CRP.

Conservation Innovation Grants (CIG)

CIG is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environmental enhancement and protection, in conjunction with agricultural production. Under CIG, EQIP funds are used to award competitive grants to non-federal governmental or non-governmental organizations, Tribes, or individuals. CIG enables NRCS to work with other public and private entities to accelerate technology transfer and adoption of promising technologies and approaches to address some of the Nation's most pressing natural resource concerns. CIG will benefit agricultural producers by providing more options for environmental enhancement and compliance with federal, state, and local regulations. The USDA oversees CIG and the NRCS administers the program.

Conservation Reserve Program (CRP)

The CRP provides technical and financial assistance to eligible farmers and ranchers to comply with federal, state, and tribal environmental laws and to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program is funded through the Commodity Credit Corporation. CRP is administered by the Farm Service Agency, with NRCS providing technical land eligibility determinations, Environmental Benefit Index Scoring, and conservation planning (Bareither, pers. comm., 2004).

The enrollment of agricultural land with a previous cropping history into CRP has removed highly erodible land from commodity production. The land is converted into permanent herbaceous or woody vegetation to reduce soil and water erosion. Farmers receive an annual rental payment for the term of the contract (Bareither, pers. comm., 2004), a maximum of 10 years (the contracts may be extended). Cover Practices that occur under CRP include planting introduced or native grasses, wildlife cover, conifers, filter strips, grassed waterways, riparian forest buffers, and field windbreaks. There are 209,206 acres of CRP in Klickitat (WA.), Gilliam and Sherman (OR.) counties combined.

CRP contract approval is based, in part, on the types of vegetation landowners are willing to plant. Cover Practice planting combinations are assigned points based on the potential value to wildlife. For example, cover types more beneficial to wildlife are awarded higher scores. Seed mixes containing diverse native species generally receive the highest scores (FSA 2003).

CRP and associated cover practices that emphasize wildlife habitat increase the extent of shrubsteppe-like habitat, provide connectivity/corridors between extant native shrubsteppe and other habitat types, reduce habitat fragmentation, increase landscape habitat diversity and edge effect, reduce soil erosion and stream sedimentation, and provide habitat for wildlife species.

Continuous Conservation Reserve Program (CCRP)

The CCRP focuses on the improvement of water quality and riparian areas. Practices include shallow water areas with associated wetland and upland wildlife habitat, riparian forest buffers, filter strips, grassed waterways and field windbreaks. Enrollment for these practices is not limited to highly erodible land, as is required for the CRP, and carries a longer contract period (10 - 15 years), higher installation reimbursement rate, and higher annual annuity rate.

Environmental Quality Incentives Program (EQIP)

The EQIP was established in the 1996 Farm Bill and was reauthorized in the Farm Security and Rural Investment Act of 2002 (Bareither, pers. comm., 2004). The EQIP is administered and implemented by the NRCS and provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. The program assists farmers and ranchers with federal, state, and tribal environmental compliance, and encourages environmental stewardship. The program is funded through the Commodity Credit Corporation.

Program goals and objectives are achieved through the implementation of a conservation plan that incorporates structural, vegetative, and land management practices on eligible land. Eligible producers commit to 5 to 10-year contracts. Cost-share payments are paid for implementation of one or more eligible structural or vegetative practices such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat. Furthermore, incentive payments are made for implementation of one or more land management practices such as nutrient management, pest management, and grazing land management.

Public Law 566 Small Watershed Program (PL 566)

PL 566 can be leveraged with other federal, state, or local program funds to provide wildlife and fisheries protection. Soil and water conservation districts using other project funding sources leverage NRCS program resources in combination to concentrate conservation within watersheds of concern.

Wetlands Reserve Program (WRP)

This voluntary program is designed to restore wetlands. Participating landowners can establish permanent or 30-year conservation easements, or they can enter into restoration cost-share agreements where no easement is involved. In exchange for establishing a permanent easement, the landowner receives payment up to the agricultural value of the land and 100 percent of the restoration costs for restoring the wetlands. The 30-year easement payment is 75 percent of what would be provided for a permanent easement on the same site and 75 percent of the restoration cost. The voluntary agreements are a minimum of 10 years in duration and provide for 75 percent of the cost of restoring the involved wetlands. The goal of NRCS is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program (Bareither, pers. comm., 2004). This program establishes wetland protection and restoration as the primary land use for the duration of the easement or agreement (Ashley and Stovall 2004) and establishes long-term conservation and wildlife practices and protection (Bareither, pers. comm., 2004). There are no Wetland Reserve Program projects within the Subbasin.

Wildlife Habitat Incentive Program (WHIP)

The WHIP is administered and implemented by NRCS and provides financial incentives to develop wildlife habitat on private lands. Participants agree to implement a wildlife habitat development plan and NRCS agrees to provide cost-share assistance for the initial implementation of wildlife habitat development practices. The NRCS and program participants enter into a cost-share agreement for wildlife habitat development. This agreement generally lasts a minimum of 10 years.

State Programs

Oregon Department of Environmental Quality - The Oregon Department of Environmental Quality (ODEQ) is required by the Federal Clean Water Act to establish water quality standards to protect the beneficial uses of the State's waters. Based on the water quality standards, ODEQ is then required to: identify stream segments where the standards are not being met; develop a list of these water-quality limited water bodies (called the 303(d) list from Section 303(d) of the Clean Water Act); and develop a Total Maximum Daily Load (TMDL) allocation for each water body included on the 303(d) lists. The TMDL describes the maximum amount of pollutants (from all sources) that may enter a specific water body without violating water quality standards.

The Department of Environmental Quality administers the EPA 319 Non-Point Source (319) Program in the State of Oregon. The 319 Program provides up to 60% cost-share for projects targeting nonpoint source water pollution issues. 319 funds are for implementation activities, including monitoring used to support TMDL development, implementation and measuring progress toward achieving TMDL allocations.

Washington Department of Ecology - Washington's principal environmental management agency. Their mission is to protect, preserve and enhance Washington's environment, and promote the wise management of our air, land and water for the benefit of current and future generations. Department goals are to prevent pollution, clean up pollution, and support sustainable communities and natural resources.

Columbia River Initiative

Conservation and fishing advocates have argued that for over a century Washington state has managed the Columbia River without knowing how much water should be left in the river and how much was actually being taken out. In 1999, a petition was filed with the Department of

Ecology by the Center for Environmental Law and Policy and American Rivers, seeking a moratorium on additional water withdrawals until Ecology determined how much water needs to be kept in the river to protect salmon and steelhead and water quality.

This promted a request by Ecology to the National Research Council to to analyze how much water should be kept in the Columbia to protect the river's salmon and steelhead (most are protected under the ESA), and to provide advice regarding salmon and water management decisions. The National Research Council reviewed and evaluated existing scientific data and analyses related to fish species listed under the ESA in the Columbia River basin, and reviewed and evaluated environmental parameters critical to the survival and recovery of listed fish species. The cumulative effects and the risks to the survival of listed fish species of potential future water withdrawals of between approximately 250,000 acre-feet and 1,300,000 acre-feet per year were also evaluated. In addition, the effects of proposed management criteria, specific diversion quantities, and specific features of potential water management alternatives provided by the State of Washington were to be evaluated.

The NRC's resulting report, *Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival* (2004), is an essential building block in the Department of Ecology's effort to establish new rules for issuing water rights from the Columbia River, a process known as the Columbia River Initiative. The purpose of the Columbia River Initiative is to develop a state water-management program for the Columbia River that: allows the basin's economy to grow, diversify, and be sustained; reflects scientifically sound information; reduces the risks to fish and maintains healthy watersheds. The Initiative involves two main ideas: 1) Securing and dedicating water to the Columbia River mainstem that will benefit fish and will allow the state to authorize new off-stream uses that are mitigated by this water; 2) State investment to secure the water, offset by annual mitigation payments from new water users.

Ecology is currently working on a comprehensive implementation package that will include: negotiated agreements with the Bureau of Reclamation, the Columbia Basin irrigation districts, the Colville Tribes and others to secure water; an executive request policy bill allowing for full legislative consideration of this approach; a substantial budget initiative to fund water acquisition and to begin to move towards new off-channel storage; and, a proposed draft rule to implement the policy bill and to comply with the terms of our legal settlement with the Columbia Snake irrigators.

The State's proposal offers a pragmatic and responsible approach for securing water in a timely and affordable manner. It addresses water needs during drought years, considers future storage capabilities, and recommends funding for water conservation and water acquisition programs.

Washington Water Resources Inventory Areas – The WRIA program is responsible for Washington's watershed planning and is managed by the Department of Ecology. Also see Watershed Management Act (WMA, ESHB 2514) in State Laws. Watershed planning focuses on assessing all aspects of water quantity and quality in the state's designated 62 watersheds. Planning has commenced in the Rock, Pine and Glade Creek watersheds (WRIA 31), but is not expected to produce reports until 2007.

Oregon Department of Fish and Wildlife - Oregon Department of Fish and Wildlife (ODFW) is responsible for protecting and enhancing Oregon's fish and wildlife and their habitats for use and enjoyment by present and future generations. Management of the fish and wildlife and their habitats in the Columbia Gorge subbasin is guided by ODFW policies and federal and state legislation. ODFW policies and plans that pertain to the subbasin include the Natural Production Policy (OAR 635-07-521 to 524), The Native Fish Conservation Policy (635-007-0502 to 0505), and Oregon Guidelines for Timing In-Water Work to Protect Fish and Wildlife Resources. These plans present systematic approaches to conserving aquatic resources and establishing management priorities within the subbasin.

Oregon Watershed Enhancement Board – OWEB is a state agency led by a policy oversight board. Together, they promote and fund voluntary actions that strive to enhance Oregon's watersheds. The Board fosters the collaboration of citizens, agencies, and local interests. OWEB's programs support Oregon's efforts to restore salmon runs, improve water quality, and strengthen ecosystems that are critical to healthy watersheds and sustainable communities. OWEB administers a grant program that awards more than $20 million annually to support voluntary efforts by Oregonians seeking to create and maintain healthy watersheds. To accomplish this OWEB funds projects that restore, maintain, and enhance the state's watersheds; supports the capacity of local watershed-based citizen groups to carry out a variety of restoration projects; promotes citizen understanding of watershed needs and restoration ideas; provides technical skills to citizens working to restore urban and rural watersheds; and monitors the effectiveness of investments in watershed restoration. http://www.oweb.state.or.us/

Washington Department of Fish and Wildlife - Washington Department of Fish and Wildlife manages land for fish, wildlife, and recreation needs. The Department is mandated to preserve, protect, and perpetuate fish and wildlife and their habitat. A goal of the Department is to encourage and assist local governments in adopting policies and regulations to protect fish and wildlife habitat. The Priority Habitats and Species Program is the principal means by which the Department provides important fish, wildlife, and habitat information to local governments, state and federal agencies, private landowners and consultants, and tribal biologists for land use planning purposes. The Department also provides a partnership-based information system that characterizes freshwater and estuary habitat conditions and distribution of salmonid stocks in Washington.

Washington Salmon Recovery Funding Board - In 1999 the Legislature created the Salmon Recovery Funding Board. Composed of five citizens appointed by the Governor and five state agency directors, the Board brings together the experiences and viewpoints of citizens and the major state natural resource agencies. The Board provides grant funds to protect or restore salmon habitat and assist related activities. It works closely with local watershed groups known as lead entities. SRFB has helped finance over 500 projects. Its mission "supports salmon recovery by funding habitat protection and restoration projects. It also supports related programs and activities that produce sustainable and measurable benefits for fish and their habitat." http://www.iac.wa.gov/srfb/

Oregon Department of Forestry - The Oregon Department of Forestry regulates forest management activities on non-federal lands. The Oregon Forest Practices Act (ORS 527 and administrative rules division 629-600 through 629-680) regulates forest management activities including harvesting, road construction, slash burning, chemical application and reforestation. The rules contain a large body of water protection rules (OAR 629-635 through 629-660) based on current science that reflect the best management practices required by operators when conducting cultural practices in the forest. These guidelines include mandatory stream buffers and riparian management areas, as well as protection to small tributaries important for maintaining cool water temperature downstream.

Oregon Department of Transportation - The Oregon Department of Transportation (ODOT) maintains state highways in the Columbia Gorge subbasin. Bridges and culverts, as they are upgraded or replaced, must meet guidelines designed to protect fish and fish habitat. In particular, guidelines are specified in the 4d Rule for threatened Mid-Columbia steelhead, written by NOAA Fisheries.

Washington Department of Transportation - The Environmental Services Department of the Department of Transportation is responsible for implementation of the department's transportation services with consideration of environmental resources. The goal of the program is to ensure that fish have access to available functional habitat for spawning, rearing, and migration. The Biology Branch addresses issues involved with the Endangered Species Act, Fish Passage, Wetland Mitigation, and Wetland Monitoring. The Compliance Branch addresses regulatory compliance with the National Environmental Policy Act (NEPA) and administers the Advance Environmental Mitigation Revolving Account for watershed management. Compliance also addresses flood management and hydrogeology, stormwater management, and NPDES. The Resource Branch addresses cultural resources, hazardous materials, water quality and erosion control, and air quality.

Oregon Division of State Lands - Oregon Division of State Lands is responsible for regulating the removal and fill of materials in natural waterways. Permitted fill or removal activities are required to be consistent with instream work periods established by ODFW.

Washington Department of Natural Resources - The Department of Natural Resources manages state-owned lands for various resource uses. These include preservation, mineral extraction, commercial and industrial development, dredged material disposal, and recreational development. The Department has a Habitat Conservation Plan (HCP) in place with the U. S. Fish and Wildlife Service that incorporates restoration, protection, and maintenance of existing habitat. The Department manages the Riparian Management Zone (RMZ) under the HCP for all Washington State lands. The Department oversees 2.2 million acres of forested trust lands, which include requirements for the RMZ on certain water types affected by timber harvest activities. The goal of the Department's Aquatic Land Management Program is to restore and maintain riparian habitat on non-federal forestland, while meeting the requirements of the Clean Water Act, and supporting a harvestable supply of fish.

Oregon Department of Agriculture - The DOA regulates the importation of some exotic animal species and administers the Oregon ESA for plants through its conservation Biology Program. It also administers laws for the destruction, eradication, or control of predatory animals (ODFW 1993).

Washington Department of Agriculture - The goal of the Department of Agriculture's Water Quality Protection Program is to work together with the agricultural community and regulators to protect water resources. The program addresses a variety of surface and ground water issues that involve fertilizers and pesticides. The Department is also evaluating current pesticide use practices in conjunction with pesticide residue data in surface waters that provide habitat for ESA-listed species.

Washington Conservation Commission - The WSCC supports conservation districts in Washington, promoting conservation stewardship by funding natural resource projects. The WSCC provides basic funding to conservation districts as well as implementation funds, professional engineering grants, and Dairy Program grants and loans to prevent the degradation of surface and ground waters. The Agriculture Fish and Water Program (AFWP) is a collaborative process aimed at voluntary compliance. The AFWP involves negotiating changes to the existing NRCS Field Office Technical Guide and the development of guidelines for irrigation districts to enhance, restore, and protect habitat for endangered fish and wildlife species, and address state water quality needs. This two-pronged approach has developed into two processes, one involving agricultural interests and the second concerning irrigation districts across the state.

Enforcement of Hunting and Fishing Regulations - Oregon State Police (OSP) and Washington Department of Fish and Wildlife enforce fishing and hunting regulations in the subbasin with special attention to ESA-listed salmonids through covert and overt patrols, and routine checks for licenses, tags, bag limits, weapon/gear type, area, season, and other regulations. Two Fish and Wildlife Law Enforcement Officers are based in Hood River, one of which is funded by the Oregon Plan for Salmon and Watersheds. The officers are part of a regional team of 7 covering a 5-county area. The Columbia River Inter-Tribal Fisheries Enforcement (CRITFE) monitors tribal fisheries and enforces fishing regulations in the Columbia River between Bonneville and McNary Dams.

Land Conservation and Development Commission - The Land Conservation and Development Commission regulates land use on the state level in Oregon. County land-use plans must comply with statewide land-use goals. Land-use plans have been helpful in protecting fish habitat, particularly by curtailing excessive development along streams.

Oregon Invasive Species Council - Oregon's Invasive Species Council was created by the Oregon legislature (ORS 561.685). The council began work on January 1, 2002, and is directed to conduct a coordinated and comprehensive effort to keep invasive species out of Oregon and to eliminate, reduce, or mitigate the impacts of invasive species already established in Oregon. This includes the following tasks: create and publicize a system for reporting sightings of invasive species and referring those reports to the appropriate agency, undertake educational activities to increase awareness of invasive species issues, create a statewide plan for dealing with invasive species, and administer a trust account for funding eradication and education projects. The council consists of the following members: Oregon Department of Agriculture, Portland State University, Oregon Department of Fish & Wildlife, and the Sea Grant College of Oregon State University, as well as eight at large members (two-year terms) from federal, state, and local governments, universities, industry and other groups having an interest in invasive species (OISC 2003).

Local Programs

Gilliam Soil and Water Conservation District – The Gilliam Soil and Water Conservation District was formed under the Oregon State Statues. Chapter 586. Section 210-800. The referendum was held on April 22, 1946. The district boundaries are the same as the Gilliam County boundaries.

The district was formed to provide technical assistance to farmers and ranchers in the district area. Original objectives included research needs, special equipment needs, trials on new grass and legume varieties, and technical assistance on conservation. Current objectives also include soil erosion and improving water conservation and quality. Natural resource concerns (problems, issues, needs) for Gilliam County include: Soil Condition (soil tilth and organic matter), wind Erosion, sheet and rill erosion, plant condition (productivity, health, and vigor), concentrated flow, wildlife habitat (cover and/or shelter), aquatic habitat (sediment delivery), streambank erosion, nutrient management (inorganic and organic), water quality, irrigation induced erosion, and weed control.

Gilliam's County SWCD mission is to provide support for economic sustainability for the rural community and to educate and assist the community for conservation while maintaining soil and water erosion for the future. As a small community they are able to work with one another and help each other with assistance from their district directors, OSA, NRCS, OACD, and the Watershed Council.

The seven locally elected directors who serve without pay administer the conservation programs. The directors are landowners, managers, operators and residents of Gilliam County. Directors serve four years to direct the available technical service needed to accomplish the district's long-term annual objective.

Sherman County Soil and Water Conservation District, Oregon – The Sherman County Soil and Water Conservation District (SWCD) was formed in 1950. The District is responsible for protecting and promoting the natural resources within its boundaries. Their goals are to efficiently deliver treatments to the ground, reduce soil erosion, improve water quality, enhance and restore watersheds (in conjunction with Senate Bill 1010 and The Oregon Plan), secure funding for on-the-ground projects, provide education regarding natural resources and conservation, develop and implement agricultural water quality management plans for the lower Deschutes and lower John Day rivers, and act as a buffer between government agencies and landowners whenever needed (Sherman County SWSD 2004a).

North Serman County Watershed Council, Oregton - The North Sherman County Watershed Council was established in December 2001, to address watershed management issues. The council works to improve water quality in the area's streams by reducing soil erosion and flood damage through effective resource planning. A Watershed Action Plan has been developed for North Sherman County watershed, and the council is actively in search of funding for monitoring and implementation of the plan. The council seeks support and cooperation from the Sherman County Court, the Sherman County Soil and Water Conservation District, and other interested agencies or individuals in developing and implementing the Plan (Sherman County SWCD 2004b).

Fulton and Gordon Canyons Watershed Council, Sherman County, Oregon - The Fulton and Gordon Canyons Watershed Council was formed in April 1997, to address watershed management issues. The council works to improve water quality in the area's streams by reducing soil erosion and flood damage through effective resource planning. A Watershed Action Plan has been developed for Fulton and Gordon Canyons watershed, and the council is actively in search of funding for monitoring and implementation of the plan. The council seeks support and cooperation from the Sherman County Court, the Sherman County Soil and Water

Conservation District, and other interested agencies or individuals in developing and implementing the Plan (Sherman County SWCD 2004b).

Klickitat County, Washington, Citizens Review Committee, Lead Entity for Salmon Recovery - Lead entities are voluntary organizations under contract with WDFW to see that the best projects are proposed to the Salmon Recovery Funding Board (SRFB) for funding in its annual grant process. All lead entities have a set of technical experts that assist in development of strategies, and identification and prioritization of projects. The lead entity citizen committee is responsible under state law for developing the final prioritized project list and submitting it to the SRFB for funding consideration. Lead entity technical experts and citizen committees perform important unique and complementary roles. The complementary roles of both lead entity technical experts and citizen committees help propose the best projects and increase the technical and community support for salmon recovery.

6.1.4 Projects

Table 39 Projects within the Lower Mid-Columbia Mainstem assessment unit related to conservation, restoration, and research activities

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Boardman Grasslands Preserve – habitat conservation and T&E species recovery (TNC 2003)	TNC, ODFW, and Threemile Canyon Farms;	White-tailed jackrabbit, burrowing owl, ferruginous hawk, Swainson's hawk, loggerhead shrike, long-billed curlew, grasshopper sparrow, sage sparrow, and northern sagebrush lizard	Agreement to establish habitat conservation measures on the preserve to protect various wildlife species that could become federally listed as threatened or endangered unless their population declines are reversed. TNC will develop a long-term management plan. Working with state agencies, elected officials and conservation groups, the farm and the TNC are pursuing options to purchase the entire site from the state, including the conservation area.	2001-2040	Boardman Grassland Preserve, OR	
Boardman Grasslands Preserve – Vegetation Restoration Grant $22,287. (USFWS 2004c)	USFWS and TNC	White-tailed jackrabbit, burrowing owl, ferruginous hawk, Swainson's hawk, loggerhead shrike, long-billed curlew, grasshopper sparrow, sage sparrow, and northern sagebrush lizard	This grant will restore native grasses, forbes, and shrubs to 20 acres of grassland and shrub-steppe habitat on the 22,642-acre Boardman Conservation Area.	2004-Ongoing	Boardman Grasslands Preserve	
Boardman Grasslands	National Fish and Wildlife	Multiple, terrestrial wildlife and plant	A grant from the NFWF is supporting creation of a		Boardman Grasslands Preserve, OR.	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Preserve - Weed Management Area (TNC 2003)	Foundation (NFWF)	species	collaborative 205,000-acre Weed Management Area, which will engage local landowners across the region in coordinated efforts to control the most damaging invasive species.			
USFWSPrivate Stewardship Grant Program (USFWS 2004c)	USFWS	Federally listed T&E species	In the Pacific Northwest, the U.S. Fish and Wildlife Service is awarding $839,810 in grants under the Private Stewardship Grant program. This program provides federal grants to individuals and groups engaged in voluntary conservation efforts on private lands that benefit federally listed T&E, candidate, and other at-risk species.	2004-Ongoing	Pacific Northwest	
Mule Deer - Hunting Season Management - CRP Development	WDFW	Mule deer, upland game birds	Ongoing effort to survey and manage deer populaton via hunting program. Surveys and harvest statistics provide annual data used to set hunting seasons and address population trends. WDFW is working with landowners to implement Conservation Reserve Program that benefits a multitude of species associated with grassland and shrub steppe habitat.	1950s-ongoing	Rock Creek Subbasin agricultural lands, WA.	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Synthesis and Comparison of Baseline Avian and Bat Use, Raptor Nesting and Mortality Information from Proposed and Existing Wind Developments (West Inc. 2002)	Prepared for BPA by West, Inc.	Birds, including raptors, bats, and sensitive species	Baseline and operational monitoring data were collected at proposed and existing U.S. wind plants to estimate the overall project impacts on birds (especially raptors and state and federally listed species), to guide future placement of turbines within a project boundary, and strengthen our ability to accurately predict and mitigate impacts from new projects.	2002	Oregon, Washington and other states. Within Oregon and Washington: Northeast OR.; Vansycle Wind Project, Umatilla Co.; Condon Wind Project; Stateline Project, Vansycle Ridge; Klondike Wind Project, Sherman Co.	
Western gray squirrel research and management	WDFW	Western gray squirrel	Ongoing effort to survey and manage WGS population and associated habitat. Periodic surveys are done to document occurrences in Rock Creek drainage with emphasis in the the upper subbasin. WDFW monitors timber harvest through forest practice regulations and land divisions through county planning dept. BLM is currently funding research project on WGS habitat use. The Nature Conservancy has acquired land in Rock Creek drainage and places emphasis on WGS protection.	1990-ongoing	Rock Creek Subbasin, WA.	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival	Washington Department of Ecology and National Research Council	Salmon and steelhead	The National Research Council (NRC) was commissioned by the Washington Department of Ecology to analyze how much water should be kept in the Columbia to protect the river's salmon and steelhead. NRC completed their report in 2004. It is used by Ecology to establish new rules for issuing water rights from the Columbia River.	1999-2004	Portions of the Columbia River Mainstem that flow through the state of Washington	
Environmental Contaminants In Aquatic Resources From The Columbia River - Study	USFWS, Oregon F&W Office	Multiple Species: Migratory birds and ESA species	Collected sediment, invertebrates, fish, and eggs of piscivorous and non-piscivorous birds in within various river segments to determine contaminant concentrations, compare concentrations within river segments, identify concentrations that exceed guidance or reference levels, evaluate magnitude of exceedances, and derive biomagnification factors (BMFs) for persistent, bioaccumulative compounds. BMFs were used to develop target fish concentrations (TFCs), or the concentrations in fish estimated to be protective of upper trophic level species such as bald	1990-1991	Samples were collected in the lower Columbia River below Bonneville Dam (four river segments including three NWRs), at Umatilla NWR and above McNary Dam, and in the lower Willamette River near Portland.	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
			eagles.			
198903500 Umatilla Hatchery operation and maintenance	Oregon Department of Fish and Wildlife	Spring, fall chinook, summer steelhead, coho	Restore Umatilla River Chinook and steelhead fisheries and populations through release of subyearling and yearling smolts produced at Umatilla Hatchery.	Operation began in 1991		
199000500 Umatilla Fish Hatchery monitoring and evaluation	ODFW	Sping, fall chinook, summer steelhead, coho	Evaluate juvenile rearing, adult survival, stock life history, straying, fish health and sport fishing and catch contribution for salmon and steelhead reared in oxygen supplemented and standard raceways at Umatilla Hatchery.	Ongoing since 1991		
199007700 Northern Pikeminnow Management Program	Pacific States Marine Fisheries Commission	Reduce predation on juvenile salmonids	Reduce predation on juvenile salmonids by implementing fisheries to harvest northern pikeminnow in the mainstem Columbia and Snake rivers. Monitor effects of fisheries on predation by northern pikeminnow and other resident fish.	Ongoing since 1990	Columbia River from Cathlamet Washington upstream to Priest Rapids Dam; Snake River from mouth upstream to Hells Canyon Dam	
199406900 Estimate production potential of fall chinook salmon in the Hanford Reach of the Columbia River	Pacific Northwest National Laboratory	Fall chinook salmon	Develop a production potential estimate for fall chinook salmon in the Hanford Reach, and evaluate whether the Hanford Reach functions as a healthy alluvial river.	1994	Columbia River's Hanford Reach	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
199900301 Evaluate spawning of fall chinook and chum salmon just below the four lowermost mainstem dams	Pacific States Marine Fisheries Commission, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, U.S. Geological Survey, Pacific Northwest National Laboratory	Fall chinook, chum salmon	Monitor, protect, and enhance the spawning populations of fall chinook and chum below Bonneville Dam. Search for evidence of fall chinook spawning below The Dalles, John Day, and McNary dams.	1999		
CREP	USDA/FSA/ NRCS		Anadromous streams, voluntary program for landowners, the land enrolled in CREP is removed from production and grazing under 10 or 15 year contracts. In return, landowners plant trees and shrubs to stabilize the stream bank.	1999—2016	Landowners adjacent to over 8,000 miles of streams in Washington are eligible to participate in this program.	
White sturgeon assessment BPA - 198605000	ODFW, WDFW, CRITFC, USGS, OSU	White sturgeon	White sturgeon mitigation and restoration.	1986-current	Columbia and Snake rivers upstream from Bonneville Dam	
Columbia River Fish Management Plan (US v. Oregon)	WDFW, ODFW, northwest Indian tribes, federal agencies	spring chinook, summer chinook, sockeye, fall chinook, summer steelhead, and coho salmon	This agreement between federal agencies, Indian tribes and state agencies (except Idaho) set guidelines for the management, harvest, hatchery production, and rebuilding of Columbia River Basin salmonid	1969 though 1998 (though lapsed, the agreement is being renegotiated and parties are using seasonal fish plans in the	Columbia river basin	

Project # and/or Name/	Responsible Party	Target Species	Project Description	Project Duration	Project Location or Geographic Scale Affected	GAP Analysis Statement
			stocks.	interim.)		
Watershed Planning under RCW 90.82 in WRIA 31	WRIA 31 Local Planning Unit		The Watershed Management Act to provides a framework for local citizens, interest groups, and government organizations to collaboratively identify and solve water quantity related issues in the watershed.	Started in 1991, ongoing until 1998.	Rock Creek, Pine Creek, Glade Creek, WA.	
Rock Creek Temperature Study 96-308	Ecology		High temperatures in Rock Creek were evaluated. Riparian canopy cover was compared to Washington Department of Natural Resources target coverages. Management recommendations were made based on these target coverages.	1995	Upper Rock Creek, WA.	
WSPMP92W	Ecology		Ongoing evaluation of pesticide contamination in surface water for the WSPMP.	January 1992 through January 1993	Glade Creek, WA.	
GLADEGW	Ecology		Ground-water quality characterization and investigation of nitrate contamination of ground water and surface water in the Glade Creek Watershed Horse Heaven Hills south-central Washington.	May 1995 through September 1995	Glade Creek, WA.	

7 Synthesis and Interpretation

Introduction

This synthesis and interpretation of information presented in the assessment section of this plan, focuses on the four fish species white sturgeon, summer steelhead, fall chinook, coho, and eight wildlife species, western gray squirrel, whiteheaded woodpecker, mule deer, grasshopper sparrow, Brewer's sparrow, yellow warbler, American beaver, Lewis' woodpecker. It would enhance this section, 7. Synthesis and Interpretation, to integrate additional information from 3. Subbasin Description/3.2.8 Anthroprogenic Disturbances on Terresterial and Aquatic Environments and 5. Fish Assessment/5.7.2-5.7.5 Focal Species and 5.8.1-5.8.5 Fish Habit Assessment Units in a future iteration of this subbasin plan.

7.1.1 Data Availability, Data Quality, and Data Gaps

The lower mid-Columbia mainstem, except for sturgeon, and the Oregon side of the subbasin are not reflected in the assessment of data below. For other species and habitats, some data gaps have been identified in the 4.3.4, 4.4.4, and 4.5.3 Wildlife Key Findings and 5.8.1 and 5.8.5 Key Fish Findings and in 8.2.1-8.2.6 Wildlife Objectives and Strategies and in 8.3.1-8.3.5 Fish Objectives and Strategies.

Lower Mid-Columbia Mainstem Columbia Assessment Unit

Data Availability

There was no new data collected as a part of the assessment of white sturgeon in the Lower Mid-Columbia Mainstem Columbia River. All the data used in this assessment was collected from previously conducted summaries and research. Although much of the data collected on white sturgeon in the Lower Mid-Columbia Mainstem Columbia in recent years was available, much has yet to be published and was not available for this assessment.

Data Quality

The data that was used in this assessment and management plan was obtained through public sources and much of it was peer reviewed. However, the subbasin planners assume that the data used in the assessment was of high quality.

Data Gaps

The data from recent years sturgeon research is still being analyzed in was not available for this assessment.

Key Assumptions

We assume that the data used in this assessment and management plan was of high quality and reliably reflects the current status of research regarding white sturgeon in the Lower Mid-Columbia Mainstem Columbia River.

7.1.2 Interpretation and Hypothesis – Wildlife and Fish

Key Habitat/Population Relationships – Limiting Factors

Primary limiting factors for fish, wildlife, and associated habitats in the mainstem Columbia River are generally a result of (1) hydropower system development and operation, (2) other human activities such as farming, grazing, transportation, and industrial development, or (3) introduction and proliferation of exotic species. These factors are often interrelated and hard to separate. Therefore, the following summaries of major limiting factors are not necessarily organized by these major categories.

Wildlife

Hydropower System Development and Operations

The development and operation of the hydropower system resulted in widespread changes in riparian, riverine, and upland habitats. A tremendous amount of habitat has been lost or significantly altered. Wildlife loss assessments conducted in the late 1980s documented losses associated with each hydropower facility.

Effects of hydropower development and operations on wildlife and wildlife habitat may be direct or indirect (secondary). Direct effects include stream channelization, inundation of habitat, degradation of habitat from water level fluctuations (e.g., draining and filling of wetlands, rip-rapped shorelines, and erosion), and construction and maintenance of power transmission corridors. Secondary effects include the building of numerous roads and railways, the expansion of irrigation, which has resulted in extensive habitat conversion, and increased access to and harassment of wildlife.

Specific effects of hydropower operation include limiting the availability of secure nesting and brood-rearing habitat for Canada geese, breeding ducks, and colonial nesting birds. Islands provide protection of nesting birds from terrestrial predators, and to some extent, disturbance by humans. Many islands used by birds are eroding rapidly, especially in the John Day Reservoir, thus reducing the size of islands and eliminating nests on islands with maximum nest density (McCabe 1976).

Water fluctuations cause some islands to be connected to shore during periods of low water, allowing access by terrestrial predators. Some brooding sites are a great distance from nesting sites, and mortality of young birds can be very high while traveling from nesting islands to distant brooding habitat, especially during windy conditions. Massive waves, characteristic of some parts of the Columbia River, kill young birds directly and reduce the productivity of shallow water areas used for feeding. At some brooding sites, low water elevation is lower than the downslope extent of plants, resulting in a wide band of un-vegetated shoreline. Adults and young birds attempting to traverse this un-vegetated area are very susceptible to predation. Conversely, at some brooding sites, plants eaten by birds are unreachable due to inundation. Fluctuating water levels that occur in shallow areas with highly variable bathymetry contribute to avian botulism outbreaks when terrestrial and aquatic invertebrates die as land areas are repeatedly flooded and desiccated in warm ambient conditions (Locke and Friend 1987; Levine 1965). Water level fluctuations may also reduce the productivity and availability of critical migrant shorebird habitat at deltas.

Table 40 Loss of wildlife habitat associated with federal hydropower facilities in the lower Columbia River

Hydropower Facility	Habitat Inundated (ha)	Habitat Units Lost
Bonneville	8,400	12,317
The Dalles	780	2,230
John Day	11,115	14,398
McNary	6,276	19,397

Rassmussen and Wright 1990

Hydropower operations that produce atypically high discharges can displace spawned-out salmon carcasses from the open shoreline into the permanent and dense shoreline vegetation. The dense vegetation may act to conceal those carcasses from predators such as the bald eagle, and may effectively reduce a primary food item that is especially important for wintering juvenile eagles along the Hanford Reach (Brett Tiller, PNNL, unpublished data).

Birds, and other wildlife, dependent on riparian or upland areas are also affected by hydropower development and operations. Filling of reservoirs inundated riparian and upland (shrub-steppe and steppe) habitats, and short-term water level fluctuations that result from power production at dams reduce the quantity and quality of riparian habitat on shorelines. Most species of upland game birds nest on the ground, and their nests are sometimes subject to inundation and failure. Water fluctuations and waves also decrease beaver and muskrat production by alternating flooding and exposing dens.

Mule deer in the subbasin often use islands as a location to give birth. Does likely select islands because of the security from land predators, primarily coyotes. The use of islands, in this subbasin, by mule deer is limited by the scarcity and small size (due to erosion) of islands, the formation of land bridges during low water, and inundation during high water levels.

Land Management Practices and Land Prices

Dry-land farming and extensive livestock grazing of open range land has eliminated and degraded shrub-steppe habitat and much of the riparian zone within the Lower Mid-Columbia Mainstem subbasin. Irrigated agriculture has also reduced habitat diversity and wildlife abundance through the creation of monocultures. In addition, forest practices have reduced the availability and quality of habitat. The development of the Columbia Basin Irrigation Project converted vast acreage of former shrub-steppe habitat to irrigated farming, and created a connected system of waterways and seepage areas unsuitable for farming. Generally, these areas are degraded and in need of restoration, but may be suitable to replace some functions of lost mainstem riparian zones.

Opportunities to restore wildlife populations and improve habitat diminish over time as habitat loss and degradation continue. Further, land prices continue to rise, making it more economically difficult to preserve remaining undeveloped lands for wildlife and fish.

Nutrient Cycling & Food Webs

Continued decline in populations of salmon and other fish species results in loss of overall biomass being contributed to the subbasin. This reduction has negative effects on wildlife abundance. The dramatic declines in some native wildlife species, particularly blacktail jackrabbits *Lepus californicus* and Washington ground squirrels may have contributed to the decline of associated predators such as ferruginous hawks.

Human Disturbance

Urban expansion, highway traffic, free-ranging dogs, noise pollution, light pollution, etc. can disturb wildlife populations and limit wildlife usage of quality habitat areas. In both the Columbia River and “off-river” parts of the subbasin, human disturbance during brood-rearing period reduces waterfowl and colonial nesting bird production. Mammals such as beaver also suffer high mortality from being hit by trains and cars because of the proximity of highways and railroads to the shoreline of the Columbia River.

Human recreation within the shrub-steppe communities may significantly affect nesting of ferruginous hawks, bald eagles, waterfowl, and many colonial nesting birds. Bald Eagles and American white pelicans are particularly sensitive to boating activities, with juvenile eagles being more sensitive to human activities than adults (Brett Tiller, PNNL, unpublished data).

Effects of Breeding, Transplants, and/or Introductions

The spread of non-native plant and wildlife species is a threat to wildlife habitat quality and to wildlife species themselves. For example, noxious weeds threaten the quality of deer and elk winter range. Milfoil *Myriophylum* spp. is common in the slow-water areas and the benefits and consequences to various vertebrate wildlife is not well understood.

Of particular importance is the invasion of riparian habitats by invasive exotic plant species such as Russian olive. The increase in Russian-olive may indirectly affect wildlife survival by increasing populations of predators such as coyotes and black-billed magpies. Within the adjacent upland areas, the acreage of sagebrush cover is even further reduced by the spread of cheatgrass, which increases fire frequency and magnitude while lengthening the recovery period following larger event.

The bullfrog is another introduced species whose preferred habitat parallels conditions found in the mainstem Columbia River. Numerous studies have shown that bullfrogs out-compete and contribute to the decline of native amphibians due to aggressive behavior, rapid growth rate, and predation (Corkran and Thoms 1996).

At locations away from the Columbia River in this subbasin, duck brooding habitat quantity and quality is limited by wetland succession (e.g., late successional stages characterized by low percent of open water) and high densities of carp. Carp compete with ducklings and other wildlife for invertebrate and submergent aquatic foods.

Fish

Water Quality

While construction and operation of dams and reservoirs within the subbasin have not produced a significant change in average water temperature, upstream storage projects have resulted in a temperature phase shift (Jaske and Goebel 1967). Historical records indicate that fall chinook salmon returning the mid-Columbia River may spawn as much as one month later than populations did at the beginning of the nineteenth century (DeVoto 1953). The effects of a later spawning time on the emergence timing and availability of aquatic food web resources is unknown.

Hydropower System Development and Operations

Hydroelectric development has transformed most fast-moving mainstem riverine habitats into slow-moving reservoir impoundments. Construction of McNary, John Day, and The Dalles dams inundated 200 km of fall chinook salmon spawning habitat in the Mainstem Columbia River (Van Hyning 1973). Today, only the Hanford Reach remains unimpounded and provides the majority of mainstem spawning habitat for fall chinook salmon.

In the Columbia River, flow regimes are highly regulated by the hydroelectric complex and seasonal discharge is influenced by water storage and water use practices (Ebel et al. 1989). Flow regulation hinders fish passage, alters food webs, promotes proliferation of exotic plant species, and alters connections among groundwater, floodplains, and surface water (Stanford et al. 1996), or convergence zones (hyporheic habitats) where biodiversity and bioproduction are frequently high (Stanford and Ward 1993). The relative magnitude and frequency of high flow events also acts to modify channel form, but only within constraints of existing geological features. For example, major floods are less frequent because of upstream flood-control projects constructed since the 1940s. This change is significant because rivers that flood frequently maintain different species and food webs from systems that are more ecologically benign (Stanford et al. 1996).

An important limiting factor associated with hydropower development is downstream and upstream passage of anadromous salmonids and white sturgeon at dams. Passage problems will not be emphasized here; rather, they are dealt with at greater length in other documents.

Operation of the hydropower system and conversion of the majority of the Mainstem Columbia River to reservoirs has resulted in a major decrease in the abundance of mountain whitefish and Pacific lamprey and has limited the spawning success of white sturgeon in the The Dalles, John Day, and McNary reservoirs. The loss of production of benthic insects associated with riverine habitat in the reservoirs is the probable cause for the extremely low abundance of mountain whitefish (WDFW, unpublished data). Reduced spring and summer discharges have decreased the amount of spawning habitat available for white sturgeon, and construction of dams inundated several rapids and falls that probably provided spawning habitat. The Columbia Basin Pacific lamprey work group (CBPLTWG 1999) identified habitat of juvenile and adult life histories as a critical uncertainty. Ongoing projects have focused on evaluating population status in tributaries (Hatch and Parker 1998) and passage requirements at mainstem dams (Mesa et al. 2000; Moursund et al 2000). However, there have been no studies to assess the relative importance of mainstem habitats on the spawning and rearing of Pacific lampreys.

Predation

Of the 50 fish species known to inhabit the mainstem Columbia River between The Dalles and Wanapum dams, 20 are exotic. Of primary concern are species that may compete with or prey on native species, especially salmonids.

Predator-prey relations have been altered by development of the hydropower system in many ways. Primary predators of juvenile salmonids in the Columbia River include northern pikeminnow, smallmouth bass, and walleye. Although northern pikeminnow are a native species and have always preyed on juvenile salmonids, development of the hydropower system has increased the level of predation. Dams have slowed water velocity and decreased turbidity, effects that have increased exposure time of juvenile salmonids to predators and increased predation success. Development of the hydropower system has also resulted in extended periods of warm water, and therefore increased predator activity and consumption. Dams concentrate juvenile salmonids in forebays and tailraces, and fish in tailraces are disoriented from passage through or around turbines, spillways, or bypass systems, further increasing their vulnerability to predation.

Petersen (1994) estimated the annual loss of juvenile salmonids to predation by northern pikeminnow in John Day reservoir to be 1.4 million, approximately 7.3% of all juvenile salmonids entering the reservoir. Rieman et al. (1991) determined that northern pikeminnow accounted for 78% of the loss of juvenile salmonids to fish predators. Ward et al. (1995) estimated predation on juvenile salmonids by northern pikeminnow relative to that in John Day reservoir to be approximately 190% in The Dalles reservoir and 50% in McNary reservoir.

Predation on juvenile salmonids by northern pikeminnow has decreased since implementation of the Northern Pikeminnow Management Program in 1990 (Beamesderfer et al. 1996; Friesen and Ward 1999). From 1992 through 1999, annual exploitation rate of northern pikeminnow longer than 250 mm fork length has averaged approximately 11.4% in The Dalles Reservoir, 5.2% in John Day Reservoir, and 15.3% in McNary Reservoir and the Hanford Reach combined. Friesen and Ward (1999) estimate that predation by northern pikeminnow has decreased approximately 25%, with no compensation by walleye or smallmouth bass.

Smallmouth bass and walleye are both known to prey upon juvenile salmonids and other native fish. Smallmouth bass are responsible for only a small amount of the predation on juvenile salmonids in Columbia River reservoirs (Rieman et al. 1991); however, they may become more important predators when wild subyearling chinook salmon are abundant in late spring and early summer (Tabor et al. 1993). Individual walleye consume as many juvenile salmonids as individual northern pikeminnow (Rieman et al. 1991); however, abundance of walleye is far lower than abundance of northern pikeminnow (Beamesderfer and Rieman 1991).

Food Webs

The transformation of the mainstem Columbia River into a series of reservoirs has altered the food webs that support juvenile salmonids and resident fish. Juvenile fall chinook salmon eat primarily adult and larval midges (Diptera), caddis flies (Trichoptera), and mayflies (Ephemeroptera) (Becker 1973; Dauble et al. 1980; USGS unpublished data), but in the McNary reservoir juveniles consume primarily midges, terrestrially-derived insects, and zooplankton (Rondorf et al. 1990; USGS unpublished data). The limitation imposed by altered reservoir food bases is an increased foraging cost to consume smaller, less energetically profitable zooplankton. Two factors may further limit the use of zooplankton as a food resource. First is the proliferation of *Neomysis mercedis,* an estuarine mysid, in mainstem reservoirs. *Neomysis mercedis* is related to *Mysis relicta*, which has decimated zooplankton communities in coldwater lakes and reservoirs in the western United States (Nessler and Bergersen 1991). It is unknown whether *Neomysis mercedis* eat zooplankton in Columbia River reservoirs. Second is the rapid increase in the American shad population in the last decade. Juvenile American shad are planktivorous and may compete with late-migrating fall chinook salmon for food resources.

8 Management Plan

Introduction

The management plan integrates the vision for the Lower Mid-Columbia Mainstem (including Rock Creek) Subbasin with the assessment and inventory sections of this document. That vision for the subbasin extends over 10 to 15 years and represents local policy input to the subbasin plan. The selection of objectives and strategies for restoration of fish and wildlife habitat and populations which form the bulk of the management plan is derived from that input.

The scope of the management plan is somewhat narrower than the scope of the assessment or the inventory. The assessment and inventory are designed and may be used to guide restoration and management actions by many parties under their own authorities in the course of ongoing efforts to protect and enhance the fish and wildlife populations and the aquatic and terrestrial ecosystems that exist within the Lower Mid-Columbia Mainstem Subbasin. The management plan is based on the assessment and inventory, but is specifically designed to act as a draft amendment to the Columbia Basin Fish and Wildlife Program, and to be reviewed and approved by the Northwest Power and Conservation Council (NPCC).

The management plan outlines biological objectives and strategies that the planners feel would most efficiently address primary limits to fish and wildlife production in the subbasin. That road map allows the NPCC and BPA to more effectively meet their obligations in the subbasin to mitigate and protect resources affected by the construction and operation of the Federal Columbia River Power System. As such, it is non-regulatory in nature, and is based on the use of BPA ratepayer funds to construct or improve existing infrastructure, to acquire land or protective easements as a means of habitat protection, to fund personnel to improve management of natural resources, to monitor and research the relationships between management actions and the health of the resource, and to fund other actions that protect or restore the health of natural resources that have been negatively impacted by the FCRPS.

This management plan was developed in a relatively short time frame, as the Klickitat, White Salmon and Lower Mid-Columbia Mainstem were among the last subbasins to get started in the NPCC subbasin planning process. This plan was developed with a minimal budget of less than $37,000 and is limited in geographic scope to the north side of the Lower Mid-Columbia Mainstem segment of the Columbia River from the mouth of the Walla Walla River to the mouth of the White Salmon River. Reasons for the limited geographic scope are:

- Unknown management strategies for the Hanford Reach Monument, because the U.S. Fish and Wildlife Service process of developing a management plan for the Reach has not progressed sufficiently to provide guidance to the subbasin planners;
- Uncertainty about the Federal Energy Regulatory Commission determination in response to Grant County PUD’s application to relicense the Priest Rapids Hydroelectric Project, which was filed on Oct. 29, 2003; and
- Lack of current information about the Oregon side of the river other than inventory information supplied by ODFW.

The traceable logic displayed below in table form focuses on strategies that benefit focal wildlife species that inhabit the subbasin's terrain, on three focal fish species that utilize mainstem tributaries Rock, Pine and Glade creeks and on mainstem dwelling white sturgeon. Aside from those directed at white sturgeon, there are few mainstem strategies or habitat-directed high priorities identified in the subbasin planning process.

8.1.1 Vision

We envision healthy self-sustaining populations of fish and wildlife indigenous to the Columbia Basin that support harvest and other purposes. Decisions and recommendations will be made in a community based, open and cooperative process that respects different points of view, and will adhere to all rights and statutory responsibilities. These efforts will contribute to a robust and sustainable economy.

8.1.2 Biological Objectives and Strategies

The Technical Guide for Subbasin Planners recommends that the Management Plan contain the following elements biological objectives and strategies.

Biological Objectives should:

- Be consistent with basin-level visions, objectives, and strategies adopted in the program.
- Be based on the subbasin assessment and resulting working hypothesis.
- Be consistent with legal rights and obligations of fish and wildlife agencies and tribes with jurisdiction over fish and wildlife in the subbasin, and agreed upon by co-managers in the subbasin. Where there are disagreements among co-managers that translate into differing biological objectives, the differences and the alternative biological objectives should be fully presented.
- Be complementary to programs of tribal, state and federal land or water quality management agencies in the subbasin.
- Be consistent with the Endangered Species Act recovery goals and Clean Water Act requirements as fully as possible.
- Be quantitative and have measurable outcomes.

Strategies must:

- Explain the linkage of the strategies to the subbasin biological objectives, vision and the subbasin assessment Explain how and why the strategies presented were selected over other alternative strategies (e.g. passive restoration strategies v. intervention strategies)
- Describe a proposed sequence and prioritization of strategies
- If necessary, describe additional steps required to compile more complete or detailed assessment

This subbasin plan identifies management actions that promote compliance of the federal Endangered Species and the Clean Water acts. None of the recommended management strategies are intended nor envisioned to compromise or violate any federal, state or local laws or regulations. The intent of these management strategies is to provide local solutions that will enhance the intent and benefit of these laws and regulations. The Council, Bonneville, NOAA Fisheries and the U.S. Fish and Wildlife Service (USFWS) intend to use adopted subbasin plans to help meet requirements of the 2000 Federal Columbia River Power System Biological Opinion. NOAA Fisheries and the USFWS have stated their intent to use subbasin plans as a foundation for recovery planning for threatened and endangered species.

Planners chose to use tables to link observed effects in the basin to working hypotheses (potential causes of the effect); hypotheses to objectives (to address the cause of the effect); objectives to strategies (to reverse the cause); or effect to strategies (to mitigate the effect if the cause could not be reversed).

These tables are designed to condense the information in the assessment so that the logic path from key finding to strategy can be more easily discerned.

8.1.3 Management Plan Matrixes -- Identification of Subbasin Goals and Strategies for Fish and Wildlife

The Lower Mid-Columbia Mainstem Subbasin (including Rock Creek) management plan strategies are based on an assessment of the needs of eight focal wildlife species, three focal fish species that utilize mainstem tributaries Rock, Pine and Glade creeks and on mainstem-dwelling white sturgeon. Aside from those directed at white sturgeon, there are few mainstem strategies identified in this subbasin planning process. The other focal fish species identified as being of special significance are steelhead, fall chinook and coho. The Pacific lamprey was chosen as a fish species of special interest.

The focal wildlife species for the Rock Creek watershed are western gray squirrel, mule deer, grasshopper sparrow, Brewer’s sparrow, white headed woodpecker, Lewis’ woodpecker, beaver, and the yellow warbler. Wildlife strategies were devised based on the condition, availability and potential for restoration of a variety of focal habitat types. Those habitats are interior riparian-wetlands, interior grasslands, shrub steppe and ponderosa pine/Oregon white oak.

A primary need initially is for implementation of ongoing monitoring and evaluation within Rock Creek watershed. There is a high level of certainty associated with several key findings and strategies, but without concerted monitoring and evaluation there is a margin of uncertainty about whether the best strategies achieve the highest possible benefit. Actions suggested in the management plan matrixes below include an extensive monitoring and evaluation effort within Rock Creek that is considered a high priority.

There are a few useful working understandings of Rock Creek watershed that provide context for the planning matrixes. First, changes in land cover as a result of logging, road building and other activities has increased fine sediment delivery in Rock Creek and other subbasin streams. Second, peak flows have subsequently been increased. Third, wetted perennial area in the lower watershed has decreased. Fourth, riparian function in the lower watershed has significantly decreased due to loss of riparian vegetation, hydromodification, and altered channel structure. Fifth, high water temperatures in the lower watershed are extensive and at times lethal.

For terrestrial/wildlife habitat (not necessarily in order of importance) known limiting factors include: 1) reduction in native vegetation; 2) extensive conversion of native habitats (especially shrub steppe); 3) reduction in large diameter, late seral trees, snags, and large woody debris; 4) increased stand and stem densities (increased fuel load), and 5) fragmentation of wildlife habitat, and 6) reduction in floodplain acreage.

Numerous strategies identified during the subbasin planning process and outlined in management plan's matrixes aim to contribute beneficially to limiting factors in Rock Creek and elsewhere in the subbasin. For instance, there are several actions that focus on riparian function (reconnect side channels, re-establish or enhance native vegetation, increase channel roughness, artificially introduce large woody debris as well as implement practices that allow large woody debris to naturally enter and remain in the system).

These actions would help lower stream temperatures, increase wetted perennial areas in the lower watershed, improve food availability, filter fine sediment levels, attenuate peak flows as well as other environmental benefits. Ideally, a suite of complementary actions would be implemented through project proposals.

The plan matrixes call for an evaluation of Rock Creek steelhead genetics to determine the level of competition there has been between hatchery and wild fish that are part of the Mid-Columbia "evolutionarily significant unit" listed as threatened under the Endangered Species Act. It also outlines strategies for improving the survival of steelhead kelts, mature, spawned out fish that have the potential to spawn again.

Other primary strategies are for an evaluation of lamprey habitat needs and the implementation of restoration actions.

Water quality in the watershed is impacted by increased sedimentation, which can negatively affect steelhead and salmon egg incubation and rearing. Strategies are to assess the relative contribution of the various sources of that increased sedimentation and implement action to reduce sedimentation. Those actions include improved road and off-road vehicle management and the implementation of upland management practices that mimic natural runoff and sediment production.

Factors limiting the productivity of the white sturgeon are, in most respects, related to the existence and operation of the mainstem hydrosystem. Spawning occurs in the mainstem but is limited by hydrograph and water temperatures. The sturgeon are, typically, impounded in individual reservoirs instead of being able to migrate freely as they did historically. Those impounded populations are less productive, more prone to year-class failure and their eggs and larvae more subject to predation than under historic conditions. The population is effectively fragmented with little migration between reservoirs; a majority of the migration that does occur is from upstream reservoirs to reservoirs lower in the Columbia River.

Strategies offered in this document's management plan suggest hydrosystem operational shifts that are expected to increase spawning and first-year survival. This plan urges the supplementation of less productive populations by capturing juveniles below the lowermost dam in the system, Bonneville, then transporting and releasing them upstream.

A general theme across the subbasin is a reduction in the quantity and quality of all types of wildlife habitat that the focal and other species need to flourish.

Riparian wetlands have been lost as floodplain habitats have been converted to human uses. That loss of riparian wetland habitat structure and hydrology reduces ecological function.

This plan's objectives and strategies recommend efforts to restore riparian wetland habitat in order to bring benefit to both fish and wildlife. Those actions involve both restoring habitat by increasing native vegetation and creating adequate hydrological conditions to reconnect habitats in tributary and mainstem floodplain areas.

Primary strategies in both the fish and wildlife portions of this management plans are strategies to restore beaver habitat and, where possible, to prepare for reintroduction of a species whose numbers are greatly reduced from historic levels. The restored habitat would benefit beaver, whose activities would in turn benefit the salmon and steelhead that spend a portion of their life histories in the watershed. Beaver dams result in the creation of off channel habitat and increased channel stability, which would provide a benefit to the fish focal species that utilize the Rock Creek watershed.

Among the causes of the diminution and fragmentation of shrub steppe habitat are agriculture and other human development, altered fire frequencies and invasive weed species. Habitat quality can be improved by supplementing the ability to control fires, restoring more natural fire cycles, encouraging appropriate grazing practices, prioritizing weed control areas, and implementing native plant restoration. Restoration and protection of habitats are key strategies.

Habitat quality and ecological function in Ponderosa pine/Oregon white oak habitat has been reduced because of altered forest species composition and age structure. Harvest practices have resulted in removal of late seral stands and large overstory trees across the landscape.

Objectives for the ponderosa pine/Oregon white oak habitat include retaining any existing late seral stands and large decadent wildlife trees and managing stands to restore functional habitat. Such strategies include identifying areas where thinning and/or prescribed burning would help achieve habitat objectives and thinning appropriate stands to decrease stand density.

The matrixes for focal fish species have been developed in consideration of the assessment's key uncertainties table as well as the reach assessment forms. The wildlife matrixes were similarly constructed, though in the context of focal species in three focal habitat types. The intent of each matrix is to present actions and strategies that may be implemented to address the key findings and limiting factors. Furthermore, to the extent possible, appropriate geographical locations were identified for certain actions and strategies. The geographical locations were then designated as a primary or secondary tier action area. The definitions for these designations are provided at the head of the wildlife and fish management plan matrixes.

Generally, areas and actions identified in the primary tier category are able to be implemented within the next five years and have a high likelihood of achieving the targeted biological effect. The white matrixes are ordered according to the confidence level associated with strategy. The geographical areas in the primary tier of the fish and wildlife matrixes are the most appropriate areas for that strategy to be employed. The actions identified in the secondary tier category may not be implementable within five years, may have less likelihood of achieving a targeted biological effect, and may be a geographical area for which a particular action is less important than primary tier locations.

Because the Rock Creek watershed has had no extensive, continuous monitoring and evaluation in place, much of the knowledge about the watershed originated from unpublished Yakama Nation data, field observations by Yakama Nation and WDFW personnel, and remote methods such as GIS and orthophoto analysis. QHA was initiated in the Rock Creek watershed, but the quick execution of the subbasin planning process did not afford development of a deliberate, open and cooperative process to discuss and come to consensus with the numerous assumptions necessary in providing rankings for the model.

The observed high numbers of steelhead redds within the lower miles of Rock Creek (35-45 per mile), as well as the extensive distribution of redds throughout the watershed suggest a need for modeling of abundance and capacity within the watershed. EDT is the best tool currently available for that purpose. EDT modeling in the Rock Creek watershed would provide a significant contribution to the understanding and future opportunities within the Rock Creek watershed. It was within the basic EDT definitions and approach that the reach assessment forms were produced. Therefore, when particular reaches are identified they have had a preliminary application of the EDT conceptual framework applied to them. For wildlife a lack of extensive species and habitat monitoring and evaluation also exists, so key findings, limiting factors and proposed actions were created using best scientific judgment with the help of local, residential knowledge.

In general, the strategies in the fish management plan matrix attempt to address the above-mentioned five working understandings of the watershed. Biological objectives were not identified because insufficient data and confidence was present for technical committee and planning committee members to identify quantitative measures. Some objectives may have been more clearly identified with a longer planning timeline, with the goal of reaching physical habitat capacities, but were unavailable within the current limitations.

Therefore, the left column of the fish matrixes contains strategies and types of actions that address key findings rather than quantitative biological objectives. New assessment activities, comprehensive monitoring and evaluation, and an EDT analysis would be necessary to present quantitative biological objectives with a high level of confidence.

8.2 Wildlife

8.2.1 Interior Riparian Wetlands Objectives and Strategies

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Table 41 Wildlife objectives and strategies for Interior Riparian Wetlands

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	**O = Objective**	**FO = Field Observation**	**R = Research Literature**
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**
	F=From Fish Data	**L = Local Residential Information**	**H = Habitat Database**

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	**Secondary**	
O: Restore riparian habitat quality by increasing native vegetation in degraded riparian habitat. S: Develop and continue riparian weed control programs.	Displacement of Native Riparian Vegetation by Non-Native Vegetation	Rock Creek 2, 3 and 4, Luna Gulch, Squaw Creek 1 and 2, Badger Gulch Gilliam and Sherman counties, Oregon	Rock Creek 5, Squaw Creek 2, Badger Gulch Lower mid-Columbia mainstem	F (locations), I

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	**Secondary**	
O: Slow stream flow, restore water table, repair stream banks, restore riparian vegetation and reconnect floodplain. S: Use lease, easement or purchase practices to protect functioning floodplain areas and streams. S: Reintroduce beavers, plant native vegetation and reintroduce large woody debris.	Incised Stream Reaches	Rock Creek 2, 3 and 4 Washington: identify and prioritize other key areas for stragegy application in subbasin Oregon and the mainstem:: identify and prioritize key areas for stragegy application	Rock Creek 6, Quartz Creek 1, Quartz Creek 2, Box Canyon Upper Watershed Roads	F (locations), I
O: Restore ecologically functional floodplain/riparian wetland habitats. S: Inventory roads near riparian habitat and assess impacts to determine problem areas in need of resolution. S: Implement restoration activities in the subbasin.	Reduction in Floodplain Acreage.			F (locations), I
O: Protect all riparian buffers from inappropriate timber harvesting. O: Utilize timber harvesting to enhance degraded riparian buffers. S: Create/implement guidelines to retain and enhance riparian buffers to a functional status.	Upper Watershed Hydrologic Alteration			F (locations), I
O: Increase large woody debris presence in riparian buffers. S: Promote silviculture practices that retain large woody debris within riparian buffers. S: Place large woody debris.	Loss of Stream Complexity and Increased Flows	Throughout watershed, excluding Rock Creek 6, Quartz Creek 1 and 2, Box Canyon Rock Creek 2, 3 and 4 Gilliam and Sherman counties	Luna Gulch, Squaw Creek 1	F (locations)

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
O: Restore and protect remaining riparian buffers from conversion. S: Utilize purchase easements, leases or agreements, for landowners to restore or protect riparian vegetation (e.g. Farm Program partner, etc.).	Loss of Riparian Habitat and Function Fragmentation of Habitat	Rock Creek 2, 3, 4 and 5, Luna Gulch, Squaw Creek 1 Gilliam and Sherman counties		F (locations), I
O: Restore native riparian tree and shrub habitats degraded by inappropriate grazing. S: Provide incentives through easements, leases or agreements, for landowners to manage livestock in such a way to provide for riparian vegetation restoration (e.g., farm programs).	Overall Loss of Riparian Vegetation	Rock Creek 2, 3 and 4, Squaw Creek 1 Gilliam and Sherman counties		B

8.2.2 Interior Riparian Wetlands Focal Species (Yellow Warbler, American Beaver and Lewis' Woodpecker)

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Yellow Warbler

Table 42 Objectives and strategies for Interior Riparian Wetlands—Yellow Warbler

TIER DEFINITIONS	**Project or Actions:**	**Primary—Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary—Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**		**R = Research Literature**
	S = Strategy	**B = Best Professional Judgment**		**I = Information Needed**
	F=From Fish Data	**Linda = Local Residential Information**		**H = Habitat Database**
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Increase quality and quantity of habitat for yellow warblers. O: Restore yellow warbler population numbers to historic levels. S: Inventory existing and potential yellow warbler habitat. S: Create/retain optimal habitat (see assessment).	Reduction in Floodplain Acreage Overall Habitat Loss Fragmentation of Habitat	Washington: Identify and prioritize key areas for stragegy application in subbasin	Oregon: Identify and prioritize key areas for strategy application	I,R

O: Reduce mortality of food base (insects), needed by yellow warblers, from chemical applications. S: Use alternative control measures for undesirable species in riparian buffers, especially in areas used by yellow warbler.	Reduced Food Base	Washington: Identify and prioritize key areas for stragegy application	Oregon: Identify and prioritize key areas for strategy application	I

American Beaver

Table 43 Objectives and strategies for Interior Riparian Wetlands—American Beaver

TIER DEFINITIONS	Project or Actions:	Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	O = Objective	FO = Field Observation		RL= Research Literature
	S = Strategy	B = Best Professional Judgment		I = Information Needed
	F = From Fish Data	L = Local Residential Information		H = Habitat Database
Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
O: Provide suitable habitat for beaver where they were historically found. S: Inventory existing and potential beaver habitat. S: Create optimal habitat (see assessment).	Overall Loss of Riparian Vegetation Fragmentation of Habitat Reduction in Mean Annual Floodplain Acreage	Throughout Rock Creek watershed, in appropriate habitat Oregon: Identify and prioritize key areas for strategy application		F
O: Restore beaver populations to historical levels. S: Reintroduce beaver where/when appropriate.		Throughout Rock Creek watershed, in appropriate habitat. Oregon: Identify and prioritize key areas for strategy application		F

Lewis' Woodpecker

Table 44 Objectives and strategies for Interior Riparian Wetlands—Lewis' Woodpecker

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**		
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.		
CODES:	**O = Objective**	**FO = Field Observation**	**R= Research Literature**	
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**	
		L = Local Residential Information	**H = Habitat Database**	
Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Increase quantity and quality of habitat for Lewis' woodpecker. O: Restore Lewis' woodpecker population numbers to historic levels. S: Inventory existing and potential Lewis' woodpecker habitat. S: Create optimal habitat (see assessment).	Reduction in Floodplain Acreage Fragmentation of Habitat Overall Loss of Riparian Vegetation	Washington: Identify and prioritize key areas for stragegy application	Oregon: Identify and prioritize key areas for strategy application	I,R
O: Reduce mortality of food base (insects), needed by yellow warblers, from chemical applications. S: Use alternative control measures for undesirable species in riparian buffers, especially in areas used by yellow warbler.	Reduced Food Base	Washington: Identify and prioritize key areas for stragegy application	Oregon: Identify and prioritize key areas for strategy application	I

8.2.3 Shrub Steppe/Interior Grasslands Habitat Objectives and Strategies

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Table 45 Wildlife objectives and strategies for Shrub Steppe/Interior Grasslands Habitat

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	**O = Objective**	**FO = Field Observation**	**RL= Research Literature**
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**
		L = Local Residential Information	**H = Habitat Database**

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	**Secondary**	
O: Protect remaining deep-soil shrub steppe sites S: Use lease, easement or purchase practices to protect high quality areas from land-use conversion	Loss of Shrub Steppe /Grassland Habitat	Areas throughout southern half of Rock Creek watershed Gilliam and Sherman counties		B
O: Restore habitats that provide the function attributes of shrub steppe and grasslands. S: Augment or support conservation oriented farm programs (e.g., CRP; BiOp RMS in Oregon).	Loss of Shrub Steppe /Grassland Habitat	Areas throughout southern half of Rock Creek watershed. Gilliam and Sherman counties		B

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
O: Limit expansion of invasive non-native plants and reduce occurrence. O: Restore native plant communities. S: Reduce sources of introduction of non-native seed. S: Continue and enhance shrub steppe/grassland weed control programs, for early identification and to remedy localized heavy infestations.	Displacement of Native Vegetation with Non-Native Vegetation	Washington and Oregon: Identify and prioritize key areas for strategy application in subbasin		I
O: Restore more natural fire cycles to increase mean age class of shrub steppe and restore areas of complete shrub loss where it has been altered by fire. S: Suppress fire by fighting wildfires. S: Reduce amounts of cheatgrass.	Reduction in Age Class, or Complete Loss, of Shrub Steppe Vegetation	Washington and Oregon: Identify and prioritize key areas for strategy application in subbasin		I
O: In areas of inappropriate grazing, improve vegetation and microbiotic crusts. S: Encourage and support Coordinated Resource management Programs (e.g., CRP; BiOp RMS). S: Avoid inappropriate grazing of livestock through rotational grazing regimes. S: Use proper grazing to reduce sagebrush cover to natural cover %ages where excessive.	Loss of Habitat Quality	Squaw Creek 1, Luna Gulch, other unidentified areas in Washington Gilliam and Sherman counties		L, I
O: Maintain current ephemeral wetlands in natural condition and where possible restore disturbed areas to natural function. S: Create inventory of historical and current locations of ephemeral wetlands. S: Augment or support conservation oriented	Loss of Ephemeral Wetlands	Washington: Identify and prioritize key areas for strategy application in the subbasin	Oregon: Identify and prioritize key areas for strategy application in the subbasin	I

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
farm programs (e.g., CRP).				
O: Reduce off road vehicle damage in high trespass areas. S: Remove access of off road vehicles to sensitive areas and enforce closures. S: Create public education programs.	Vegetation and Soil Damage	Upper Luna Gulch, Quartz Creek 1 and 2.		L

8.2.4 Shrub Steppe/Interior Grasslands Focal Species (Mule Deer, Grasshopper Sparrow, and Brewer's Sparrow

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Mule/Black-Tailed Deer

Table 46 Objectives and strategies for Shrub Steppe/Interior Grasslands Habitat -- Mule/Black-Tailed Deer

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	**O = Objective**	**FO = Field Observation**	**R = Research Literature**
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**
	F=From Fish Data	**L = Local Residential Information**	**H = Habitat Database**

Target Objectives and Strategies	**Associated Limiting Factor**	**Tier Rankings by Geographical Areas**		**Source**
		Primary	**Secondary**	
O: Provide quality habitat for deer. S: Augment or support conservation oriented farm programs (e.g., CRP). S: Fire suppression by fighting wildfires. S: Reduce amounts of cheatgrass. S: Use fire, along with understory thinning, to enhance forage in woodland/grassland transition zones.	Loss of Shrub Steppe Habitat Within Winter Range Reduction in Age Class, or Complete Loss, of Shrub Steppe Vegetation	Washington and Oregon: Identify and prioritize key areas for strategy application in the subbasin	Oregon: Identify and prioritize areas for strategy application	I
O: Limit inappropriate mortality from hunting. S: Continue responsible hunting management practices in subbasin.	Hunting Mortality	Throughout Rock Creek		R

Grasshopper Sparrow

Table 47 Objectives and strategies for Shrub Steppe/Interior Grasslands Habitat -- Grasshopper Sparrow

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	**O = Objective**	**F = Field Observation**	**R = Research Literature**
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**
	F = From Fish Data	**L = Local Residential Information**	**H = Habitat Database**

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
O: Increase quantity of habitat for grasshopper sparrow. S: Inventory existing and potential grasshopper sparrow habitat. S: Augment or support conservation oriented farm programs (e.g., CRP).	Loss of Grassland Habitat within Breeding Range	Washington: Identify and prioritize important areas for strategy application Oregon: Identify and prioritize key areas for strategy application in the subbasin		I
O: Increase quality habitat for grasshopper sparrow. O: Create habitats that provide the functional	Loss of Grassland Habitat Quality Displacement of Native	Washington: Identify and prioritize important areas for strategy application		I,R

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
attributes of grasslands. S: Create / retain optimal habitat for the species (see assessment). S: Use proper grazing to reduce sagebrush cover to natural cover percentages where excessive. S: Augment or support shrub steppe / grassland weed control programs.	Vegetation with Non-Native Vegetation	Oregon: Identify and prioritize key areas for strategy application in the subbasin		

Brewer's Sparrow

Table 48 Objectives and strategies for Shrub Steppe/Interior Grasslands Habitat -- Brewer's Sparrow

TIER DEFINITIONS	Project or Actions:	Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	O = Objective	FO = Field Observation	R = Research Literature
	S = Strategy	B = Best Professional Judgment	I = Information Needed
	F = From Fish Data	L = Local Residential Information	H = Habitat Database

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
O: Increase quantity of habitat for Brewer's sparrow. O: Restore Brewer's sparrow population numbers to historic levels. S: Inventory existing and potential Brewer's sparrow habitat. S: Augment or support conservation oriented farm programs (e.g., CRP). S: Use lease, easement or purchase practices to protect high quality areas from land-use conversion.	Loss of Shrub Steppe Habitat within Breeding Habitat	Washington: Identify and prioritize key areas for strategy application in the subbasin	Oregon: Identify and prioritize key areas for strategy application in the subbasin	I
O: Increase quality of habitat for Brewer's sparrow. O: Lengthen fire cycles and reduce loss of Brewer's sparrow habitat by catastrophic fire. S: Avoid inappropriate grazing of livestock through rotational grazing regimes. S: Augment or support shrub steppe/grassland weed control programs. S: Fire suppression by fighting wildfires. S: Reduce amounts of cheatgrass.	Loss of Shrub Steppe Habitat Quality Displacement of Native Vegetation with Non-Native Vegetation	Washington: Identify and prioritize key areas for strategy application in the subbasin	Oregon: Identify and prioritize key areas for strategy application in the subbasin	I,R

8.2.5 Ponderosa Pine/Oregon White Oak Habitat Objectives and Strategies

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Table 49 Wildlife objectives and strategies for Ponderosa Pine/Oregon White Oak Habitat

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	**O = Objective**	**FO = Field Observation**	**R = Research Literature**
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**
	F = From Fish Data	**L = Local Residential Information**	**H = Habitat Database**

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	**Secondary**	
O: Increase average dbh and decrease understory density. S: Encourage silviculture practices that retain large diameter trees and reduce understory density.	Reduction of Large Diameter Trees and Snags	Throughout upper Rock Creek watershed, data gaps		I
O: Retain late seral stands and large decadent trees. S: Create/implement guidelines to retain specified number of large diameter, decadent live trees.	Reduction of Large Diameter Trees and Snags	Throughout upper Rock Creek watershed, data gaps		I

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
O: Decrease stand density of ponderosa pine. O: Decrease stem density of ponderosa pine. S: Reduce fuel loads through forestry practices. S: Reintroduce low intensity, controlled, site-specific fires. S: Manage grazing and forest practices that mimic fire, when necessary.	Increased Stand Density and Decreased Average Tree Diameter	Upper Rock Creek watershed, data gaps		I
O: Retain existing tracts of late seral forests and reduce future fragmentation. S: Continuation of conservation oriented programs on small private land holdings. S: Use lease, easement or purchase practices to conserve remaining intact pine/oak forests.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Upper Rock Creek watershed, data gaps.		I
O: Reduce non-native species presence and reestablish native plant communities. S: Site-specific grazing management plans for habitat improvement, including reduction of non-native species and reestablishment of native species.	Loss of Native Understory Vegetation and Composition	Washington: Identify and prioritize key areas for strategy application in the subbasin		I

8.2.6 Ponderosa Pine/Oregon White Oak Focal Species (Western Gray Squirrel and White-Headed Woodpecker)

Biological Objectives and Strategies and Tier Rankings by Geographical Areas

Western Gray Squirrel

Table 50 Objectives and strategies for Ponderosa Pine/Oregon White Oak Habitat -- Western Gray Squirrel

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	**O = Objective**	**FO = Field Observation**	**R = Research Literature**
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**
	F=From Fish Data	**L = Local Residential Information**	**H = Habitat Database**

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
O: Increase quantity of western gray squirrel habitat. S: Increase compliance with forest guidelines for western gray squirrels. S: Retain remaining large, unfragmented tracts of western gray squirrel habitat.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Washington: Identify and prioritize key areas for strategy application in the subbasin		I
O: Increase quality of western gray squirrel habitat. S: Use site-specific fire prescriptions to enhance potential and used western gray	Increased Stand Density and Decreased Average Tree Diameter Loss of Native Understory	Washington: Identify and prioritize key areas for strategy application in the subbasin		I,R

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
squirrel habitat. S: Create site-specific grazing management plans for habitat improvement, including reduction of non-native species and reestablishment of native species. S: Create/retain optimal habitat (see assessment).	Vegetation and Composition			
O: Retain decadent and other important wildlife trees. S: Encourage woodcutting to be used as a tool for thinning overstocked areas. S: Create public education programs.	Loss of Individual, Late Seral Trees (From Woodcutting)	Washington: Identify and prioritize key areas for strategy application in the subbasin		I
O: Reduce pressure to western gray squirrels from California ground squirrels. S: Create programs to control non-native wildlife and other non-historical species. S: Create public education programs.	Increased Competition with Western Gray Squirrels	Washington: Identify and prioritize key areas for strategy application in the subbasin		I,R

White-Headed Woodpecker

Table 51 Objectives and strategies for Ponderosa Pine/Oregon White Oak Habitat -- White-Headed Woodpecker

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective.**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.	
CODES:	**O = Objective**	**FO = Field Observation**	**R = Research Literature**
	S = Strategy	**B = Best Professional Judgment**	**I = Information Needed**
		L = Local Residential Information	**H = Habitat Database**

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
O: Increase quantity of white-headed woodpecker habitat. S: Retain remaining large, unfragmented tracts of white-headed woodpecker habitat.	Loss of Large Tracts of Old Growth, or Late Seral Forests	Throughout upper Rock Creek watershed, data gaps		I
O: Increase quality of white-headed woodpecker habitat. S: Increase number of snags and snag recruitment in white-headed woodpecker habitat (review assessment for guidelines on optimal number and diameter of snags needed). S: Use site-specific fire prescriptions to enhance potential and used white-headed woodpecker habitat. S: Create/retain optimal habitat (see	Reduction of Large Diameter Trees and Snags Increased Stand Density and Decreased Average Tree Diameter	Throughout upper Rock Creek watershed, data gaps		I,R

Target Objectives and Strategies	Associated Limiting Factor	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
assessment).				
O: Retain decadent and other important wildlife trees. S: Encourage woodcutting to be used as a tool for thinning overstocked areas. S: Create public education programs.	Loss of Individual, Late Seral Trees (From Woodcutting)	Washington: Identify and prioritize key areas for strategy application in the subbasin		I

8.3 Fish

8.3.1 Mainstem Objectives and Strategies: Steelhead, Coho, Fall Chinook

Table 52 Mainstem Objectives, Strategies and Associated Findings by Tier Rankings: Steelhead, Coho, Fall Chinook

Target Objective and Strategy	Associated Key Finding	Tier Rankings* by Geographical Areas	
		Primary	Secondary
Rebuild and maintain healthy steelhead populations. Rebuild ESA-listed upriver steelhead stocks to levels that support increased fishing opportunities.	Steelhead use the subbasin primarily as a migration corridor from upstream spawning areas to the ocean. Upriver steelhead are a mix of hatchery and wild stocks. Naturally spawning steelhead are returning below escapement objectives.		Subbasin mainstem
Restore coho populations.	Coho use the subbasin primarily as a migration corridor from upstream spawning areas to the ocean. Although indigenous to upstream tributary areas, most of the coho currently migrating through the subbasin are the product of hatchery outplantings. Coho remain historic levels in the upper basin.		Subbasin mainstem
Rebuild and maintain healthy fall chinook populations. Rebuild ESA-listed Snake River fall chinook to levels that support increased fishing opportunities	Fall chinook use the subbasin mainstem primarily as a migration corridor from upstream spawning areas; Hanford Reach and the Snake River are the two main spawning areas. Hanford population consistently exceeds escapement objectives. Snake River escapement underdevelopment, but population remains below desired levels.		Subbasin mainstem
Make continued progress toward tribal goals to halt declining trends in salmon populations, including steelhead, coho, and fall chinook, to naturally sustainable levels that also support tribal harvest opportunities. Make progress toward protecting and rebuilding ESA-listed steelhead and fall chinook.	The subbasin's mainstem area is an important part of four tribes' treaty-guaranteed traditional fishing areas. Rights to the fish passing here have been repeated upheld in *U.S. v. Oregon*. Upriver steelhead stocks and Snake River fall chinook populations using this mainstem subbasin are listed for protection under the Endangered Species Act.		Subbasin mainstem

Target Objective and Strategy	Associated Key Finding	Tier Rankings* by Geographical Areas	
		Primary	Secondary
Improve juvenile passage conditions at The Dalles, John Day and McNary dams though water management actions, including extending summer spill	The construction of the hydropower system turned the river into a series of reservoirs, which has greatly extended the juvenile migration period. Juvenile steelhead migrate through the area throughout the spring and early summer; juvenile coho in the spring; and fall chinook in late spring and late summer.	All three dams and reservoirs	
Restore normative hydrograph will improve migration conditions.	Reduced travel time will improve survival and subsequent adult returns. Flow augmentation can increase water velocities. Alternative flood control strategies can helpful recapture the historical timing of flow. Increased spill diverts fish from the turbines and increases survival.	All three dams and reservoirs	
Investigate the efficacy of the planned installation of removable spillway weirs to aid in directing migrants to safer passage routes.	The technology is new and has being tested only at Lower Granite Dam. Not all dams and reservoirs have the same passage conditions.		At dams with weirs and those where proposed
Improve adult passage conditions by restoring features of the normative hydrographs to improve migration conditions.	Altered hydrologic conditions affect adult migrating salmon survival. Enhanced migration survival should contribute to increased adult returns. Adult steelhead actively migrate through the subbasin from March to October; adult coho migrate in September and October; adult fall chinook from August to October.	McNary Dam	The Dalles and John Day dams
Develop a temperature TMDL for the subbasin and implement specific actions to reduce exposure to elevated water temperatures	Prolonged exposure to elevated water temperatures is stressful for upstream migrants. Steelhead are thought to seek cold water refuges, including tributary mouths.		Subbasin mainstem
Monitor fishways regularly at the dams for compliance with adult fish passage criteria	When monitored, adult fish passage perfomance criteria are often not in compliance.	The Dalles, John Day, and McNary dams	
Identify and correct adult steelhead fallback conditions at dams.	Adult steelhead fallback at dams.	McNary Dam	The Dalles, John Day dams
Continue research on kelt reconditioning to identify conditions that improve survival	Steelhead kelts migrate back to the ocean after spawning. Collecting and reconditioning the kelts improves the chances of repeat spawning.	McNary Dam	

Target Objective and Strategy	Associated Key Finding	Tier Rankings* by Geographical Areas	
		Primary	Secondary
Improve water quality by reducing exposure to contaminants.	Contaminants input from upstream land-use activities are often trapped in the reservoirs behind dams. Dredging suspends contaminants accumulated in sediments. Dredging can also lead to direct mortalities of juveniles (and adults).		Subbasin mainstem
Eliminate dredging.	Same as above		Subbasin mainstem
Identify contaminants in the sediment and water and the effects of the contaminants on salmon	Same as above	Subbasin mainstem	
Develop TMDLs for contaminants, including identifying remedial actions.	Same as above		Subbasin mainstem
Minimize juvenile stranding; start by identifying areas vulnerable to stranding	Rapid changes in reservoir levels can isolate or dewater rearing areas and lead to juvenile mortalities. Reservoir levels in The Dalles Pool can change several feet in one day.		The Dalles, John Day, and McNary reservoirs
Protect rearing habitat.	Juveniles can be entrained into irrigation pumps. Irrigation withdrawals can affect water quantity and contribute to potential stranding of juveniles.		Subbasin mainstem
Determine abundance, distribution, and habitat use of rearing juveniles	The information on the mainstem subbasin's rearing habitat is incomplete.	Subbasin mainstem	
Screen all irrigation pumps	Juveniles can be entrained into irrigation pumps. Irrigation withdrawals can affect water quantity and contribute to potential stranding of rearing juveniles.	Data gap? Learn extent of current compliance	Subbasin mainstem
Enact a moratorium on additional mainstem water withdrawals and quantify the effects of irrigation withdrawals	Same as above		Subbasin mainstem

Target Objective and Strategy	Associated Key Finding	Tier Rankings* by Geographical Areas	
		Primary	Secondary
Remove lost fishing gear by identifying locations of lost gear removing it; quantify the impact of lost fishing gear	Commercial and recreational fisheries occur in the subbasin. Commercial gillnets used in The Dalles and John Day pools may break free and get lost. Under certain conditions the lost gear will continue to trap fish.		The Dalles and John Day reservoirs
Predation		Subbasin mainstem	
Less reliance on peak flows		The Dalles, John Day, and McNary dams and reservoirs	

TIER DEFINITIONS: Project or Actions: **Primary -** Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective; **Secondary -** Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.

8.3.2 Mainstem Objectives and Strategies: White Sturgeon

Table 53 Mainstem Objectives, Strategies and Associated Findings by Tier Rankings: White Sturgeon

Key Finding	Cause/Working Hypothesis	Confidence Effect Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain
Spawning occurs in the mainstem but can be limited by hydrograph and water temperatures	Modification of the historic hydrograph due to dam operation can result in peak flows that do not coincide with optimal spawning temperatures and can result in year class failure	High	High	High	Increase spawning success of white sturgeon in the LMM Columbia River	Operate hydrosystem so that peak flows occur when water temperature is suitable for white sturgeon spawning
Impounded WS populations incur periodic year-class failures	Inadequate spawning ground water velocities, lack of multi-day uniformity in flow, turbulence, and turbidity produce year class failures	High	High	High	Increase first-year survival of naturally spawned WS in the LMM Columbia River	Operate hydrosystem for multi-day uniform peak flow (no excessive hourly or daily variation) when water temperature is suitable for white sturgeon spawning
Egg, larval stage, and YOY WS are susceptible to predation	Indigenous and introduced predators cause mortality in pre-juvenile white sturgeon	High	High	High	Reduce predation in LMM Columbia River, especially on egg and larval stage WS, but also sub-yearling WS	Develop predator control studies for the LMM Columbia River. Identify predator population densities and dynamics. Develop experimental predator removal programs. Establish predator removal M&E including predator population exploitation, WS egg, larvae, and YOY consumption rates, and pre-yearling WS survival rates.
Impounded WS populations are less productive than the unimpounded lower Columbia	Construction and operation of Mainstem hydroelectric dams has reduced WS population productivity especially in The Dalles and John Day	High	High	High	Restore LMM Columbia River population abundance and productivity	Supplement less productive impounded WS populations through capture of juvenile WS from below Bonneville Dam and transporting them into The Dalles and John Day reservoirs to compensate for year

Key Finding	Cause/Working Hypothesis	Confidence Effect Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain
River population	pools					class failures.
The health of WS populations show up in density, condition factor, reproductive potential, age structure, and fish growth rates	Construction and operation of Mainstem hydroelectric dams has reduced or eliminated WS population productivity resulting in reduced or negated sustainable WS harvest	High	High	High	Restore LMM Columbia River population abundance and productivity to levels that can sustain reasonable harvest	Identify the need for and evaluate the success of LMM WS population recovery activities. Sustainable tribal and sport harvest is dependent upon periodic population status updates. Expand the periodic stock assessment program into McNary pool, the Hanford Reach, and into Priest Rapids Pool.
Reservoir specific intensive harvest management can influence WS abundance levels	Population over harvest has been mitigated by WDFW, ODFW, and CRITFC through many years of adapted reservoir specific harvest management involving in-season harvest monitoring linked to periodic population assessment and harvest regulation modeling	Medium	Medium	Medium	Increase LMM Columbia River WS populations to levels supporting reasonable harvest opportunities	Continue to monitor harvest levels and adjust fishing regulations as necessary between Bonneville and McNary Dams. Expand annual angler survey program to McNary pool, the Hanford Reach, and eventually to Priest Rapids Pool .
Hatchery technology has progressed and it may be possible to supplement white sturgeon populations in the LMM		Medium	Medium		Increase white sturgeon population abundance in the LMM Columbia River, especially the population in Priest Rapids Pool which is likely dying out	Continue to develop hatchery technology and methodologies and supplement the white sturgeon population in Priest Rapids Pool with hatchery fish. Consider using hatchery fish to supplement The Dalles and John Day WS populations.
White sturgeon populations are fragmented,	Construction of Mainstem hydroelectric dams has caused fragmentation of	High	High	High	Reduce fragmentation of white sturgeon population	Improve upstream passage. Improve spawning success in upstream reservoirs.

Key Finding	Cause/Working Hypothesis	Confidence Effect Actually Occurring	Level of Confidence in Causal Relationship	Relative Contribution to Causal Relationship	Biological Objective (Reduce/Eliminate Negative Causes, Improve/Maintain Positive Causes)	Strategy to Reduce/Eliminate or Improve/Maintain
there is little passage upstream but some downstream passage	sturgeon population					Capture and transport sturgeon from downstream to upstream reservoirs.
There is thought to be a net downstream displacement of sturgeon from upstream reservoirs	There is little upstream passage through fish ladders at mainstem projects.	Medium	Medium		Increase white sturgeon population abundance in the LMM Columbia River	Research possible improvements to fish ladders to allow upstream passage of juveniles.

8.3.3 Mainstem Objectives and Strategies: Pacific Lamprey

Table 54 Mainstem Objectives, Strategies and Associated Findings by Tier Rankings: Pacific Lamprey

Target Strategy or Objective	Associated Key Finding	Tier Rankings by Geographical Areas	
		Primary	Secondary
Restore Pacific lamprey populations. Attain self-sustaining natural production of Pacific lamprey that provides for fishing opportunities at traditional locations.	Recent counts of Pacific lamprey at The Dalles, John Day and McNary dams indicate a serious decline in abundance. Pacific lamprey serve an important role in the ecological function of the area by contributing to nutrient budgets and transporting marine nutrients to freshwater systems. Pacific lamprey are important part of the natural food web. Pacific lamprey are an important tribal cultural food source. Low abundances preclude fishing opportunities in upstream tributaries.		Subbasin mainstem
Make continued progress toward tribal goals to halt declining trends in Pacific lamprey; increase to naturally sustainable levels that also support tribal harvest opportunities.	The subbasin's mainstem area is an important part of four tribes' treaty-guaranteed traditional fishing areas. Rights to the fish passing here have been repeated upheld in *U.S. v. Oregon*. Pacific lamprey have been petitioned for designation under the Endangered Species Act.		
Improve adult passage at dams.	Adult fishways are difficult for lamprey to negotiate. Research indicates that rounding corners and alternative substrates improves passage efficiency.	The Dalles, John Day, and McNary dams	
Investigate auxiliary passage systems, similar to those being researched at Bonneville Dam.	Same as above and alternative passage routes may be more effective.		The Dalles, John Day, and McNary dams
Identify areas and make improvements in juvenile passage that do not conflict with salmonid passage needs.	Juvenile lamprey suffer from high impingement rates on bypass screens because they are relatively poor swimmers. John Day Dam, in particular, impinges large numbers of lamprey.		The Dalles, John Day, and McNary dams
Identify contaminants and the effects on lamprey	Contaminants input from upstream land-use activities are often trapped in the reservoirs behind dams. Dredging suspends contaminants accumulated in sediments. Dredging can also lead to direct mortalities. Dredging should be minimized and limited to periods outside of the active migration period.		The Dalles, John Day, and McNary dams and reservoirs
Reduce exposure to contaminants	Same as above		The Dalles, John Day, and McNary dams and reservoirs

Target Strategy or Objective	Associated Key Finding	Tier Rankings by Geographical Areas	
		Primary	Secondary
Minimize stranding.	Rapid changes in reservoir levels can isolate or dewater rearing areas and lead to mortalities of juveniles. Reservoir levels in The Dalles Pool can change several feet in one day.		The Dalles, John Day, and McNary reservoirs
Identify areas vulnerable to stranding.	Data gap. Important to know where stranding occurs.		The Dalles, John Day, and McNary reservoirs
Determine abundance, distribution, and habitat use of rearing juveniles	Data gap. Essential for efforts to restore Pacific lamprey.	The Dalles, John Day, and McNary reservoirs	

TIER DEFINITIONS: Project or Actions: **Primary -** Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective; **Secondary -** Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.

8.3.4 Rock Creek Objectives and Strategies

Table 55 Rock Creek Objectives, Strategies and Associated Findings by Tier Rankings

TIER DEFINITIONS	**Project or Actions:**	**Primary-- Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective**	
		Secondary-- Not able to be implemented in next 5 years and/or less certainty of achieving biological objective	
	Assessments (Data Gaps, M&E):	**Primary-- Able to be implemented within next 5 years and addresses critical uncertainties and/or assumptions**	
		Secondary-- Not able to be implemented in the next 5 years and/or addresses less immediately critical uncertainties and/or assumptions	
SOURCE CODES:	**S= Subbasin Summary**	**FO= Field Observation**	**B= Best Professional Judgement**
	RL= Research Literature	**O= Orthophoto Interpretation**	

Target Strategy or Objective	Associated Key Finding	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
Evaluate genetics of Rock Creek steelhead	Hatchery Fish compete with Natural Origin fish for space and food resources; clipped fish morts have been observed in lower river in very low numbers; competition with natural origin fish	Throughout Watershed		RL
Support Corps studies of fish passage at mainstem Columbia dams. Evaluate habitat conditions for survival in the mainstem Columbia habitat.	Survival of steelhead kelts (mature spawned out fish with the potential to spawn again) migrating out of the Rock Creek watershed and through the mainstem Columbia to the ocean is believed to be at or near zero.		Out of basin effect	RL

Target Strategy or Objective	Associated Key Finding	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
Increase kelt survival and repeat spawner success. Increase steelhead productivity.	Capture, rehabilitation, and release of these fish in the Rock Creek watershed increases survival and could act as a source of broodstock/genetic material for reintroduction efforts	Rock Creek 2		RL
Fund Kelt reconditioning in Rock Creek. Determine breeding success of Kelts.	Same as above	Rock Creek 2 for faciliities.		RL
Restore/supplement fish populations such that escapement is sufficient in number to provide adequate carcasses.	Food availability decreased by lack of nutrient transport/carcasses; Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	Throughout Watershed, excluding lower miles of Rock Creek 2		RL
Fertilize streams with artificial carcasses	Same as above		Throughout watershed, excluding Rock Creek 2	RL
Increase floodplain and channel roughness	Road, timber, and grazing management activities have lead to increased sediment supply from incoming tributaries	Throughout watershed excluding Secondary tier reaches	Rock Creek 6, Quartz Creek 1, Quartz Creek 2, Box Canyon	F, S, RL
	Summer/Early Fall Habitat availability lower in comparison with pre-settlement environment			S, B,
	Hydrologic routing in watershed has been modified; Land use management activities have modified flow timing and discharge			S, B, RL
	Rock Creek Road and other infrastructure in watershed have altered floodplain , confined river and tributaries			S, B, F, O
Reconnect side channels	Same as above	Rock Creek 2, Rock Creek 3		S, F ,B, O

Target Strategy or Objective	Associated Key Finding	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
Improve floodplain connectivity	Same as above	Rock Creek 2, Rock Creek 3, Rock Creek 4,Rock Creek 5, Luna Gulch, Squaw Creek 1		S, F, B, O
Relocate floodplain infrastructure, roads; improve maintenance, rehabilitate, decommission as approriate	Same as above	Rock Creek 2, Rock Creek 3, Rock Creek 4	Upper Watershed Roads	F, B, O
Re-establish and/or enhance native vegetation on floodplain	Same as above	Rock Creek 2, Rock Creek 3, Rock Creek 4,, Luna Gulch, Squaw Creek 1, Squaw Creek 2, Badger Gulch,	Rock Creek 5, Squaw Creek 2, Badger Gulch,	S, F, B, O
Implement appropriate practices which leave sources of Large Woody Debris to naturally enter and remain in the system		Throughout watershed, excluding Rock Creek 6, Quartz Creek 1 and 2, Box Canyon		S, F, B, O
Artificially introduce Large Woody Debris		Rock Creek 2, Rock Creek 3, Rock Creek 4	Luna Gulch, Squaw Creek 1,	F, B, O
Inventory existing and potential beaver habitat, include reintroduction of beaver into restoration actions.	Reduction of habitat, conflict with water infrastructure results in removal of dams and beavers, current trapping and historic population reduction and fragmentation. Other effects: Loss of fine sediment storage capacity, beaver dams also created grade control structures which resulted in off channel habitat and increased channel stability and maintained channel planform	Throughout watershed		S Rl, B, F
Encourage beaver colonization	Same as above.	Throughout watershed		S, F, B

Target Strategy or Objective	Associated Key Finding	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
Study presence of pathogens in juveniles and adults during high temperatures.	High Temperatures have resulted in increased susceptibility of native salmonids to pathogens.		Rock Creek 2, Rock Creek 3, Rock Creek 4, Rock Creek 5, Luna Gulch, Squaw Creek 1 and 2, Badger Gulch	RL, F, B
Explicitly include desired carcass numbers within escapement goals to benefit ecosystem processes in population/harvest management decisions.	Carcasses of anadromous fish were critical components of the inland food web, supplying ocean-derived food and energy to the watershed, greatly increasing aquatic, riparian, and upland ecosystem productivity.	Primary Policy Consideration		RIL, B
Study/Characterize productivity in relation to water quality parameters.	Fluctuations in water quality parameters have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity	Throughout watershed		S, RL, F, B
Study and assess sources/attribute relative contributions of fine sediment.	Same as above.	Luna Gulch, Squaw Creek, Badger Gulch, Quartz Creek, Box Canyon, Rock Creek 6, Rock Creek 2		S, F, B,
Implement off road vehicle management actions that reduce fine sediment inputs.	Same as above.		Upper Quartz, Box Canyon	F, B
Implement road management actions that reduce fine sediment inputs.	Same as above.	Throughout watershed		S, RL, F, B
Implement upland management practices that mimic natural runoff and sediment production.	Same as above.	Throughout watershed		Rl, S
Assess significance of predation by native birds	Loss of abundance of native salmonids has resulted in a greater proportional impact from native predation	Common need throughout Assessment Unit		Rl, B

Target Strategy or Objective	Associated Key Finding	Tier Rankings by Geographical Areas		Source
		Primary	Secondary	
Study specific habitat relationships for Pacific lamprey.	Poor passage for anadromous forms through the mainstem Columbia River (and possibly in the Subbasin) have severed life history pathways and reduced population abundance, productivity and spatial diversity.	Rock Creek 2, Rock Creek 3, Rock Creek 4, Squaw Creek 1, Luna Gulch		RL, B
	Changes in habitat conditions and reduction in salmon populations within the subbasin have reduced habitat suitability and reduced abundance, productivity and life history diversity. Improvement in habitat conditions for salmonids will improve lamprey populations as well.			
Implement habitat restoration actions for pacific lamprey.	Same as above.		Lower Watershed	Rl, B

8.3.5 Fulton Canyon and Spanish Hollow Objectives and Strategies

Table 56 Fulton Canyon and Spanish Hollow Objectives, Strategies and Associated Findings by Tier Rankings

Target Strategy or Objective	Associated Key Finding	Tier Rankings by Geographical Areas	
		Primary	Secondary
Implement Dry Cropland or Range and Pastureland Resource Management Systems (RMS) in Gilliam and Sherman counties in conjunction with the Natural Resources Conservation Service (NRCS) as per the April 2004 Biological Opinion. (All but the last two strategies relate to the proscribed RMS.)	Agricultural and rangeland practices have contributed to the decline in steelhead and other anadromous species in Fulton Canyon and Spanish Hollow watersheds/	Gilliam and Sherman counties	
Restore historical hydrologic regime and increase extent and distribution of perennial habitat	Groundwater withdrawals lower base flows, decreasing perennial flow area	Entire Assessment Unit (Fulton Canyon and Spanish Hollow watersheds) or e.g., Mud Hollow, lower 5 miles of Fulton Canyon, etc.	
	Historic data suggests loss of wetland structure	?	
	Increased peak runoff	?	
Study and monitor groundwater withdrawals in area	Same as above	Entire Assessment Unit	
Study and evaluate sources and attribute relative sources of fine sediment	Land and water uses caused watershed-level changes in vegetation cover, soil quality and disposition (erosion), gully development, stream channel instability, and water quality.	?	
	Fluctuations in water quality parameters have reduced native aquatic vegetation and faunal (insect, zooplankton, vertebrates) communities and productivity	?	
Study/characterize productivity in relation to water quality parameters	Same as above		

Target Strategy or Objective	Associated Key Finding	Tier Rankings by Geographical Areas	
		Primary	Secondary
Reduce temperatures to near pre-settlement conditions	Reduction in summer low flow and loss of riparian vegetation	?	
Conduct spawning surveys or?	Historical data suggests abundance is far below pre-development era	Entire Assessment Unit	
Restore steelhead population abundance, productivity and spatial distribution to sustainable levels	Steelhead populations have been dramatically reduced from pre-settlement abundance levels because of habitat degradation and alterations		Entire Assessment Unit
Support Corps studies of fish passage at mainstem Columbia dams and evaluate other habitat conditions for improved survival in mainstem Columbia habitat	Many juvenile and some adult anadromous fish are killed by migatrory conditions created dams and reservoirs		Out of basin effect
Support efforts to reduce predator population levels in mainstem Columbia	Increased habitat for native and non-native predators in Columbia mainstem leads to increased predator populations in lower tributary areas		Out of basin effect

TIER DEFINITIONS: Project or Actions: Primary - Able to be implemented within next 5 years and addresses significant limiting factors; high likelihood of achieving biological objective; Secondary - Not able to be implemented in next 5 years and/or less certainty of achieving biological objective.

8.4 Monitoring, Evaluation and Adaptive Management

Monitoring and evaluation efforts in this subbasin have been minimal to date. The following guidelines extracted from the Washington State Salmon Recovery Funding Board will be used when preparing project proposals in the future unless project proponents have a specific reason for changing the monitoring and evaluation criteria.

The Monitoring and Evaluation Strategy For Habitat Restoration documents published by the Washington Salmon Recovery Funding Board (SRFB) can be found at http://www.iac.wa.gov/srfb.

The following project types are addressed by this subbasin monitoring and evaluation plan:

- Fish passage projects
- Instream structure projects
- Riparian vegetation restoration projects
- Livestock exclusion projects
- Constrained channel projects
- Channel connectivity projects
- Spawning gravel projects
- Habitat protection projects at the parcel scale

8.4.1 Fish Passage Projects

The objective for fish passage projects is to increase access to areas blocked by human-cause impediments.

Types of Fish Passage Projects

Bridge projects, culvert improvements, small dam removals, debris removals, diversion dam passage, fishway construction, weirs, and water management projects.

Monitoring Goal

Determine whether fish passage projects are effective in restoring upstream passage to targeted fish species.

Questions to be answered:

- Have the engineered fish passage projects continued to meet design criteria post-project for at least five years?
- Have fish passage projects as an aggregate demonstrated increased abundance of target species post-project within five years?

Objectives

Before Project Objectives (year 0)

Project managers determine the proper design criteria for meeting the fish passage objectives for the project. Determine fish abundance both in the downstream control reach and impact reach upstream of the fish blockage for the sampled projects.

After Project Objectives (Years 1, 2, and 5)

Determine whether fish passage design criteria are being met at each project monitored. Determine salmon abundance both in the downstream control reach and impact reach upstream of the fish blockage for each project.

Response Indicators

- Design criteria: Project design criteria taken from construction blueprints or pre-project plan.
- Abundance: Salmon abundance can be determined using both adult spawner and redd counts and juvenile counts. Adult estimating procedures are found in SRFB Protocol 9. Juvenile estimating procedures are found in SRFB Protocols 7 and 8. The least intrusive monitoring protocol should be used whenever possible. Impact areas will be compared to the controls and to controls and impacts on other streams as well. The metrics used will be numbers per square meter for juveniles and number per kilometer or redds per kilometer for adults depending upon the target species.

8.4.2 Instream Structure Projects

Types Of Instream Structure Projects

Channel reconfiguration, installed deflectors, log and rock control weirs, roughened channels, and woody debris.

The objective for instream projects is to increase instream cover, spawning, and resting areas by constructing artificial instream structures. The basic assumption is creating more diverse pools, riffles, and hiding cover will result in an increase in local fish abundance.

Monitoring Goal

Determine if projects that place artificial instream structures (AIS) into streams are effective in improving stream morphology and increasing local fish abundance in the treated area at the stream reach level.

Questions to be answered:

- Have AIS as designed remained in the stream for up to ten years for the sampled instream structure projects?
- Has stream morphology improved significantly in the treated stream reach for the sampled instream structure projects within ten years?
- Has salmon abundance increased significantly in the impact area for the sampled instream structure projects within ten years?

Objectives

Before Project Objectives (Year 0)

Determine the Thalweg profile in the impact and control areas for each of the instream structure projects sampled. Determine the numbers of adult and juveniles of the targeted salmon species in the control and impact areas for each of the instream structure projects sampled.

After Project Objectives (Years 1, 3, 5, and 10)

Determine the number and location of AIS within the treated area for the sampled instream structure projects. Determine the Thalweg Profile in the control and impact areas for the sampled instream structure projects. Determine the numbers of adult and juvenile of the target salmon species within the control and impact areas for the sampled instream structure projects.

Response indicators

- Number of AIS remaining in sampled reach: AIS must be identified using GPS coordinates and other techniques such as tags affixed to LWD in order to track the life of AIS over time. AIS sampling methods are found in Protocol 13 (SRFB 2003).
- Thalweg profile: The Thalweg profile characterizes pool-riffle relationships, sediment deposits, wetted width substrate characteristics, and channel unit-pool forming categories. Stream morphology sampling methods are taken from EMAP (Peck et al. unpubl.), Section 7.4. Protocols summarizing EMAP Table 7-3 and 7-4 are found in Protocols 14, 15, and 16. Sampling is based upon establishing 11 regular transects within each identified stream reach. Pre-project measures of the variation of depth throughout the stream reach and the residual pool volume will be compared to detect post-project changes.
- Abundance numbers of adult and juvenile salmon in the reach: Salmon abundance can be determined using both adult counts, redd counts, and juvenile counts. Adult estimating procedures are found in Protocol 9. Juvenile estimating procedures are found in Protocols 7 and 8. The least intrusive monitoring protocol should be used whenever possible. Impact areas will be compared to the controls and to controls and impacts on other streams as well. The metrics used will be numbers per square meter for juveniles and number per mile or redds per mile for adults depending upon the target species.

8.4.3 Riparian Vegetation Restoration Projects

The goal of riparian planting projects is to restore natural streamside vegetation to the stream bank and riparian corridor. The assumption is that riparian vegetation increases shading of the stream, leading to cooler temperatures more desirable for salmon rearing. Vegetative cover also reduces sedimentation and erosion, which can impact egg survival, food organisms, and the ability of salmon to find food.

Monitoring Goal

Determine whether riparian plantings are effective in restoring riparian vegetation, stream bank stability, and reducing sedimentation.

Questions to be answered:

- Have at least 50% of the riparian plantings survived for at least 10 years?
- Have the riparian shading and riparian vegetative structure been improved by year 10?
- Has erosion and stream sedimentation been significantly reduced by year 10?

Objectives

Before Project Objectives (Year 0)

Determine the proportion of the three layers of riparian vegetation present within the project impact and control areas. Determine the proportion of shading within the project impact and control areas. Determine the proportion of actively eroding stream banks within the project impact and control areas.

After Project (Years 1, 3, 5, And 10)

Determine the overall survival of the species of riparian vegetation planted. Determine the proportion of the three layers of riparian vegetation present within the project impact and control areas. Determine the proportion of shading within the project impact and control areas. Determine the proportion of actively eroding stream banks within the project impact and control areas.

Response Indicators

- Number of trees and shrubs planted: The number of trees and shrubs planted at the time of the project. The Level 1 indicator tracks how many plantings actually survived over time as a measure of project effectiveness.
- Riparian vegetation: Using EMAP protocols (Peck et al. unpubl.), the percent shading is calculated using a densitometer and the riparian species diversity understory ground cover and canopy can be determined in a consistent manner. One would expect the percent shading and the species diversity to change over time as the plantings grow. The proportion of actively eroding streambanks is an indicator of sedimentation and erosion into the stream. If riparian plantings are effective in creating riparian cover, then bank erosion should decline.

8.4.4 Livestock Exclusion Projects

The goal of livestock exclusion fencing is to exclude cattle from the riparian area of the stream where they can cause severe damage to the stream by breaking down stream banks and increasing erosion, destroying shade producing trees and shrubs, and increasing sedimentation. By excluding cattle with fencing, these adverse impacts can be avoided and restoration of the shoreline can occur.

Monitoring Goal

Determine whether livestock exclusion projects are effective in excluding livestock, restoring riparian vegetation and restoring stream bank stability.

Questions to be answered:

- Are livestock excluded from the riparian area?

- Has riparian vegetation been restored in the impact area?
- Has bank erosion been reduced in the impact area?

Objectives

Before Project Objectives (Year 0)

Determine overall use by livestock of the riparian area to be excluded. Determine the total acreage to be fenced. Determine the total kilometers of stream protected. Determine the overall riparian vegetation cover layers and percent shading within the project area.

Determine the overall proportion of stream bank actively eroding.

Post-Project Objectives (Years 1, 3, 5, and 10)

Determine the overall use by livestock of the riparian area excluded. Determine the overall riparian vegetation cover layers and percent shading within the project area.

Determine the overall proportion of stream bank actively eroding.

Response Indicators

- Exclusion effectiveness: Using Protocol 10, the presence or absence of livestock inside the exclusion can be used as a measure of the effectiveness of the fencing design in excluding livestock from the riparian area.
- Riparian indicators: Using EMAP protocols (Peck et al. unpubl.), the percent shading (using a densiometer) is a metric that can be determined in a consistent manner. This metric was chosen because it has been shown to have one of the highest signal to noise ratios (17) of 18 different parameters measured involving riparian vegetation. Using EMAP protocols, the percent of riparian area containing all three layers of vegetation, canopy layer (.5m high), understory (0.5 to 5m high), and ground cover (0.5m high). This metric was chosen because it has been shown to have one of the highest signal to noise ratios (8) of 18 different parameters measured involving riparian vegetation. Using methods outlined in Protocol #17, the proportion of actively eroding streambanks can be determined within the sampled stream reaches.

8.4.5 Constrained Channel Projects

The goal of constrained channel projects is to restore the natural flood flow basin width so that gravel, large wood, and normal stream morphology and fish habitat can be restored. Diking, road construction, fills, and other construction work within the stream's normal flood line can constrain flow within the normal flow channel leading to scouring effects upon stream gravel, loss of hiding cover and food organisms, and unsuitable habitat for rearing juvenile salmon. Unconstrained streams dissipate flood flow energy over a broader valley floor and provide slower velocities for preserving stream channel morphology and rearing habitat for salmon.

Types of Constrained Channel Projects

Dike removal or setback, riprap removal, road removal or setback, and landfill removal.

Monitoring Goal

Determine whether projects that remove or set back dikes, riprap, roads, or landfills are effective in restoring stream morphology and eliminating channel constraints in the treated area.

Questions to be answered:

- Has removal and/or setback reduced channel constraints and increased flood flow capacity for ten years?
- Has stream morphology improved over ten years?

Objectives

Before Project Objectives (Year 0)

Determine the overall channel capacity and constraints in the impact area. Determine the overall stream morphology using Thalweg Profile in the impact area.

After Project Objectives (Years 1, 3, 5, and 10)

Determine the overall changes in channel constraints and flow capacity in the impact area. Determine the overall stream morphology using Thalweg Profile in the impact area.

Response Indicators

- Channel capacity: Channel capacity as cross-sectional area calculated from mean bankfull width (XBF_W) and height (XBF_H) measures the overall channel flow capacity. When a channel is constrained the velocity of the water increases to compensate for higher volume. Increased velocity scours stream bottom eliminating pools, large wood, and other structures associated with fish habitat.
- Thalweg profile: The Thalweg profile characterizes pool-riffle relationships, sediment deposits, wetted width substrate characteristics, and channel unit-pool forming categories. Stream morphology sampling methods are taken from EMAP (Peck et al. unpubl.), Section 7.4. Protocols summarizing EMAP Table 7-3 and 7-4 are found in Protocols 15, and 16 (SRFB, 2003). Sampling is based upon establishing 11 regular transects within each identified stream reach. Pre-project measures of the variation of depth throughout the stream reach (RP100) and the residual pool volume (AREASUM) will be compared to detect post-project changes.

8.4.6 Channel Connectivity Projects

Channel connectivity projects and off-channel habitat projects are designed to reconnect flood flow channels, oxbows, and other winter flood flow channels and winter rearing areas for fish and other aquatic organisms. Loss of channel connectivity is most often caused by manmade disturbances such as dikes, roads, fills, etc.

Types of Channel Connectivity Projects

Channel connectivity, off-channel habitat, and wetlands

The goal of channel connectivity projects is to restore lost channels and side channel rearing areas to active fish production and to dissipate the destructive effects of flood flows upon habitat.

Monitoring Goal

Determine whether projects that restore connectivity to channels that have previously been disconnected from the stream are effective in improving stream morphology and increasing fish abundance in the impacted area. This would include side channels, meander bends, old oxbows, and wetlands.

Questions to be answered:

- Has the reconnected channel remained attached to the stream as designed?
- Has off-channel stream morphology improved over time?
- Has riparian vegetation in the off-channel impact area changed from upland to wetland species?
- Has salmon abundance increased in the off-channel impact area over time?

Objectives

Before Project Objectives (Year 0)

Determine the overall size and configuration of the disconnected channel in the impact and control areas. Determine the plant community characteristics in the impact and control areas. Determine the overall stream morphology using Thalweg Profile in the impact and control areas. Determine the overall abundance of targeted fish species in the impact and control areas.

After Project Objectives (Years 1, 2, and 5)

Determine the effectiveness of the connected channel within the impacted area. Determine the plant community characteristics within the impact and control areas. Determine the overall stream morphology using Thalweg Profile in the impact and control areas. Determine the abundance of target fish species within the control and impact areas.

Response Indicators

- Connected channel. The channel connection must remain functional as designed for the project to be considered a success. The response indicator in this case is whether the channel has remained connected to the main channel of the stream thereby meeting design criteria.
- Thalweg profile. The Thalweg profile characterizes pool-riffle relationships, sediment deposits, wetted width substrate characteristics, and channel unit-pool forming categories. Stream morphology sampling methods are taken from EMAP (Peck et al. Unpubl.), Section 7.4. Protocols summarizing EMAP Table 7-3 and 7-4 are found in Protocols 14, 15, and 16 (SRFB, 2003). Sampling is based upon establishing 11 regular transects within each identified stream reach. Pre-project measures of the variation of depth throughout the stream reach and the residual pool volume will be compared to detect post-project changes.
- Riparian species diversity and percent shading: Using EMAP protocols, the percent shading (using a densiometer) and riparian species diversity are metrics that can be determined in a

consistent manner. One would expect the percent shading and the species diversity to change over time after the channel has been reconnected.

- Abundance: Salmon abundance can be determined using both adult counts and juvenile counts. Adult estimating procedures are found in Protocol 9. Juvenile estimating procedures are found in Protocols 7 and 8. The least intrusive monitoring protocol should be used whenever possible. Impact areas will be compared to the controls and to controls and impacts on other streams as well. The metrics used will be numbers per square meter for juveniles and number per mile or redds per mile for adults depending upon the target species.

8.4.7 Spawning Gravel Projects

Spawning salmon require clean gravel of the proper size in order to spawn successfully. Where the stream is subjected to high sediment loading, gravel that is normally the proper size and location may become embedded into a matrix of silt and clay sediments that do not provide aeration of the redd.

The goal of gravel placement projects is to improve spawning capabilities within the impacted area by artificially placing gravel in the stream. The assumption is that spawning areas are a limiting factor in producing juvenile salmon, and placing gravel in the stream should result in an increase in successful spawning and local juvenile and adult fish abundance.

Monitoring Goal

Determine if projects that place spawning gravel into streams are effective in improving salmon spawning, and increasing local adult fish abundance in the impacted area at the stream reach level.

Questions to be answered:

- Has gravel placed in the stream remained in the stream for up to ten years for the sampled gravel replacement projects?
- Has gravel remained usable for spawning over time or has it become embedded with fines?
- Have more adult salmon utilized the new spawning gravel?

Objectives

Before Project Objectives (Year 0)

Determine the total area of spawning gravel in the impact and control areas for each of the gravel placement projects sampled. Determine how embedded the spawning gravel is in the control and impact areas for the sampled gravel placement projects. Determine the %age of fines in the gravel in the control and impact areas for the sampled gravel placement projects. Determine the numbers of adult spawners of the targeted salmon species in the control and impact areas for each of the gravel placement projects sampled.

After Project Objectives (Years 1, 3, 5, and 10)

Determine the total area of spawning gravel in the impact areas for each of the gravel placement projects sampled. Determine how embedded the spawning gravel is in the control and impact areas for the sampled gravel placement projects. Determine the %age of fines in the gravel in the control and impact areas for the sampled gravel placement projects. Determine the numbers of adult spawners of the targeted salmon species in the control and impact areas for each of the gravel placement projects sampled.

Response Indicators

- Area of gravel remaining in the sampled reach: Spawning gravel placed in the stream must be identified using GPS coordinates and other techniques such as streambank markers in order to track the life of the gravel placement over time.
- Gravel characteristics. Gravel characteristics can be quantified using the EMAP protocol for characterizing stream substrate (Peck et al. Unpubl.). This protocol measures size of substrate. Percent of fines is commonly used as a measure of siltation. Embeddedness is also determined (see Protocol 12, SRFB, 2003).
- Abundance: Salmon abundance can be determined using adult spawner counts. Adult estimating procedures are found in Protocol 9. The least intrusive monitoring protocol will be used whenever possible.

8.4.8 Habitat Protection Projects at the Parcel Scale

A protection project is a property acquired either in fee title or a property protected by a restrictive use agreement or easement for the purpose of:

- Protecting identified blocks of critical habitat that protect fish and wildlife from further population declines.
- Protection of property providing key linkages connecting fragmented habitats.
- Protection of property used to enhance habitat and to offset poor habitat elsewhere in the watershed.

Determine whether habitat protection parcels as a whole and individually are effective in maintaining or improving fish and wildlife habitat and invertebrate species assemblages within the parcel boundaries.

Monitoring Goal

Determine whether habitat protection parcels as a whole and individually are effective in maintaining and/or, improving fish and wildlife and invertebrate species assemblages within the parcel boundaries.

Questions to be answered:

- Have the protected properties maintained or improved the riparian habitat benefits for which they were purchased?
- Have the protected properties maintained or improved the upland habitat benefits for which they were purchased?
- Has the biological condition of the macro-invertebrate and fish and wildlife assemblages improved, declined or stayed the same within the protected properties?

Objectives

Baseline (Year 0)

Determine status of instream, riparian and upland habitat within each randomly selected parcel. Determine the biological condition of macro-invertebrate and fish and wildlife species assemblages using a multi-metric index for each randomly selected parcel.

Post-Acquisition Objectives (Years 3, 6, 9, and 12)

Determine trends in instream, riparian and upland habitat within each randomly selected parcel compared to the baseline year. Determine status of macro-invertebrate and fish and wildlife species assemblages using a multi-metric index for each randomly selected parcel.

Response Indicators

- Thalweg profile. The Thalweg profile characterizes pool-riffle relationships, sediment deposits, wetted width substrate characteristics, and channel unit-pool forming categories. Stream morphology sampling methods are taken from EMAP (Peck et al. unpubl), Section 7.4.
- Riparian plants: Riparian condition is determined by measuring the plant density and species composition within the study reach. It is also important to measure stream bank erosion. Streamside riparian habitat sampling methods are taken from EMAP (Peck et al. Unpubl.), Section 7.4.
- Upland plants: Upland plant community sampling methods are taken from the National Park Service "Fire Monitoring Handbook (FMH)", Chapter 4 Monitoring Program Design, Table 3, Table 4 and Figures 9-14; and Chapter 5 Vegetation Monitoring Protocols Tables 5-10 and Figures 15-20. SFRB Protocols summarizing FMH protocols are found in Protocol X (SRFB, 2003).
- Macro-invertebrate assemblages: Stream macro-invertebrate species composition and relative abundance of particular groups show strong correlations with water quality and watershed health factors. Changes in macro-invertebrates would indicate that water quality conditions within the parcel have changed over time. Macro-invertebrate sampling methods are taken from EMAP (Peck et al. unpubl), Section 11. Protocols summarizing EMAP Table 11-2, 11-3, and 11-4 are found in Protocols X (SRFB, 2003) and in the Department of Ecology's "Benthic Macro-Invertebrate Biological Monitoring Protocols for Rivers and Streams", Publ No. 01-03-028. Indicators considered most sensitive to regional change are compared using a multi-metric index (Karr and Chu, 1999; Wiseman, 2003).

Abundance: Salmon abundance can be determined using both adult counts and juvenile counts. Adult estimating procedures are found in Protocol 9. Juvenile estimating procedures are found in Protocols 7 and 8. The least intrusive monitoring protocol should be used whenever possible. Impact areas will be compared to the controls and to controls and impacts on other streams as well. The metrics used will be numbers per square meter for juveniles and number per mile or redds per mile for adults depending upon the target species.

9 References

Ackerman, S. 1994. American white pelicans nest successfully at Crescent Island, Washington. Washington Birds 3:44-49.

Agee, J. 1993. Fire ecology of Pacific Northwest forests. Washington D. C.: Island Press.

Allendorf, F., and N. Ryman. 1987. Genetic management of hatchery stocks. Pages 141-160 in N. Ryman and F. Utter, editors. Population genetics and fishery management. University of Washington Press, Seattle, Washington.

Altman, B. 2000. Conservation strategy for landbirds of the east-slope of the Cascade Mountains in Oregon and Washington. Oregon-Washington Partners in Flight.

_____, and A. Holmes. 2000. Conservation strategy for landbirds in the Columbia Plateau of eastern Oregon and Washington. Oregon-Washington Partners in Flight.

Ammon, E. and P. Stacey. 1997. Avian nest success in relation to past grazing regimes in a montane riparian system. Condor 99:7-13.

ANS Task Force. 1990. Nonindigenous Aquatic Nuisance and Control Act. http://www.anstaskforce.gov/nanpca.htm

Asher, R. 2004. Supervisor - County Weed Dist., Sherman County, Oregon. Personal Communication, Nov. 2004

Asherin, D., and J. Claar. 1976. Inventory of riparian habitats and associated wildlife along the Columbia and Snake Rivers. Vol. 3A. U. S. Army Corps of Engineers, North Pacific Division. Portland, Oregon.

Atzet, T., and D. Wheeler. 1984. Preliminary plant associations of the Siskiyou Mountains Province, Siskiyou National Forest. U.S. Forest Service, Pacific Northwest Region, Portland, OR.

Backman, T.W.H. and A.F. Evans. 2002. Gas bubble trauma incidence in adult salmonids in the Columbia River Basin. North American Journal of Fisheries Management. 22:579-584.

Bajkov, A. 1951. Migration of white sturgeon (Acipenser transmontanus) in the…this citation incomplete

Bailey, V. 1936. The mammals and life zones of Oregon. N. American Fauna, No. 5, U.S. Govt. Print. Off., Washington, D.C., 416 pp.

Barnum, D. 1975. Aspects of western gray squirrel ecology. M.S. Thesis, Washington State University, Pullman. WA.

Barrett, R. 1980. Mammals of California oak habitats -- management implications. Pages 275-291 in T. R. Plumb, tech. coor. Ecology, management, and utilization of California oaks. U.S. For. Serv. Gen. Tech. Rep. PSW-44.

Bate, L. 1995. Monitoring woodpecker abundance and habitat in the central Oregon Cascades. M.S. Thesis, Univ. Idaho, Moscow, ID.

Bayer, R. 2003. Revew: Bird predation of juvenile salmonids and management of birds near 14 Columbia Basin dams. Yaquina Studies in Natural History No. 10. Abstract at http://www.oregonvos.net/~rbayer/salmon/gullprd.htm (November 2004)

Beamesderfer, R. 1993. A standard weight (Ws) equation for white sturgeon. California Fish and Game 79:63-69.

_____, D. Ward, and A. Nigro. 1996. Evaluation of the biological basis for a predator control program on northern squawfish (Ptychocheilus oregonensis) in the Columbia and Snake rivers. Canadian Journal of Fisheries and Aquatic Sciences 53:2898-2908.

_____, T. Rien, and A. Nigro. 1995. Differences in the dynamics and potential production of impounded and unimpounded white sturgeon populations in the lower Columbia River. Transactions of the American Fisheries Society 124:857-872.

_____, and B. Rieman. 1991. Abundance and distribution of northern squawfish, walleyes, and smallmouth bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:439-447.

Becker, C. 1990. Aquatic bioenvironmental studies: The Hanford experience 1944-84. Elsevier, New York.

_____. 1985. Anadromous salmonids of the Hanford Reach, Columbia River: 1984 status. Report by Pacific Northwest Laboratory to U. S. Department of Energy, Contract DE-AC06-76RLO 1830.

_____. 1973. Food and growth parameters of juvenile chinook salmon, Oncorhynchus tshawytscha, from the central Columbia River. U.S. National Marine Fisheries Service Fishery Bulletin 71:387-400.

_____. 1971. Cestrahelmins rivularis sp. n. (Digenea: Deropristiidae) from white sturgeon Acipenser transmontanus, in the Columbia River, Washington. Proceedings of the Helminthological Society of Washington 38:23-26.

_____, and R. Gray. 1992. Past and present water-quality conditions in the Hanford Reach, Columbia River. Environmental Monitoring and Assessment 22: 137-152.

_____, and M. Fujihara. 1978. The bacterial pathogen Flexibacter columnaris and its epizootiology among Columbia River fish. Monograph No. 2. American Fisheries Society, Washington D.C.

Becker, J. 1993. A preliminary survey of selected structures on the Hanford Site for Townsend's big-eared bat (Plecotus townsendii). PNL-8916. Battelle, Pacific Northwest National Laboratories, Richland, Washington.

Beeman, J., and J. Novotny.1994. Pen Rearing and Imprinting of Fall Chinook Salmon. Final Report. A 137 13084-6 Bonneville Power Administration, Portland, OR.

Bennett, D. 1999. Locke Island Landslide Study, Phase 1, White Bluffs Area, Columbia Basin Project, Washington - DRAFT. Bureau of Reclamation, PNW Region, Boise, Idaho.

Berg, L., ed. 2001. Draft Rock Creek Subbasin Summary. Prepared for the NPPC.

Berggren, T., and M. Filardo. 1993. An analysis of variables influencing the migration of juvenile salmonids in the Columbia River basin. North American Journal of Fisheries Management 13:48-63.

Bjornn, T. 1971. Trout and salmon movements in two Idaho streams as related to temperature, food, stream flow, cover, and population density. Transactions of the American Fisheries Society 100:423-438.

Blair, G., and G. Servheen. 1993. Species conservation plan for the white-headed woodpecker (Picoides albolarvatus). US Dept. Agric. For. Serv. (R-1) and Idaho Dept. of Fish and Game.

Blaustein, A., J. Beatty, D. Olson, and R. Storm. 1995. The biology of amphibians and reptiles in old-growth forests in the Pacific Northwest. Gen. Tech. Rep. PNW-GTR-337. Portland, OR: USDA, Forest Service, Pacific Northwest Research Station. 98 p.

Bliss Dam to C.J. Strike Dam. Idaho Department of Fish and Game, River and Stream Investigations, Job Performance Report, Project F-73-R-2, Job 1-b, Boise Idaho. 25 pp.

BLM (Bureau of Land Management). 1986. Summary of Rock Creek Stream Survey, May 20, 1986 by Art Oakley, State Office Fishery Biologist. Central and Eastern Klickitat Conservation Districts. 1991. Watershed Inventory Project – Final Report. Prepared for the Washington State Conservation Commission. Grant Contract Number 89-34-02.

_____. 1985. Field exam of Rock Creek, Klickitat County. Memorandum to Wenatchee Area Manager. November 4, 1985. 2pp (plus attachments).

Bock, C. 1982. Personal communication (letters dated 5 March 1982 and 2 August 1982). Dept. Environal, Population, and Organismic Biology, Univ. Colorado, Boulder, CO.

_____. 1970. The ecology and behavior of the Lewis woodpecker (Asyndesmus lewis). Univ. Calif. Publ. Zool. 91.

_____, J. Bock, and B. Bennett. 1999. Songbird abundance in grasslands at a suburban interface on the Colorado High Plains. Pages 131-136 in P. D. Vickery and J. R. Herkert, editors. Ecology and conservation of grassland birds of the Western Hemisphere. Studies in Avian Biology 19.

_____, V. Saab, T. Rich, and D. Dobkin. 1993. Effects of livestock grazing on neotropical migratory land birds in western North America. Pages 296-309 in Proc. national workshop on status and management of neotropical migratory birds. U.S. For. Serv. Gen. Tech. Rep. RM-229.

_____, and J. Bock. 1992. Response of birds to wildfire in native versus exotic Arizona grassland. The Southwestern Naturalist. 37(1): 73-81.

Bollinger, E., P. Bollinger, and T. Gavin. 1990. Effects of hay-cropping on eastern populations of the bobolink. Wildl. Soc. Bull 18(2):142-150.

Booth, E. 1947. Systematic Review of the Land Mammals of Washington. Ph.D. Diss., State Coll. Wash. (WSU), Pullman, WA.

Boyce, M. 1981. Habitat ecology of an unexploited population of beavers in interior Alaska. Pages 155-186 in J. A. Chapman and D. Pursley, eds. - Worldwide Furbearer Conf. Proc. Vol. I.

BPA (Bonneville Power Administration). 1984. Complete citation unavailable.

Bradt, G. 1947. Michigan beaver management. Mich. Dept. Conserv., Lansing, MI.

Brady. 1993. WDFW.

Brannon, E., S. Brewer, A. Setter, M. Miller, F. Utter, and W. Hersberger. 1985.

Brauning, D.W., ed. 1992. Atlas of breeding birds in Pennsylvania. Univ. of Pittsburgh Press, Pittsburgh, PA.

Brett, J. 1967. Swimming performance of sockeye salmon (Oncorhynchus nerka) in relation to fatigue time and temperature. Journal of the Fisheries Research Board of Canada 24:1731-1741.

_____. 1952. Temperature tolerance in young Pacific salmon, genus Oncorhynchus. Journal of the Fisheries Research Board of Canada 9:265-322.

Brewer, R., G. McPeek, and R. Adams, Jr., eds. 1991. The atlas of breeding birds of Michigan. Michigan State Univ. Press, East Lansing, MI.

Browers. 2004. USFWS

Buchanan, J., R. Rogers, D. Pierce, and J. Jacobson. 2003. Nest-site habitat use by white-headed woodpeckers in the eastern Cascade Mountains, Washington. Northwest. Nat. 84:119-128.

Busby, P., T. Wainwright, G. Bryant, L. Lierheimer, R. Waples, F. Waknitz, and I. Lagomarsino. 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon and California. U.S. Dept. of Commerce. NOAA Tech Memo. NMFS-NWFSC-27. 261pp.

Buss, I.O. 1965. Wildlife ecology. Washington State University. Pullman, WA.

Buttery, R., and P. Shields 1975. Range management practices and bird habitat values. Pages 183-189 in D. R. Smith, ed., Symp. on management of forest and range habitats for non-game birds. U.S. For. Serv. Gen. Tech. Rep. WO-1.

Cadwell, L. 1995. Wildlife studies on the Hanford Site: 1994 highlights report. Report by Pacific Northwest Laboratory for U. S. Department of Energy, Contract DE-AC06-76RLO1830.

Campbell, R., N. Dawe, I. McTaggert-Cowan, J. Cooper, G. Kaiser. 2003 The birds of British Columbia. Volume 4. Royal British Columbia Museum, Victoria, British Columbia.

CBPLTWG (Columbia Basin Pacific Lamprey Technical Work Group) 1999. Planning of Columbia Basin Pacific lamprey projects and needs. Report to the Northwest Power Planning Council and Bonneville Power Administration, Portland, Oregon.

Cederholm, C., D. Johnson, R. Bilby, L. Dominguez, A. Garrett, W. Graeber, E. Greda, M. Kunze, B. Marcot, J. Palmisano, R. Plotnikoff, W. Pearcy, C. Simenstad, and P. Trotter. 2000. Pacific salmon and wildlife-ecological contexts, relationships, and implications for management. Special Edition Technical Report, Prepared for D.H. Johnson and T. A. O'Neil (Manag. Dirs.), Wildlife-Habitat Relationships in Oregon and Washington. Washington Department of Fish and Wildlife, Olympia.

Chasko, G., and J. Gates. 1982. Avian habitat suitability along a transmission-line corridor in an oak-hickory forest region. Wildl. Monogr. 82:1-41.

Childs. 1997. Complete citation unavailable.

Cline, D. 1976. Reconnaissance of the water resources of the upper Klickitat river basin, Yakima Indian reservation. Washington: U.S. Geological Survey Open-File Report 75-518, 54p.

Close, D., M. Fitzpatrick, H. Li, B. Parker, D. Hatch, and G. James. 1995. Status report of the Pacific lamprey (Lampetra tridentata) in the Columbia River basin. Prepared for the U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

Cochnauer, T. G. 1981. Survey status of white sturgeon populations in the Snake River.

Collins, K. et al. 2003. Barges as temporary breeding sites for Caspian terns: Assessing potential sites for colony restoration. Wildlife Society Bulletin: in press.

Collins, T. 1976a. Population characteristics and habitat relationships of beaver in Northwest Wyoming. Ph.D. Diss., Univ. Wyoming, Laramie [Abstract only, from Diss. Abst. Int. B Sci. Eng. 37(11):5459, 19771.

_____. 1976b. Stream flow effects on beaver populations in Grand Teton National Park. Pages 349-352 in Proceedings of the First Conference - on Scientific Research in the National Parks, U.S. Dept. Int. Nat. Park Serv., Trans. Proc. Series 5. Vol. I.

Colorado. Pages 186-197 in Proc. of the wildlife livestock relationships symposium. For. Wildl. Range Exp. Stn., Univ. Idaho, Moscow.

Columbia River white sturgeon (Acipenser transmontanus) early life history and genetics study. Report to the Bonneville Power Administration, Portland Oregon.

Columbia River. Oregon Fish and Game Commission Research Briefs 3(2):8-21.

Conley, W., F. Dobler, J. Matthews, B. Sharp. 2001. Draft Rock Creek Subbasin Summary. Prepared for the Northwest Power Planning Council.

Connel, D., G. Davis, S. McCormick, and C. Bushey. 1973. The hospitable oak: coordination guidelines for wildlife habitats, No. 3. California Reg., U.S. For. Serv.

Connor, R. 1979. Minimum standards and forest wildlife management. Wildlife Society Bulletin 7: 293-296.

_____, J. Via, and I. Prather. 1979. Effects of pine-oak clearcutting on winter and breeding birds in southwestern Virginia. Wilson Bull. 92:301-306.

Connor, W., H. Burge, R. Waitt, and T. Andersen. 1998. Early life history and survival of Snake River natural subyearling fall chinook salmon in 1996. Chapter 1 in J.G. Williams, and T.C. Bjornn, editors. Fall chinook salmon survival and supplementation studies in the Snake River and lower Snake River reservoirs, 1996. Draft Annual Report, 1996. DOE/BP 93-029. Bonneville Power Administration, Portland, Oregon.

Conte, F., S. Doroshov, P. Lutes, and E. Strange. 1988. Hatchery manual for

Cooper, S., K. Neiman, and D. Roberts. 1991. Forest habitat types of northern Idaho: a second approximation. U.S. Forest Service, General Technical Report INT-236.

Corkran, C. and C. Thoms. 1996. Amphibians of Oregon Washington and British Columbia. Lone Pine Publishing. Edmonton, Alberta. 175pp.

Cornish, T., M. Linders, S. Little, and W. Vander Haegen. 2001. Notoedric mange in western gray squirrels from Washington. Journal of Wildlife Diseases 37:630-633.

Coutant, C. 1973. Effect of thermal shock on vulnerability of juvenile salmonids to predation. J. Fish. Res. Board Can. 30:965-973.

Crawford, R., and J. Kagan. 2001. Shrub-steppe in Wildlife Habitat Relationships in Oregon and Washington, D.H. Johnson and T.A. O'Neil editors. Oregon State University Press, Corvalis, OR.

CRITFC (Columbia River Inter-Tribal Fish Commission). 1995. Wy-Kan-Ush-Mi Wa-Kish-Wit. The Columbia River anadromous fish restoration plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes. CRITFC, Portland, Oregon.

Cross, S. 1969. Behavioural aspects of western gray squirrel ecology. Ph.D. Dissertation. University of Arizona, Tucson, AZ.

Crouch, G. 1981. Wildlife on ungrazed and grazed bottom lands on the South Platte River in northeastern [end of citation missing]

_____. 1978. Effects of protection from livestock grazing on a bottomland wildlife habitat in northeastern Colorado. Pages 118-125 in Proc. lowland river and stream habitat in Colorado. Univ. North Colorado, Greeley.

Cummins, K. , and J. Wuycheck. 1971. Caloric equivalents for investigations in ecological energetics. International Association of Theoretical and Applied Limnology, Communication 18, Stuttgart, Germany.

Cushman, R. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5:330-339.

Daubenmire, R. 1970. Steppe vegetation of Washington. Washington Agricultural Experiment Station Technical Bulletin 62. Washington State University, Pullman, WA.

_____, and J. Daubenmire. 1968. Forest vegetation of eastern Washington and northern Idaho. Technical Bulletin 60. Washington Agricultural Experiment Station, College of Agriculture, Washington State University, Pullman, WA.

Dauble, D. and D. Geist. 2000. Comparison of Mainstem spawning habitats for two populations of fall chinook salmon in the Columbia River Basin. Regulated Rivers: Research & Management 16:345-361.

_____, and R. Mueller. 2000. Upstream passage monitoring, difficulties in estimating survival for adult chinook salmon in the Columbia and Snake rivers. Fisheries 25(8):24-34.

_____, and D. Watson. 1997. Status of fall chinook salmon populations in the mid-Columbia River, 1948-1992. North American Journal of Fisheries Management 17:283-300.

_____, K. Price, and T. Poston. 1992. Radionuclide concentrations in white sturgeon from the Columbia River. Report by Pacific Northwest Laboratory for U. S. Department of Energy, Contract DE-AC06-76RLO1830.

_____, Gray, and T. Page. 1980. Importance of insects and zooplankton in the diet of 0-age chinook salmon (Oncorhynchus tshawytscha) in the central Columbia River. Northwest Science 54:253-258.

Daugherty, C., and A. Sheldon. 1982. Age-determination, growth, and life history of a Montana population of the tailed frog (ascaphus truei). Herpetologica 38 (4): 46l-468.

Davis, J. 1982. Livestock vs. riparian habitat management--there are solutions. Pages 175-183 in Proc. Of the wildlife livestock relationships symposium. For. Wildl. Range Exp. Stn., Univ. Idaho, Moscow.

Davis, S., and S. Sealy. 2000. Cowbird parasitism and nest predation in fragmented grasslands of southwestern Manitoba. Pages 220-228 In J. N. M. Smith, T. L. Cook, S. I. Rothstein, S. K.

Robinson, and S. G. Sealy, editors. Ecology and management of cowbirds and their hosts. University of Texas Press, Austin, TX.

Deacutis, C. 1978. Effect of thermal shock on predator avoidance by larvae of two fish species. Transactions of the American Fisheries Society 107:632-635.

DeHart, M. 2003. Letter to Independent Scientific Advisory Board, Northwest Power Planning Council. Prepared with the Fish Passage Center. Portland, OR.

Denney, R. 1952. A summary of North American beaver management. 1946-1948. Colo. Fish Game Dept. Rep. 28, Colo. Div. Wildl.

DEQ. 2003. Lower Umatilla Basin Groundwater Management Area Fact Sheet. Portland, OR.

Detling, L. 1968. Historical background of the flora of the Pacific Northwest. Mus. Nat. Hist. Bull. No. 13, Univ. Oregon, Eugene, OR.

DeVore, J., B. James, and R. Beamesderfer. 1999. Lower Columbia River white sturgeon current stock status and management implications. Washington Department of Fish and Wildlife Report Number 99-08, Olympia, Washington.

DeVoto, B., Ed. 1953. The journals of Lewis and Clark. Houghton Mifflin Company, Boston.

Dixon, R. 1995a. Density, nest-site and roost-site characteristics, home-range, habitat-use, and behavior of white-headed woodpeckers: Deschutes and Winema National Forests, Oregon. Oregon Department of Fish and Wildlife Nongame Report 93-3-01, Portland, OR.

_____. 1995b. Ecology of the white-headed woodpecker in the Central Oregon Cascades. Thesis, University of Idaho, Moscow, ID.

Dobler F., J. Eby, C. Perry, S. Richardson, M. Vander Haegen. 1996. Status of Washington's shrub-steppe ecosystem: Extent, ownership, and wildlife/vegetation relationships. Washington Department of Fish and Wildlife, Olympia, WA.

Dobler, F. 1994. Washington state shrubsteppe ecosystem studies with emphasis on the relationship between nongame birds and shrubs and grass cover densities. Pages 149-161 In.(S. B. Monsen and S. G. Kitchen, compilers). Proceedings - Ecology and management of annual rangelands. U.S. Department of Agriculture, Forest Service General Technical Report. INT-GTR 313.

_____, J. Eby, C. Perry, S. Richardson, and M. Vander Haegen. 1996. Status of Washington's shrub-steppe ecosystem: extent, ownership, and wildlife/vegetation relationships. Research Report. Washington Department of Fish and Wildlife, Olympia, WA.

Downs, J., and 10 co-authors. 1993. Habitat types on the Hanford Site: wildlife and plant species of concern. Report by Pacific Northwest Laboratory for U. S. Department of Energy, Contract DE-AC06-76RLO1830.

Duff, D. 1979. Riparian habitat recovery on Big Creek, Rich County, Utah. Pages 91-92 in Proc. of the forum--grazing and riparian/stream ecosystems. Trout Unlimited, Inc. Vienna, Va.

Dugger, C. 1999. Washington Department of Fish and Wildlife, Personal communication to Kevin Lautz.

EKCD (Eastern Klickitat Conservation District). 1997. 1997 Water Quality and Quantity Monitoring Report. 33 pp.

Ebel, W., C. Becker, J. Mullan, and H. Raymond. 1989. The Columbia River – toward a holistic understanding. Canadian Special Publication of Fisheries and Aquatic Sciences 106:205-219.

Eberhardt, L.., E. Hanson, and L. Cadwell. 1984. Movement and activity patterns of mule deer in the sagebrush-steppe region. Journal of Mammalogy 65:404-409.

Eckert, K. 1990. A winter record of a Grasshopper Sparrow. Loon 62: 39-41.

Ecosystem Standards Advisory Board and the Washington Conservation Commission, 1994. Ecosystem standards for state-owned agricultural and grazing land (HB 1309), Olympia, Washington.

Ehinger, W. 1996. Evaluation of High Temperature in Rock Creek (Klickitat County). Washington Department of Ecology Report # 96-308. 3 pp.

Ehrlich, P., D. Dobkin, and D. Wheye. 1992. Birds in Jeopardy: the Imperiled and Extinct Birds of the United States and Canada, Including Hawaii and Puerto Rico. Stanford University Press, Stanford, CA.

Eldred, D. 1970. Steelhead spawning in the Columbia River, Ringold to Priest Rapids Dam, September 1970 Progress Report. Washington Department of Game, Ephrata, Washington.

Elliott, J. 1982. The effects of temperature and ration size on the growth and energetics of salmonids in captivity. Comparative Biochemistry and Physiology 73 B(1):81-91.

Elliott, P. 1978. Cowbird parasitism in the Kansas tall grass prairie. Auk 95:161-167.

_____. 1976. The role of community factors in cowbird-host interactions. Ph.D. dissertation. Kansas State University, Manhattan, KS.

Evans, K., and R. Krebs. 1977. Avian use of livestock watering ponds in western South Dakota. U.S. For. Serv. Gen Tech. Rep. RM-35.

Ewing, R., S. Johnson, H. Pribble, and J. Lichatowich. 1979. Temperature and photoperiod effects on gill (Na+K)-ATPase activities in chinook salmon (Oncorhynchus tshawytscha). Journal of the Fisheries Research Board of Canada 36:1347-1353.

Farrar, D. 2004. Weed Control Officer, Gilliam County, Oregon. Nov. 2004.

Fickeisen, D. 1985. White sturgeon work plan. Bonneville Power Adm., Contr'act No. DE- AI79-85BP22209. Portland, OR.

Fischer, W. and A. Bradley. 1987. Fire Ecology of western Montana forest habitat types. USDA Forest Service, Intermountain Forest and Range Research Station, General Technical Report, INT-223.

Fitzner, R., and R. Gray. 1991. The Status, Distribution and Ecology of Wildlife on the U.S. DOE Hanford Site: A Historical Review of Research Activities. Environmental Monitoring and Assessment 18:173-202.

_____, and W. Hanson. 1979. A congregation of bald eagles. Condor 81:311-313.

Foley, T. and R. Lothrop. 2003. Tribal Energy Vision. Prepared by Tom Foley Consultants and Columbia River Inter-Tribal Fish Commission, Portland, OR. 53pp.

Foster, S. 1992. Studies of ecological factors that affect the population and distribution of the western gray squirrel in northcentral Oregon.

Frankel, O., and M. Soulé. 1981. Conservation and Evolution. Cambridge Univ. Press, London.

Franklin, J., and C. Dyrness. 1984. Natural Vegetation of Oregon and Washington. Oregon State University Press. Oregon.

_____. 1973. Natural vegetation of Oregon and Washington. U.S. Pacific Northwest Forest and Range Experiment Station, General Technical Report. PNW-8, Portland, OR.

Frederick, G. and T. Moore. 1991. Distribution and habitat of white-headed woodpecker (Picoides albolarvatus) in west central Idaho. Cons. Data Centre, Idaho Dept. of Fish and Game, Boise, ID.

French, R. 2003. Personal communication to Laura Berg. Oct. 2003

Frenzel, R. 1998. Nest-sites and nesting success of white-headed woodpeckers on the Winema and Deschutes National Forests, Oregon in 1997. Unpubl. rept. submitted to Oreg. Nat. Heritage Prog,, The Nature Conserv. Of Oregon, Portland, OR.

Frest, T., and E. Johannes. 1993. Mollusc survey of the Hanford Site, Benton and Franklin counties, Washington. Report by Pacific Northwest Laboratory for U. S. Department of Energy, Contract DE-AC06-76RLO1830.

Friesen, T., and D. Ward. 1999. Management of northern pikeminnow and implications for juvenile salmonid survival in the lower Columbia and Snake rivers. North American Journal of Fisheries Management 19:406-420.

Fryer, J., and K. Pilcher. 1974. Effects of temperature on diseases of salmonid fishes. EPA-660/3-73-020 to Office of Research and Development, EPA, by Western Fish Toxicology Laboratory, EPA, Corvalis, OR. 114 pp.

Fulton, L.. 1968. Spawning areas and abundance of chinook salmon in the Columbia River basin—past and present. U.S. Fish and Wildlife Service Special Scientific Report Fisheries 571.

Gabrielsen, I., and S. Jewett. 1940. Birds of Oregon. Oregon State College, Corvallis. (Reprinted in 1970 as Birds of the Pacific Northwest by Dover Publications, New York).

Gadomski, D., M. Parsley, D. Gallion, and P. Kofoot. 2001. Describe reproduction and early life history characteristics in white sturgeon populations in the Columbia River between Bonneville and Priest Rapids dams and define habitat requirements for spawning and rearing white sturgeon and quantify the extent of habitat available in the Columbia River between Bonneville and Priest Rapids dams. Pages 48 – 88 in D. L. Ward, Editor. White sturgeon mitigation and restoration in the Columbia and Snake Rivers upstream of Bonneville Dam. Annual Progress Report to the Bonneville Power Administration, Portland Or.

Garrett L., M. Raphael, and R. Dixon. 1996. White-headed woodpecker (Picoides albolarvatus). In The Birds of North America No. 252 (A. Poole and F. Gill eds.). The Academy of Natural Sciences, Philadelphia, PA and the American Ornithologists Union, Washington D.C.

_____, and T. Dunn. 1981. Birds of southern California. Los Angeles Audubon Soc., Los Angeles, CA.

Garrott, R., G. White, R. Bartmann, L. Carpenter, and A. Alldredge. 1987. Movements of female mule deer in northwest Colorado. Journal of Wildlife Manangement 51:634-643.

Geist, D. 2000. Hyporheic discharge of river water into fall chinook salmon (Oncrohynchus tshawytscha) spawning areas in the Hanford Reach, Columbia River. Canadian Journal of Fisheries and Aquatic Sciences 57:1647-1656.

_____. 1995. The Hanford Reach: what do we stand to lose? Illahee 11:130-141.

_____, J. Jones, C. Murray, and D. Dauble. 2000. Suitability criteria analyzed at the spatial scale of redd clusters improved estimates of fall chinook salmon (Oncorhynchus tshawytscha) spawning habitat use in the Hanford Reach, Columbia River. Canadian Journal of Fisheries and Aquatic Sciences 57:1636-1646.

_____, and D. Dauble. 1998. Redd site selection and spawning habitat use by fall chinook salmon: the importance of geomorphic features in large rivers. Environmental Management 22: 655-669.

Gilligan, J., Rogers, M. Smith, and A. Contreras. 1994. Birds of Oregon. Cinclus Publishers, McMinnville, OR.

Gilman, K. 1986. The Western Gray Squirrel (Sciurus griseus): Its Summer Home Range, Activity Times, and Habitat Usage in Northern California. M.S. Thesis, California State Univ., Sacramento, CA.

Giorgi, A., T. Hillman, J. Stevenson, S. Hays, and C. Peven. 1997. Factors that influence the downstream migration rate of juvenile salmon and steelhead through the hydroelectric system in the mid-Columbia River basin. North American Journal of Fisheries Management 17:268-282.

Gislason, J. 1985. Aquatic insect abundance in a regulated stream under fluctuating and stable flows. North American Journal of Fisheries Management 5:39-46.

Global Security. 2004. Boardman Range. http://www.globalsecurity.org/military/facility/boardman.htm (Oct. 2004)

Grant PUD. 2000. Complete citation unavailable.

Gray, G., and D. Rondorf. 1986. Predation on juvenile salmonids in Columbia Basin reservoirs. Pages 178-185 in G.E. Hall and M.J. Van Den Avyle, editors. Reservoir Fisheries Management: Strategies for the 80's. American Fisheries Society, Bethesda, Maryland.

Gray, R., and D. Dauble. 1977. Checklist and relative abundance of fish species from the Hanford Reach of the Columbia River. Northwest Science 51:208-215.

_____. 1976. Synecology of the fish community near Hanford Generating Project and assessment of plant operational impacts. Pages 5.1 to 5.55 in Final Report on Aquatic Ecological Studies Conducted at the Hanford Generating Project, 1973-1974. WPPSS Columbia River Ecology Studies Vol. 1. Prepared for Washington Public Power Supply System under Contract No. 2311201335 with United Engineers and Constructors, Inc., by Battelle, Pacific Northwest Laboratories, Richland, Washington.

Guenther 1997. Complete citation unavailable.

Gumtow-Farrior, D. 1991. Cavity resources in Oregon white oak and Douglas-fir stands in the mid-Willamette Valley, Oregon. M.S. Thesis, Oregon State Univ., Corvallis, OR.

Habeck, J. 1990. Old-growth Ponderosa pine-western larch forests in western Montana: ecology and management. The Northwest Environmental Journal. 6: 271-292.

Hallock, L. 1998. Herpetofauna inventory of Bureau of Land Management sites in Douglas, Franklin, Grant, Lincoln, Klickitat, Washington. Bureau of Land Management, Spokane, Washington.

Hammann, M. 1981. Utilization of the Columbia River estuary by American shad (Alosa sapidissima Wilson). Master's Thesis. Oregon State University. 48 pp.

Hansen, B. 2002. A description of the North American Migration Count. Available at http://www.wvi.com/~bhansen/namcdesc.htm.

Hanson, E., and Sytsma, M. 2001. Oregon Aquatic Nuisance Species Management Plan. Portland State University, Center for Lakes and Reservoirs, Portland, OR. http://www.clr.pdx.edu/publications/OR_ANS_Plan.pdf

Hatch, D., and B. Parker. 1998. Lamprey research and restoration project. 1996 Annual Report. Part (B), Abundance monitoring for Columbia and Snake rivers. Prepared for the U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.

Hatch, D. et al. 2003. Kelt Reconditioning: A Research Project to Enhance Iteroparity in Columbia Basin Steelhead (*Oncorhynchus mykiss*) Annual Report prepared by Columbia River Inter-Tribal Fish Commission and Yakama Nation for Bonneville Power Administration, Portland, Oregon.

Haufler, J. 2002. Planning for species viability: Time to shift from a species focus. Presented at the Northwestern Section Meeting: The Wildlife Society. Spokane, WA.

Hawkins, C., L. Gottschalk, and S. Brown. 1988. Densities and habitat of tailed frog tadpoles in small streams near Mt. St. Helens following the 1980 eruption. J. N. Am. Benthol. Soc. 7 (3): 246-252.

Haynes, J., R. Gray, and J. Montgomery. 1978. Seasonal movements of white sturgeon (Acipenser transmontanus) in the mid-Columbia River. Transactions of the American Fisheries Society 107: 275-280.

Heinith, B. and R. Lothrop. 2004. The biological benefits of spill. CRITFC PowerPoint presentation. Portland, OR

Herkert, J. 1994a. The effects of habitat fragmentation on midwestern grassland bird communities. J. Ecol. Appl. 4: 461-471.

_____. 1994b. Breeding bird communities of midwestern prairie fragments: the effects of prescribed burning and habitat-area. Nat. Areas J. 14:128-135.

_____ 1991. An ecological study of the breeding birds of grassland habitats within Illinois. Ph.D. thesis. University of Illinois, Urbana, IL.

Hillis, J., V. Applegate, S. Slaughter, M. Harrington, and H. Smith. 2000. Simulating historical disturbance regimes and stand structures in old-forest ponderosa pine/Douglas-fir forests. In: Proceedings of the 1999 National Silvicultural Workshop. USDA Forest Service. RMRS-P-19: 32-39.

Hjort, R., and 6 Co-authors. 1981. Habitat requirements for resident fishes in the reservoirs of the lower Columbia River. Report to the U.S. Army Corps of Engineers, contract DACW57-79-C-0067.

Hobbs, T. 1989. Linking Energy Balance to Survival in Mule Deer: development and test of a Simulation Model. Widl. Monogr. No. 101 Apr.

Hodgdon, H., and J. Hunt. 1953. Beaver management in Maine. Maine Dept. Inland Fish Game, Game Div. Bu 11. 3.

Holman, E. Personal Communication. Complete citation unavailable.

Holmes, J., 2001. Develop artificial propagation techniques and protocols in preparation for supplementation of selected white sturgeon population. Pages 114 – 130 in D. L. Ward, Editor. White sturgeon mitigation and restoration in the Columbia and Snake Rivers upstream of Bonneville Dam. Annual Progress Report to the Bonneville Power Administration, Portland Or.

Holt, R., J. Sanders, J. Zinn, J. Fryer, and K. Pilcher. 1975. Relation of water temperature to Flexibacter columnaris infection in steelhead trout (Salmo gairdneri), coho (Oncorhynchus kisutch), and chinook (O. tshawytscha) salmon. Journal of the Fisheries Research Board of Canada 32:1553-1559.

Hudson, M. 2003. Klickitat County NWB, Personal Communication.

Hunn, E., 1990. Nch'i Wana "The Big River": Mid-Columbia Indians and Their Land, University of Washington Press, Seattle and London.

Hutto, R., and J. Young. 1999. Habitat relationships of landbirds in the Northern Region, USDA Forest Service. USDA Forest Service General Technical Report RMRS-GTR-32.

IBIS (Interactive Biodiversity Information System). .2003. Website created by the Northwest Habitat Institute for Subbasin Planning: http://www.nwhi.org/ibis/subbasin/home.asp.

Imhof, J., J. Fitzgibbon, and W. Annable. 1996. A hierarchical evaluation system for characterizing watershed ecosystems for fish habitat. Canadian Journal of Fisheries and Aquatic Sciences 53(Suppl.1):312-326.

Ingles, L. 1947. Ecology and life history of the Califormia gray squirrel. California Fish and Game Bulletin. 33:139-157.

ISG (Independent Scientific Group). 2000. Return to the river, restoration of salmonid fishes in the Columbia Riber ecosystem. Northwest Power Planning Council, Portland, OR. http://www.nwcouncil.org/library/return/2000 http://www.nwcouncil.org/library/return/2000-12.htm 12.htm

Jackman, S. 1975. Woodpeckers of the Pacific Northwest: their characteristics and their role in the forests. M.S. Thesis, Oregon State Univ., Corvallis, OR.

James, B., D. Gilliland, B. Cady, and J. DeVore. Evaluate the success of developing and implementing a management plan for enhancing production of white sturgeon in reservoirs between Bonneville and McNary dams. Pages 26 – 48 in D. L. Ward, Editor. White sturgeon mitigation and restoration in the Columbia and Snake Rivers upstream of Bonneville Dam. Annual Progress Report to the Bonneville Power Administration, Portland Or.

Jaske, R., and J. Goebel. 1967. Effects of dam construction on temperatures of Columbia River. Journal of American Water Works Association 59:935-942.

Jenkins, S., and P.Busher. 1979. Castor canadensis. Am. Sot. Mammal, New York. Mammalian Species 120:1-8.

Johnson, D. 1997. Effects of fire on bird populations in mixed-grass prairie. p.181-206 in F.L. Knopf and F.B. Samson, eds. Ecology and conservation of Great Plains vertebrates. Springer-Verlag, NY.

_____, and T. O'Neill. 2001. Wildlife-habitat relationships in Oregon and Washington. Oregon State University Press, Corvallis, Oregon.

Johnson, R., and K. Cassidy. 1997. Mammals of Washington State: Location data and predicted distributions. Volume 3 in Washington State Gap Analysis – Final Report (K.M. Cassidy, C.E. Grue, M.R. Smith, and K.M. Dvornich, eds.). Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, WA.

Kagan, J. et al. 2004. Classification of native nvgetation of Oregon. Oregon Natural Heritage Program, Portland, OR.

Kaigle, W. University of Idaho, unpublished data on Pacific lamprey

Karr, J., and E. Chu. 1999. Restoring life in running waters: Better biological monitoring. Island Press, Washington, D.C.

Keefer, M. L. and C. Peery. 2004. Adult salmonid fallback and escapement during summer (July-August) spill/no spill periods at Bonneville, The Dalles, John Day and Ice Harbor dams. Letter Report, University of Idaho, Moscow.

Keefer, M. L., C. Peery, K. Tolotti, S. Lee, M. Jepson, M. Heinrich, and M. Morasch. 2004. Reach and hydrosystem escapement estimates for radio-tagged salmon and steelhead: 1996-2002. Report to the U.S. Army Corps of Engineers and Bonneville Power Administration, University of Idaho, Idaho Cooperative Fish and Wildlife Research Unit, Moscow.

Kiefer, R. 2004 Impacts of 2001 migration conditions on adult returns: Evidence that flow and spill are more important than direct survival estimates (like SIMPAS) indicate. IDFG. www.nwd-wc.usace.army.mil/ tmt/agendas/2004/1110-rk-migration.pdf

Kennedy, V. 1990. Anticipated effects of climate change on estuarine and coastal fisheries. Fisheries 15(6):16-42.

Kern, J., M. Hughes, and T. Rien. 2004. Report A. Evaluate the success of developing and implementing a management plan for white sturgeon in reservoirs between Bonneville and McNary dams in enhancing production. Pages 4 to 45 in D.L. Ward, editor. Status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

_____. 2002. Report A. Evaluate the success of developing and implementing a management plan for white sturgeon in reservoirs between Bonneville and McNary dams in enhancing production. Pages 5 to 68 in D.L. Ward, editor. Status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

Kern, J., T. Rien, and R. Farr. 1999. Report A. Evaluate the success of developing and implementing a management plan for white sturgeon in reservoirs between Bonneville and McNary dams in enhancing production. Pages 5 to 42 in D.L. Ward, editor. Status and habitat requirements of white sturgeon populations in the Columbia River downstream from McNary Dam. Annual Progress Report to Bonneville Power Administration, Portland, Oregon.

Key, L., R. Garland, and K. Kappenman. 1996. Nearshore habitat use by subyearling chinook salmon and non-native piscivores in the Columbia River. Pages 64-79 in D. W. Rondorf and K. F. Tiffan, editors. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River basin. 1994 Annual Report to the Bonneville Power Administration, contract DE-AI79-91BP21708, Portland, Oregon.

Key, L., R. Garland, and E. Kofoot. 1994. Nearshore habitat use by subyearling chinook salmon in the Columbia and Snake rivers. Pages 74-107 in D.W. Rondorf and K.F. Tiffan, editors. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River basin. 1993 Annual Report to the Bonneville Power Administration, contract DE-AI79-91BP21708, Portland, Oregon.

Kirsch, M. 2001. ODFW. Jan. 2001

Knopf, F., J. Sedgwick, and D. Inkley. 1990. Regional correspondence among shrubsteppe bird habitats. Condor 92:45-53.

Knutsen, C., and D. Ward. 1999. Biological characteristics of northern pikeminnow in the lower Columbia and Snake rivers before and after sustained exploitation. Transactions of the American Fisheries Society 128:1008-1019.

Knutson, K., and V. Naef. 1997. Management recommendations for Washington's priority habitats: riparian. Wash. Dept. Fish and Wildl., Olympia, WA.

Kofoot, E., D. Feil, and W. Stastny. 1994. Comparison of field and In Situ acoustic target strengths of juvenile fall chinook salmon and American shad. Pages 132-149 in D.W. Rondorf and K.F. Tiffan, editors. Identification of the spawning, rearing, and migratory requirements of fall chinook salmon in the Columbia River basin. 1993 Annual Report to the Bonneville Power Administration, contract DE-AI79-91BP21708, Portland, Oregon.

LaFramboise and LaFramboise. 1998. Complete citation unavailable.

Lambeck, R. 1997. Focal species: a multi-species umbrella for nature conservation. Cons. Biol. 11(4):849-856.

LaRiviere, P. WDFW

Larsen, E., and J. Morgan. 1998. management recommendations for Washington’s priority habitats: Oregon white oak woodlands. Wash. Dept. Fish and Wildl., Olympia, WA.

Larson, D., and C. Bock. 1986. Determining avian habitat preference by bird-centered vegetation sampling. Pages 37-43 in J. Verner, J. L. Morrison, and C. J. Ralph, eds. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. Univ. Wisconsin Press, Madison, WI.

Lautz, K. 2000. Salmon and Steelhead Habitat Limiting Factors: Water Resource Inventory Area 31. Washington State Conservation Commission.

Leary, A. 1996. Home Ranges, Core Use Areas, and Dietary Habits of Ferruginous Hawks in Southcentral Washington. Master’s thesis, Boise State University, Boise, Idaho.

Leege, T. 1969. Burning seral brush ranges for big game in northern Idaho. Trans. N. Amer. Wildl. and Natur. Resour. Conf. 34:429-437.

_____. 1968. Prescribed burning for elk in northern Idaho. Tall Timbers Fire Ecol. Conf. Proc. 8:235-254.

Leonard et al. 1993. Complete citation unavailable.

Levine, N. 1965. Pages 456-460 in Buster and Schwartz, editors. Diseases of Poultry. 1965.

Lewis, J., M. Whalen, and E. Rodrick. 2002. Washington Depart of Fish and Wildlife’s priority habitat and species management recommendations Volume IV: Birds. Lewis’ Woodpecker (Melanerpes lewis).

Lies, M., “Bill would loosen strings on Columbia water withdrawals,” March 3, 2003. Capitol Press. Salem, OR

Ligon J. 1973. Foraging behavior of the white-headed woodpecker in Idaho. Auk 90: 862-869.

Linders, M. 2000. Spatial ecology of the western gray squirrel in Washington: The interaction of season, habitat and home range. M.S. Thesis. Univ. of Washington, Seattle, WA.

Locke, L. and M. Friend. 1987. Pages 83-93 In M. Friend, editor. Field Guide to Wildlife Diseases. Fish and Wildlife Publication No. 167.

Longley, W., and J. Moyle. 1963. The beaver in Minnesota. Minn. Dept. Conserv. Tech. Bull. 6.

Losensky, B. 1993. Historical vegetation in Region One by climatic section. Unpublished report. Available at Lolo National Forest, Missoula, MT.

Lowther, P., C. Celada, N. Klein, C. Rimmer, and D. Spector. 1999. Yellow Warbler Dendroica petechia. Pages 1-32 In Poole, A. and F. Gill (editors), The birds of North America, No. 454. The Birds of North America, Inc., Philadelphia, PA.

Lukas, J. 2001. Operations and monitoring of the 2000 Hanford Reach juvenile fall chinook protection program. Public Utility District No. 2 of Grant County, Ephrata, WA.

_____. 1999. Grant PUD operations under the 1999 Hanford Reach juvenile fall chinook protection program. Public Utility District No. 2 of Grant County, Ephrata, WA.

Lyons C., and B. Merilees. 1995. Trees, Shrubs and Flowers to Know in Washington and British Columbia. Lone Pine Publishing, Vancouver, British Columbia.

McCullough, D.A. 1999. A review and synthesis of effects of alterations to the water temperature regime of freshwater life stages of salmonids, with special reference tochinook salmon. Prepared for Region 10, EPA. By Columbia River Inter- Tribal Fish Commission. Portland, OR.

Macy, T., C. Burley, and W. Ambrogetti. 1997. Sturgeon studies of the Jon Day Reservoir, 1979-1981. U. S. Fish and Wildlife Service, Columbia River Fisheries Program Office, Vancouver, Washington.

Manual, D., 1997. Neotropical bird communities in oak woodland of South-central Washington. Final report to Washington Department of Fish and Wildlife, Olympia. WA. and US Fish and Wildlife Service, Portland OR.

_____. 1989. Birds of the riparian and adjacent oak habitats along the Klickitat River, Washington. Final Report. Washington Department of Wildlife, Vancouver, WA.

Marshall, D., Hunter, M., Contreras, A. (Eds.). 2003. Birds of Oregon. Oregon State University Press, Corvallis, OR.

Matthews, J. 2001. Yakama Nation Fisheries Resource Management, Personal communication to Laura Berg.

Matylewich, M. 2004. Personal communication to Laura Berg.

McCabe, G., and C. Tracy. 1993. Spawning characteristics and early life history of white sturgeon (Acipenser transmontanus) in the Lower Columbia River. Pages 19 – 49 in Pages 89-108 in R. C. Beamesderfer and A. A. Nigro, eds. Status and habitat requirements of the white sturgeon ppulations in the Columbia River downstream from McNary Dam. Vol. 1 Final report to the Bonneville Power Administration, Portland Or.

McCabe, T. 1976. Productivity and nesting habitat of Great Basin Canada Geese; Umatilla National Wildlife Refuge. M. S. Thesis, Oregon State Univ., Corvallis. 72 pp.

McCorquodale, S. 1999. Ecology and Co-Management of Black-Tailed Deer in the Klickitat Basin of Washington. Research Report Series, No. 1, Prepared for Yakama Nation, Wildlife Resource Management, Toppenish, WA.

McKern, J. 1976. Inventory of riparian habitats and associated wildlife along Columbia and Snake rivers. Summary Report, Volume 1. U. S. Army Corps of Engineers, North Pacific Division.

Meninick, J. 2001. Yakama Nation Cultural Committee, Personal communication to Thomas Backman.

Mesa, M. J. Bayer, J. Seelye, and L.Weiland. 2000. Swimming performance and exhaustic stress in Pacific lampreys (Lampetra tridentata): implications for upstream migrations past dams. Submitted to US Army Corps of Engineers, Portland, Oregon by USGS/BRD, Cook Washington.

Mesa, Matt and Mary Moser et al. Passage Considerations for Pacific Lamprey. Endorsed by CBFWA. Prepared by the Columbia River Basin Lamprey Technical Workgroup. 2004.

Mesa, M., S. Duke, and D. Ward. 1990. Spatial and temporal variation in proportional stock density and relative weight of smallmouth bass in a reservoir. Journal of Freshwater Ecology 5:323-339.

Meyers, G. 2004. District Manager, Gilliam County SWCD, Gilliam County Soil & Water Conservation District. Nov. pers. comm. 2004

Mighetto, L., and W. Ebel. 1995. Saving the salmon: a history of the U. S. Army Corps of Engineers' efforts to protect anadromous fish on the Columbia and snake rivers. Report to the U. S. Army Corps of Engineers. Historical Research Associates, Inc., Seattle, Washington.

Miller, A., T. Counihan, M. Parsley, and L. Beckman. 2004. Columbia River

Miller, H. 1985. Oregon white oak. Pages 275-278 in H. A. Miller and S. H. Lamb., eds. Oaks of North America. Naturegraph Publ., Happy Camp, CA.

Milne, K. and S. Hejl. 1989. Nest site characteristics of white-headed woodpeckers. Journal of Wildlife Management 53:50-55.

Montgomery, D., and J. Buffington. 1993. Channel classification, prediction of channel response, and assessment of channel condition. Report TFW-SH10-93-002 prepared for the SHAMW committee of the Washington State Timber/Fish/Wildlife Agreement.

Montgomery, J., D. Fickeisen, and C. Becker. 1980. Factors influencing smallmouth bass production in the Hanford area, Columbia river. Northwest Science 54:296-302.

Morgan, R. 2004. Wildlife Biologist, Oregon Department of Fish and Wildlife, Heppner, OR. Personal Communication.

Moser et al. 2002. Pacific lamprey

Moursund, R., D. Dauble, and M. Bleich. 2000. Effects of John Day Dam bypass screens and project operations on the behavior and survival of juvenile Pacific Lamprey (Lampetra tridentata). U.S. Army Corps of Engineers, Portland, Oregon.

Mueller, R., and D. Geist. 1999. Steelhead spawning surveys near Locke Island, Hanford Reach of the Columbia River. PNNL-13055. Pacific Northwest National Laboratory, Richland, Washington.

Muir, W., and six co-authors. 1998. Passage survival of hatchery subyearling fall chinook salmon to Lower Granite, Little Goose, and Lower Monumental dams, 1996. Chapter 2 in J.G. Williams, and T.C. Bjornn, editors. Fall chinook salmon survival and supplementation studies in the Snake River and lower Snake River reservoirs, 1996. Draft Annual Report, 1996. DOE/BP 93-029. Bonneville Power Administration, Portland, Oregon.

Murray, D. 1961. Some factors affecting the production and harvest of beaver in the upper Tanana River Valley, Alaska. M.S. Thesis, Univ. Alaska, Anchorage, AK.

National Research Council. 1996. Upstream: salmon and society in the Pacific Northwest. Report of the Committee on Protection and Management of Pacific Northwest Anadromous Salmonids for the National Research Council of the National Academy of Sciences. Available: http://books.nap.edu/books/0309053250/html/index.html (June 2003)

Neitzel, D. and T. Frest. 1993. Survey of Columbia River basin streams for Columbia pebblesnail Fluminicola columbiana and shortface lanx Fisherola nuttalli. Report by Pacific Northwest Laboratory for U. S. Department of Energy, Contract DE-AC06-76RLO1830.

Nelson, W. and four co-authors.. 1987. Pen Rearing and Imprinting of Fall Chinook Salmon. Annual Report. A43 13084-4. Bonneville Power Administration, Portland, OR.

NMI (Northeast Midwest Institute). 2001. National Invasive species Act of 1996. http://www.nemw.org/nisa_summary.htm

Nessler, T. and E. Bergersen. 1991. Mysids and their impacts on fisheries: an introduction to the 1988 mysid-fisheries symposium. American Fisheries Society Symposium No. 9:1-4.

Nixon, C., and J. Ely. 1969. Foods eaten by a beaver colony in southeastern Ohio. Ohio J. Sci. 69(5):313-319.

NMFS (National Marine Fisheries Service). 2000. Salmonid travel time and survival related to flow management in the Columbia River Basin. White Paper. Northwest Fisheries Science Center, Seattle, Washington.

NMFS. 2000. Biological Opinion on Reinitiation of Consultation on Operation of the Federal Columbia River Power System, Including the Juvenile Transportation Program, and 19 Bureau of Reclamation Projects in the Columbia Basin. National Marine Fisheries Service, Hydro Division, Portland, OR.

NOAA/Fisheries Biological Recovery Team. 1997. Tech Memo 27.

North, J., R. Beamesderfer, and T. Rien. 1993. Distribution and movements of white sturgeon in three lower Columbia River reservoirs. Northwest Science 67:105-111.

Northwest Area Committee. 2004a. Middle Columbia River Dalles Pool Area Geographic Response Plan. Northwest Area Committee. Revision 3; Prepared for WDE, ODEQ, IBM, USCGMSO, EPA. Portland, Oregon.

_____. 2004b. Middle Columbia River John Day Pool Area Geographic Response Plan. Northwest Area Committee. Revision 3; Prepared for WDE, ODEQ, IBM, USCGMSO, EPA. Portland, Oregon.

_____. 2004c. Middle Columbia River McNary Pool Area Geographic Response Plan. Northwest Area Committee. Revision 3; Prepared for WDE, ODEQ, IBM, USCGMSO, EPA. Portland, Oregon.

Noss, R., E. LaRoe III, and J. Scott. 1995. Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation. Biological Report 28. U.S. Department of the Interior, National Biological Service, Washington D.C. http://biology.usgs.gov/pubs/ecosys.htm

NRC (National Research Coucnil). 2004. Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival. A report of the National Research Council of the National Academies http://www.ecy.wa.gov/programs/wr/cri/Images/PDF/nasexesumry.pdf http://www.ecy.wa.gov/programs/wr/cri/crihome.hmtl

NW Ecosystem Alliance and Tacoma Audubon Society. 2000. Petition for an emergency rule to list the Washington populations of western gray squirrel, Sciurus griseus griseus, as threatened or endangered under the Endangered Species Act, 16 U.S.C., 1531 et seq. (1973 as amended). Unpublished report, NW Ecosystem Alliance, 1421 Cornwall Ave., Ste. 201, Bellingham, WA 98225. O'Connell, M., J. Hallet, and S. West. 1993. Wildlife use of riparian habitats: A literature review. TFW-WL1-93-001.

ODA (Oregon Department of Agriculture). 2001. Oregon Noxious Weed Strategic Plan. Oregon Department of Agriculture, Plant Division, Weed Control Program. Salem, OR. http://www.oda.state.or.us/Plant/weed_control/plan/contents.html

ODFW (Oregon Department of Fish and Wildlife). 2004a. Draft white sturgeon focal species in Lower Mid-Columbia Mainstem Columbia River Subbasin. Subbasin Plan to the Northwest Power and Conservation Council, Portland Or.

_____. 2004b. Oregon Department of Fish and Wildlife Sensitive Species. Oregon Department of Fish and Wildlife, Salem, OR. http://www.dfw.state.or.us/ODFWhtml/InfoCntrWild/InfoCntrWild.html

_____, 2004c. Oregon Admininstrative Rules, Oregon Department of Fish and Wildlife, Division 100 Wildlife Diversity Plan. Oregon Department of Fish and Wildlife, Salem, OR. http://www.dfw.state.or.us/ODFWhtml/InfoCntrWild/InfoCntrWild.html

_____. 2004d. Oregon's large mammals. Oregon Department of Fish and Wildlife, Salem, OR. http://www.dfw.state.or.us/south_willamette/largeanimals.html (Oct. 2004)

_____. 2004e. Mule Deer. Oregon Department of Fish and Wildlife, Salem, OR.

http://www.dfw.state.or.us/ODFWhtml/wildlife/statbooks/howto.htm.#mule (Oct. 2004)

_____. 2004f. Oregon Adminstrative Rules, Division 056: Importation, possession, confinement, transportation and sale of nonnative wildlife. Oregon Department of Fish and Wildlife, Salem, OR. http://www.dfw.state.or.us/ODFWhtml/Wildlife/Integrity/1FDraft.html (Oct. 2004)

_____. 2004g. Oregon big game statistics, How to use this book. Oregon Department of Fish and Wildlife, Salem, OR. http://www.dfw.state.or.us/ODFWhtml/wildlife/statbooks/howto.htm

______. 2003a. Oregon's mule deer management plan. Oregon Department of Fish ane Wildlife, Portland, OR.

______. 2003b. Oregon's bighorn sheep and Rocky Mountain goat management plan. Oregon Department of Fish and Wildlife, Salem, OR., USA.

______. 2000-2001. Oregon big game hunting statistics, 2000 and 2001. Oregon Department of Fish and Wildlife, Salem, OR. http://www.dfw.state.or.us/ODFWhtml/InfoCntrWild/InfoCntrWild.htm

______. 1999. Historical Deer Harvest Summary: Deer Hunting Trends 1952-1999. http://www.dfw.state.or.us/ODFWhtml/wildlife/statbooks/Table_of_contents_01.htm (Oct. 2004)

______, 1997. Oregon Department of Fish and Wildlife Sensitive Species, December 1997. Oregon Department of Fish and Wildlife, Salem, OR. http://www.dfw.state.or.us/ODFWhtml/InfoCntrWild/InfoCntrWild.html (Oct. 2004)

______. 1993. Oregon Wildlife Diversity Plan. Updated in January, 1999. Oregon Department of Fish and Wildlife, Portland, OR.

http://www.dfw.state.or.us/ODFWhtml/InfoCntrWild/Diversity/PlanOrder.html

OISC (Oregon Invasive Species Council). 2003. Oregon Invasive Species Action Plan. Oregon Invasive Species Council, Center for Lakes & Reservoirs, Portland State University, Portland, OR. http://www.oda.state.or.us/Plant/Inv_spp/OISCActionPlan_2=03.pdf http://www.oda.state.or.us/plant/inv_spp/

Oliver, W. 1986. Historical Review and Discussion of Deer Unit Management in Klickitat and Yakima Counties (and relationships with Yakima Indian Reservation). Unpublished Report. Yakama Nation, Toppenish, WA.

O'Neil, T. 2003. NHI.

ONHIC (Oregon Natural Heritage Information Center). 2004. Oregon rare, threatened, and endangered plants – vascular plants and non-vascular plants. OSU Oregon Natural Heritage Information Center, Corvallis, OR. http://oregonstate.edu/ornhic/data/vascular.html http://oregonstate.edu/ornhic/data/nonvasc.html (Oct. 2004)

Oregon Progress Board. 2000. Oregon State of the Environment Report 2000, Salem, OR.

Oregon-Washington Interagency Wildlife Committee. 1979. Managing riparian ecosystems (zones) for fish and wildlife in eastern Oregon and eastern Washington. Prepared by Riparian Habitat Subcomm. of the Oreg./Wash. Interagency Wildlife Comm. Portland, Oreg. 44pp.

OSA (Oregon State Archives). 2004. County Comprehensive Plans. Oregon State Archives, Oregon Historical County Records Guide), Salem, OR. http://arcweb.sos.state.or.us/county/cpgilliam/comp.html http://arcweb.sos.state.or.us/county/cpsherman/comp.html (Oct. 2004)

Overmire, T. 1963. The effects of grazing upon habitat utilization of the dickcissel (Spiza americana) and Bell's vireo (Vireo bellii) in northcentral Oklahoma. Ph.D. Thesis, Oklahoma State Univ., Stillwater.

PSFMC (Pacific States Marine Fisheries Commission). 1992. White sturgeon

Paige, C., and S. Ritter. 1998. Birds in a sagebrush sea: managing sagebrush habitats for bird communities. Western Working Group of Partners in Flight, Boise, ID.

Park, D. 1969. Seasonal changes in downstream migration of age-group 0 chinook salmon in the upper Columbia River. Transactions of the American Fisheries Society 98:315-317.

Parsley, M., and L. Beckman. 1994. White sturgeon spawning and rearing habitat in the lower Columbia River. North American Journal of Fisheries Management 14:812-827.

______, and G. McCabe, Jr. 1993. Spawning and rearing habitat use by white sturgeons in the Columbia river downstream from McNary Dam. Transactions of the American Fisheries Society 122:217-227.

Patton, G. and E. Crecelius. 2001. Simultaneously Extracted Metals/Acid-Volatile Sulfide and Total Metals in Surface Sediment from the Hanford Reach of the Columbia River and the Lower Snake River. PNNL-13417, Pacific Northwest National Laboratory, Richland, Washington.

Payne, N., G. Munger, J. Matthews, and R. Taber. 1976. Inventory of vegetation and wildlife in riparian and other habitats along the upper Columbia River. Vol. 4A. U. S. Army Corps of Engineers, North Pacific Division. Portland, Ore. 560 pp.

Peck, D., J. Lazorchak, and D. Klemm (Eds.). Unpublished draft. Environmental Monitoring and Assessment Program -Surface Waters: Western Pilot Study Field Operations Manual for Wadeable Streams. EPA. U.S. Environmental Protection Agency, Washington, D.C. 242p. 69

Pemberton, J. 1917. Notes on the Western Grasshopper Sparrow. Condor XIX, Jan. 1917, pp. 24-25.

Petersen, J. 1994. Importance of spatial pattern in estimating predation on juvenile salmonids in the Columbia River. Transactions of the American Fisheries Society 123:924-930.

Pfeifer, B., J. Hagen, D. Weitkamp and D. Bennett. 2000. An evaluation of fish species present in the Priest Rapids Project area. Prepared for Public Utility District No. 2 of Grant County by Parametrix, Inc., Kirkland, WA and University of Idaho, Moscow, ID.

Platts, W. 1990. Managing fisheries and wildlife on rangelands grazed by livestock: a guidance and reference document for biologists. Nev. Dept. Wildl. (Irr. Pag.).

Platts, W. 1979. Livestock grazing and riparian/stream ecosystems. Pages 39-45 in Proc., forum-grazing and riparian/stream ecosystems. Trout Unlimited, Inc.

PNNL (Pacific Northwest National Laboratory). 1998. Screening assessment and requirements for a comprehensive assessment. Columbia River Comprehensive Impact Assessment. DOE/RL-96-16, U.S. Department of Energy, Richland, Washington.

Poe, T., H. Hansel, S. Vigg, D. Palmer, and L. Prendergast. 1991. Feeding of predaceous fishes on out-migrating juvenile salmonids in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:405-420.

Poff, N. and seven co-authors. 1997. The natural flow regime. Bioscience 47:769-784.

Poston, T., R. Hanf, and R. Dirkes. 2000. Hanford site environmental report for calendar year 1999. PNNL-1320. Pacific Northwest National Laboratory, Richland, Washington.

Poulton, C. 1955. Ecology of the Non-Forested Vegetation in Umatilla and Morrow Counties, Oregon. PhD dissertation, State College of Washington.

PSMFC (Pacific States Marine Fisheries Commission). 2004. Report regarding white sturgeon in the Columbia River. Article on the ?

Quigley, T., and S. Arbelbide, Technical Eds. 1997. An assessment of ecosystem components in the interior Columbia basin and portions of the Klamath and Great Basins. Volume 2. U.S. Forest Service General Technical Report PNW-GTR-405.

Quinn, T., S. Hodgson, and C. Peven. 1997. Temperature, flow, and the migration of adult sockeye salmon (Oncorhynchus nerka) in the Columbia River. Canadian Journal of Fisheries and Aquatic Sciences 54:1349-1360.

Raedeke, K., L. Melampy, N. Elston, and S. Paulus. 1995. Ecology of mule deer on the Yakima training center. Prepared for the United States Army, Yakima, WA.

Raphael, M., and M. White. 1984. Use of snags by cavity nesting birds in the Sierra Nevada. Wildl. Monographs 86:1-66.

Rassmussen, L., and P. Wright. 1990. Wildlife impact assessment – John Day project, Oregon and Washington. Annual Report by U. S. Fish and Wildlife Service to Bonneville Power Administration.

_____. 1989. Wildlife Impact Assessment, John Day Project, Oregon and Washington. Annual Report 1989, Project No. 88-12. U.S. Dept of Energy, BPA Division of Fish and Wildlife Portland OR.

Rautenstrauch, K., and P. Krausmann. 1989. Influence of water availability on rainfall and movements of desert mule deer. J. Mamm. 70:197-201.

Raymond, H. 1988. Effects of hydroelectric development and fisheries enhancement on spring and summer chinook salmon and steelhead in the Columbia River basin. North American Journal of Fisheries Management 8:1-24.

_____. 1969. Effect of John Day Reservoir on the migration rate of juvenile chinook salmon in the Columbia River. Transactions of the American Fisheries Society 98:513-514.

_____. 1968. Migration rates of yearling chinook salmon n relation to flows and impoundments in the Columbia and Snake rivers. 97:356-359.

Reed, L., and N. Sugihara. 1987. Northern oak woodlands -- ecosystem in jeopardy or is it already too late? Pages 59-63 in T. R. Plumb and N. H. Pillsbury, tech. coords. Proc. symposium on multiple-use of California's hardwood resources. U.S. For. Serv. Gen. Tech. Rep. PSW-100.

Retzer, J., H. Swope, J. Remington, and W.H. Rutherford. 1956. Suitability of physical factors for beaver management in the Rocky Mountains of Colorado. Colorado Department of Game, Fish, and Parks, Tech. Bull. 2:1-32.

Reynolds, T., and C. Trost. 1980. The response of native vertebrate populations to crested wheatgrass planting and grazing by sheep. J. Range Manage. 33:122-125.

Rich, T. 1996. Degradation of shrubsteppe vegetation by cheatgrass invasion and livestock grazing: effect on breeding birds. Abstract only. Columbia Basin Shrubsteppe Symposium. April 23-25, 1996. Spokane, WA.

Rickard, W., and D. Watson. 1985. Four decades of environmental change and their influence upon native wildlife and fish on the mid-Columbia River, Washington, USA. Environmental Conservation 12:241-248.

Rickard, W., and L. Poole. 1989. Terrestrial wildlife of the Hanford Site: past and future. Northwest Science 63:183-193.

Ridgely, R., and J. Gwynne. 1989. A guide to the birds of Panama with Costa Rica, Nicaragua, and Honduras. 2d. ed. Princeton Univ. Press, Princeton, NJ.

Rieman, B., R. Beamesderfer, S. Vigg, and T. Poe. 1991. Estimated loss of juvenile salmonids to predation by northern squawfish, walleyes, and smallmouth bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:448-458.

Rien, T., and J. North. 2002. White sturgeon transplants within the Columbia river. In Van Winkle, W. P., P. J. Anders, D. H. Secor, and D. A. Dixon, eds. Biology, Management, and Protection of Sturgeons. American Fisheries Society Special Publication.

Rien, T., and K. Biningen (Eds.) 1997. Effects of mitigative measures on productivity of white sturgeon populations in the Columbia River downstream from McNary Dam, and determine the status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. Annual report by ODFW to Bonneville Power Administration. Contract DE-AI79-86BP63584.

Risser, P., E. Birney, H. Blocker, S. May, W. Parton, and J. Wiens. 1981. The True Prairie Ecosystem. Hutchinson Ross Publishing Company, Stroudburg, PA.

Robbins, C, D. Bystrak, and P. Geissler. 1986. The Breeding Bird Survey: its first 15 years, 1965-1979. USDI, Fish and Wildl. Serv. Res. Publ. 157.

Roche, C., and B. Roche Jr. 1988. Distribution and amount of four knapweed (Centaurea L.) species in eastern Washington. Northwest Science 62:242-253.

Roderick, E., and R. Milner (Eds). 1991. Management Recommendations for Washington's Priority Habitats and Species. Washington Department of Wildlife. Olympia, Washington.

Rodrick, E. 1986. Survey of historic habitats of the western gray squirrel (Sciurus griseus) in the southern Puget Trough and Klickitat County, WA. Unpubl. report to Washington Dept. of Wildlife.

_____, and R. Milner (Eds.). 1991. Management recommendations for Washington's priority habitats and species. Wash. Dept. Wildl., Olympia, WA.

Rogers, L., P. Beedlow, D. Dauble, L.. Eberhardt, and R. Fitzner. 1989. Ecological baseline study of the Yakima Firing Center proposed Land Acquisition: a status report. Report by Pacific Northwest Laboratory to the U. S. Army, contract DE-AC06-76RLO 1830.

_____. 1988. Ecological baseline study of the Yakima Firing Center proposed Land Acquisition: a preliminary report. Report by pacific Northwest Laboratory to the U. S. Army, contract DE-AC06-76RLO 1830.

Rohrbaugh, R. Jr., D.. Reinking, D. Wolfe, S. Sherrod, and M. Jenkins. 1999. Effects of prescribed burning and grazing on nesting and reproductive success of three grassland passerine species in tallgrass prairie. Pages 165-170 In P. D. Vickery and J. R. Herkert, editors. Ecology and conservation of grassland birds of the Western Hemisphere. Studies in Avian Biology 19.

Rolph, D. 1998. Assessment of Neotropical migrant landbirds on McChord Air Force Base, Washington. Unpubl. rep. The Nature Conservancy of Washington, Seattle, WA.

Rondorf, D., G. Gray, and R. Fairley. 1990. Feeding ecology of subyearling chinook salmon in riverine and reservoir habitats of the Columbia River. Transactions of the American Fisheries Society 119:16-24.

Rood, S., and J. Mahoney. 1990. Collapse of riparian poplar forests downstream from dams in western prairies: probable causes and prospects for mitigation. Environmental Management 14:431-464.

Rotenberry, J., and J. Wiens. 1980. Habitat structure, patchiness, and avian communities in North American steppe vegetation: a multivariate analysis. Ecology 61:1228-1250.

Rue, L., III. 1964. The world of the beaver. J. B. Lippincott Co., Philadelphia and New York.

Ryan, L., and A. Carey. 1995. Biology and management of the western gray squirrel and Oregon white oak woodlands: with emphasis on the Puget Trough. Gen. Tech. Rep. PNW-GRT-348. Portland, OR: U.S. Dept. of Agric., For. Serv., PNW Research Station. 36 p.

Saab, V. and K. Vierling. 2001. Reproductive success of Lewis' woodpecker in burned pine and cottonwood riparian forests. Condor 103:491-501.

Saab, V., and T. Rich. 1997. Large-Scale Conservation Assessment for Neotropical Migratory Land Birds in the Interior Columbia Basin. PNW-GTR-399. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Saab, V., C. Bock, T. Rich, and D. Dobkin. 1995. Livestock grazing effects in western North America. Pages 311-353. In. (T. E. Martin and D. M. Finch, eds). Ecology and management of neotropical migratory birds. Oxford University Press, New York, NY.

Samson, F. 1980. Island biogeography and the conservation of prairie birds. Proceedings of the North American Prairie Conference 7:293-305.

Sauer, J , J. Hines, I. Thomas, J. Fallon, and G. Gough. 1999. The North American Breeding Bird Survey: results and analysis. Version 98.1. Patuxent Wildl. Res. Center, Laurel, MD.

Scheffer, T. 1959. Field studies of the Garry oak in Washington. Univ. Washington Arboretum Bull. 22:88-89

Scherzinger. 1983. Complete citation unavailable.

Schroeder, M., D. Hays, M. Livingston, L. Stream, J. Jacobson, and D. Pierce. 2000. Changes in the distribution and abundance of sage grouse in Washington. Northwestern Naturalist 81:104-112.

Schroeder, R. 1982. Habitat suitability index models: Yellow warbler. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.27.

Scott, W., and E. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184, Ottowa. 966 pp.

Severson, K., and A. Carter. 1978. Movements and habitat use by mule deer in the Northern Great Plains, South Dakota. Pages 466-468, In D.N. Hyder, editor. Proceedings of the First International Rangeland Congress. Society for Range Management. Denver, CO.

Sherman County SWCD (Soil and Water Conservation District). 2004a. History of the Sherman County SWCD. http://sherman.oacd.org/

_____. 2004b. Sherman County Watersheds: North Shore and Fulton-Gordon. http://sherman.oacd.org/watersheds.html

Shugart, H., and D. James. 1973. Ecological succession of breeding bird populations in northwestern Arkansas. Auk 90:62-77.

Slough, B., and R. Sadleir. 1977. A land capability classification system for beaver (Castor canadensis Kuhl). Can. J. Zool. 55(8):1324-1335.

Smith, M., P. Mattocks, Jr., and K. Cassidy. 1997. Breeding birds of Washington State: Location data and predicted distributions. Volume 4 in Washington State Gap Analysis – Final Report (K.M. Cassidy, C.E. Grue, M.R. Smith, and K.M. Dvornich, eds.). Seattle Audubon Society Publications in Zoology No. 1, Seattle, WA.

St. John, A. 2002. Reptiles of the Northwest. Lone Pine Publishing, Renton, WA.

Stanford, J., and six co-authors. 1996. A general protocol for restoration of regulated rivers. Regulated Rivers Research and Management 12:391-413.

Stanford, J., and J. Ward. 1993. An ecosystem perspective of alluvial rivers: connectivity and the hyporheic corridor. Journal North American Benthological Society 12:48-60.

State, Federal and Tribal Fishery Agencies Joint Technical Staff: USFWS, CRITFC, IDFG, ODFW. 2003. Comment on the Independent Scientific Advisory Board's (ISAB) draft document "Review of Flow Augmentation: Update and Clarification" as it relates to the Northwest Power Planning Council's Draft Mainstem Amendments.

Stebbins and Cohen. 1995. Complete citation unavailable.

Steele, R. 1988. Ecological relationships of ponderosa pine. In: Baumgartner, D.M. and J.E. Lotan, comps. Ponderosa pine: The species and its management:Symposium proceedings; 1987 September 29 - October 1; Spokane, WA. Pullman, WA: Washington State University, Cooperative Extension: 71-76.

_____, R. Pfister, R. Ryker, and J. Kittams. 1981. Forest habitat types of central Idaho. U.S. Forest Service, General Technical Report INT-114.

Stein, W. 1980. Oregon white oak 233. Pages 110-111 in F. H. Eyre, ed. Forest cover types of the United States and Canada. Soc. Amer. For., Washington D.C.

Stepniewski, A. 1999. The Birds of Yakima County. Yakima Valley Audubon Society, Yakima WA.

Stradley, B. 2004. Sherman County Soil and Water Conservation District, Sherman County, Oregon. Nov. 2004

Stuehrenberg, L., G. Swan, L. Timme, P. Ocker, M. Eppard, R. Iwamoto, B. Iverson, and B. Snadford. 1995. Migrational characteristics of adult spring, summer, and fall chinook salmon passing through reservoirs and dams of the Mid-Columbia River. Final Report. Coastal Zone and Estuarine Studies Division, National Marine Fisheries Service, Seattle, Washington.

Sylvester, J. 1972. Effect of thermal stress on predator avoidance in sockeye salmon. J. Fish. Res. Board Can. 29:601-603.

_____. 1976. Inventory of riparian habitats and associated wildlife along the Columbia River, Volume 2A. Oregon State University, Oregon Cooperative Wildlife Research Unit. Prepared for the U. S. Army Corps of Engineers, North Pacific Division.

Tabor, J., B. Thompson, C. Turner, R. Stocker, C. Detrick, and J. Howerton. 1981. Study of Impacts of Project Modification and River Regulation on Riparian Habitats and Associated Wildlife Along the Columbia River. Washington Department of Game. Prepared for the U. S. Army Corps of Engineers, North Pacific Division.

Tabor, R., R. Shively, and T. Poe. 1993. Predation on juvenile salmonids by smallmouth bass and northern squawfish in the Columbia River near Richland, Washington. North American Journal of Fisheries Management 13:831-838.

Tate, J., Jr. 1981. The Blue List for 1981. Am. Birds 35(1):3-10.

_____. 1992. Sagebrush Country: A Wildflower Sanctuary. Mountain Press Publishing Company, Missoula, MT.

Taylor, R., and T. Boss. 1975. Biosystematics of Quercus garryana in relation to its distribution in the state of Washington. Northwest Sci. 49:48-57.

Thomas, J., C. Maser, and J. Rodiek. 1979a. Riparian zones. Pages 40-47 in: J.W. Thomas editor. Wildlife habitats in managed forests: the Blue Mountains of Washington and Oregon.

Thomas, J., R. Anderson, C. Maser, and E. Bull. 1979b. Snags. Pages 60-77 in J. W. Thomas, tech. ed. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. U.S. Dept. Agric., For. Serv. Agric. Handbook 553.

Tiffan, K., D. Rondorf, and P. Wagner. 2000. Physiological development and migratory behavior of subyearling fall chinook salmon in the Columbia River. North American Journal of Fisheries Management 20:28-40.

Tiller, B., R. Zufelt, S. Turner, L. Cadwell, L. Bender, and G. Turner. 2000. Population Characteristics and Seasonal Movement Patterns of the Rattlesnake Hills Elk Herd—Status Report 2000. PNNL-13331, Pacific Northwest National Laboratory, Richland, Washington.

TNC (The Nature Conservancy). 2003. Oregon Annual Report, The Nature Conservancy, Portland, OR. http://nature.org/wherewework/northamerica/states/oregon/preserves/art6793.html

_____. 1999. Biodiversity inventory and analysis of the Hanford Site. 179 pp.

Tobalske, B. 1997. Lewis' Woodpecker (Melanerpes lewis). In A. Poole and F. Gill, editors, The Birds of North America, No. 284. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, DC.

Torland. 1983. Complete citation unavailable.

Uebelacker, M. 1985. Time Ball: A Story of the Yakima People and Their Land. Shields Bag and Printing Company, Yakima, WA.

USACE (U.S. Army Corps of Engineers). 2000. Salmon recovery through John Day Reservoir: John Day drawdown Phase 1 study. U. S. Army Corps of Engineers, Portland District.

_____. 1995. Columbia River system operation review final environmental impact statement, Summary. North Pacific Division. DOE/EIS-0170.

USDA (United States Food and Drug Administration) Forest Service. 2000. National Forest System land and resource management planning (36 CFR Parts 217 and 219). Federal Register 65:67514-67581.

USDA – FSA (Farm Service Agency). 2004. Summary of practice acreages for active contracts for all program years (1987-2005), as of 09-30-2004.
http://www.fsa.usda.gov/crpstorpt/09approved/r1pracyr/or.htm
http://www.fsa.usda.gov/crpstorpt/09approved/r1pracyr/wa.htm (Nov. 2004)

USDI National Park Service. 2003. Fire Monitoring Handbook. Boise (ID): Fire Management Program Center, National Interagency Fire Center. 274p.

USFS (United States Forest Service). 1965. Silvics of forest trees of the United States. U.S. For. Serv. Agric. Handb. No. 271. Washington D.C.

USFWS (United States Fish and Wildlife Service). 2004a. Federally Listed Species in Washington State, Website: http://ecos.fws.gov/tess_public/TESSWebpageUsaLists?usMap=1&status=listed&state=WA.

_____. 2004b. Federally Threatened and Endangered Animals and Plants Website: http://endangered.fws.gov/wildlife.htm.

_____. 2004c. Pacific regional director highlights grants to benefit wildlife. U.S. Fish and Wildlife, News Release, August 26, 2004. http://news.fws.gov/NewsReleases/R1/9C66FBAA-65B8-D693-7235F04D5F1B1471.html

_____. 2004d. Environmental Contaminants In Aquatic Resources From The Columbia River, Final Report. U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, Portland, OR.

_____. 2001. North Columbia Basin Waterfowl Surveys 1990-2001. Columbia NWR, Othello, WA

_____. 1997. Wildlife monitoring of the John Day pool from 1994-1996. USFWS Mid-Columbia River refuge complex, Umatilla, Oregon.

_____. 1990. Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service: Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990. http://laws.fws.gov/lawsdigest/nonindi.html

_____. 1986. Recovery plan for the Pacific bald eagle. U.S. Fish and Wildlife Service, Portland, OR. 160 pp.

_____. 1982. Columbia River backwater study: Phase 2. U. S. Fish and Wildlife Service, Fisheries Assistance Office, Vancouver, WA. Report to the Bonneville Power Administration.

_____. 1980. Columbia River backwater study: Phase 1. U. S. Fish and Wildlife Service, Fisheries Assistance Office, Vancouver, WA. Report to the Bonneville Power Administration.

USGS. Unpublished data taken from the Lower Mainstem Columbia Subbasin Plan. 2001. NPCC, Portland, OR.

Vander Haegen, W., F. Dobler, and D. Pierce. 2000. Shrubsteppe bird response to habitat and landscape variables in eastern Washington, USA. Conservation Biology 14:1145-1160.

Van Hyning, J. 1973. Factors affecting the abundance of fall chinook salmon in the Columbia River. Research Reports of the Oregon Fish Commission 4:1-84.

Van Velson, R. 1979. Effects of livestock grazing upon rainbow trout in Otter Creek, Nebraska. Pages 53-55 in O. B. Cope, ed. Proc. of the forum--grazing and riparian/stream ecosystems. Trout Unlimited, Inc., Vienna, Va. 94pp.

Vickery, P. 1996. Grasshopper Sparrow (Ammodramus savannarum). In The Birds of North America, No. 239 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Vierling, K. 1997. Habitat selection of Lewis' woodpeckers in southeastern Colorado. Wilson Bull. 109:121-130.

Wagner, P. and T. Hilson. 1993. 1991 evaluation of adult fallback through the McNary Damjuvenile bypass system. Contrasct No. DACW68-82-C-0077 to Walla Walla District. ByWashington Department of Fish and Wildlife. Olympia, Washington.

Wagner, P., J. Nugent, W. Price, R. Tudor, and P. Hoffarth. 1999. 1997-99 evaluation of juvenile fall chinook stranding on the Hanford Reach. Annual Report to the Bonneville Power Administration, Contract 97BI30417, Portland, Oregon.

Wake and Morowitz. 1991. Complete citation unavailable.

Ward, D. 2001a. Mainstem Columbia Basin Subbasin Summary. Prepared for the NPPC.

_____, Editor. 2001b. White sturgeon mitigation and restoration in the Columbia and Snake Rivers upstream of Bonneville Dam. Annual Progress Report to the Bonneville Power Administration, Portland Or.

_____, Editor. 1999. Effects of mitigative measures on productivity of white sturgeon populations in the Columbia River downstream from McNary Dam, and determine the status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. Annual report by ODFW to Bonneville Power Administration. Contract DE-AI79-86BP63584.

______, Editor. 1999. White sturgeon mitigation and restoration in the Columbia and Snake Rivers upstream of Bonneville Dam. Annual Progress Report to the Bonneville Power Administration, Portland Or.

_____, Editor. 1998. Effects of mitigative measures on productivity of white sturgeon populations in the Columbia River downstream from McNary Dam, and determine the status and habitat requirements of white sturgeon populations in the Columbia and Snake rivers upstream from McNary Dam. Annual report by ODFW

_____, Editor. 1998 White sturgeon mitigation and restoration in the Columbia and Snake Rivers upstream of Bonneville Dam. Annual Progress Report to the Bonneville Power Administration, Portland Or.

_____, and M. Zimmerman. 1999. Response of smallmouth bass to sustained removals of northern pikeminnow in the lower Columbia and Snake rivers. Transactions of the American Fisheries Society 128:1020-1035.

_____, J. Petersen, and J. Loch. 1995. Index of predation on juvenile salmonids by northern squawfish in the lower and middle Columbia River and in the lower Snake River. Transactions of the American Fisheries Society 124:321-334.

Warner, R. 1992. Nest ecology of grassland passerines on road rights-of-ways in central Illinois. Biol. Cons. 59:1-7.

Warren, J., and L. Beckman. 1993. Fishway use by white sturgeon to bypass mainstem Columbia River dams. U.S. Fish and Wildlife Service Sea Grant Extension Project, Columbia River Series WSG-AG 93-02.

Watson, D. 1973. Estimate of steelhead trout spawning in the Hanford Reach of the Columbia River. Report by Pacific Northwest Laboratory to U. S. Army Corps of Engineers, Contract DACW67-72-C-0100.

Watson, J., and E. Rodrick. 2001. Washington Department of Fish & Wildlife's Priority Habitat and Species Management Recommendations, Volume IV: Birds, Bald Eagle *Haliaeetus leucocephalus.* Washington Department of Fish and Wildlife, Olympia, WA. http://wdfw.wa.gov/hab/phs/vol4/baldeagle.pdf

Watson, J., and D. Pierce. 2000. Migration and Winter Ranges of Ferruginous Hawks from Washington. Annual Report. Washington Department of Fish and

WDF and WDW (Washington Department of Fish and Washington Department of Wildlife). 1993. Washington State Salmon and Steelhead Stock Inventory. Appendix Three: Columbia River Stocks. WDF, WDW. 580 pp.

WDF (Washington Department of Fish). 1990. Mid-Columbia River Subbasin (Bonneviile Dam to Priest Rapids Dam), Salmon and Steelhead Production Plan. Co-writers: Oregon Department of Fish and Wildlife, Washington Department of Wildlife. 91 pp.

WDW (Washington Department of Wildlife). 1993. Status of the western gray squirrel (Sciuris griseus) in Washington. Unpublished report. Olympia, WA.

WDFW (Washington Department of Fish and Wildlife). 1998. Screening and passage on Columbia River and tributaries. Proposal to BPA. Vancouver, WA

WDFW, 2003a. Final Game Management Plan, 2003-2009. Washington Department of Fish and Wildlife, Olympia, WA. http://wdfw.wa.gov/wlm/game/management

_____. 2003b. Species of Concern Website: http://wdfw.wa.gov/wlm/diversity/soc/concern.htm.

_____. 2003c. Priority Habitats and Species Website: http://wdfw.wa.gov/hab/phslist.htm.

_____. 2003d. Fishing in Washington, Sport Fishing Rules, 2004/2005 edition.

_____. 2003e. Fishing in Washington: Sport Fishing Rules. 2003/2004 pamphlet edition.

_____. 2001-2003. Deer Harvest Data by Reporting Unit Query. Washington Department of Fish and Wildlife, Olympia, WA. https://fortress.wa.gov/dfw/gohunt/default.htm (Oct. 2004)

_____. 2001. Washington State Aquatic Nuisance Species Management Plan. Washington Department of Fish and Wildlife, Olympia, WA. http://wdfw.wa.gov/fish/nuisxsum.htm

_____. 1998. Fish Passage Barrier Assessment and Prioritization Manual. 57 pp. plus appendices.WDE. 1998. Impaired and Threatened Surface Waters Requiring Additional Pollution Controls (Proposed 1998 Section 303(d) List). Publication No. 97-14.

_____. 1993. Washington State Salmon and Steelhead Stock Inventory. Appendix Three: Columbia River Stocks. 580 pp.

_____ and ODFW. 2000. Status Report. Columbia fish runs and fisheries, 1938-1999.

_____ and ODFW. 1999. Status Report. Columbia fish runs and fisheries, 1938-1998.

_____ and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI). March. 1993, 212 pp.

WDNR (Washington Department of Natural Resources). 1998. Management Plan for Badger Gulch Natural Area Preserve. 55pp.

WDE (Washington Department of Ecology). 2003. Rock / Glade Watershed Planning – WRIA 31. http://www.ecy.wa.gov/watershed/31.html. Nov. 2004

_____. 2000. Final 1998 Section 303(d) List - WRIA 31. www.ecy.wa.gov/programs/wq/303d/1998/wrias/wria31.pdf

_____ . 1998. Impaired and Threatened Surface Waters Requiring Additional Pollution Controls (Proposed 1998 Section 303(d) List). Publication No. 97-14.

Weiss, S., and R. Mitchell. 1992. A synthesis of ecological data from the 100 areas of the Hanford Site. WHC-EP-0601. Westinghouse Hanford Company, Richland, Washington.

Welsh, T., and R. Beamesderfer. 1993. Maturation of female white sturgeon in the lower Columbia River impoundments. Pages 89-108 in R. C. Beamesderfer and A. A. Nigro, eds. Status and habitat requirements of the white sturgeon ppulations in the Columbia River downstream from McNary Dam. Vol. 2 Final report to the Bonneville Power Administration, Portland Or.

West, Inc. 2002. Synthesis and comparison of baseline avian and bat use, raptor nesting and mortality information from proposed and existing wind eevelopments. Final. Prepared for Bonneville Power Administration, Portland, OR. by WEST, Inc., Cheyenne, WY

West, N. 1996. Strategies for maintenance and repair of biotic community diversity on rangelands. Pages 326-346 in R.C. Szaro and D.W. Johnston, editors. Biodiversity in managed landscapes. Oxford University Press, New York, NY.

_____. 1988. Intermountain deserts, shrub steppes and woodlands. Pages 209-230 in M.G. Barbour and W.D. Billings, editors. North American terrestrial vegetation. Cambridge University Press, Cambridge, UK.

Wiens, J. 1985. Response of breeding passerine birds to rangeland alteration in a North American shrubsteppe locality. Journal of Applied Ecology 22:655-668.

_____, and J. Rotenberry. 1981. Habitat associations and community structure of birds in shrubsteppe environments. Ecological Monographs 51:21-41.

Williams, R. 1965. Beaver habitat and management. Idaho Wildl. Rev. 17(4):3-7.

Winegar, H. 1977. Camp Creek channel fencing--plant, wildlife, soil, and water response. Rangeman's J. 4:10-12.

Wisdom, M., B. Wales, R. Holthausen, C. Hargis, V. Saab, W. Hann, T. Rich, D. Lee and M. Rowland 1999. Wildlife habitats in forests of the Interior Northwest: history, status, trends and critical issues confronting land managers. Trans, 64th No. Am. Wildl. and Natur. Resour. Conf.

Wiseman, C. 2003. Multi-metric index development for biological monitoring in Washington state streams. Publ. No. 03-03-035. Dept. Ecology. Olympia. 28p.

WNHP (Washington Natural Heritage Program, Washington State Department of Natural Resources). 2003. Website: http://www.dnr.wa.gov/nhp/refdesk/plan/index.html.

WPN (Watershed Professionals Network). 2001. Home page. http://www.watershednet.com/index.htm

Wright, H., and A. Bailey. 1982. Fire Ecology: United States and Canada. John Wiley and Sons, New York, NY.

WSNWCB (Washington State Noxious Weed Control Board). 2004. Website: http://www.nwcb.wa.gov/.

WSSRB (Washington State Salmon Recovery Board). 2004. Field Sampling Protocols for effectiveness Monitoring of habitat restoration and acquisition projects. 70p.

Wydoski, R., and R. Whitney. 1979. Inland Fishes of Washington. University of Washington Press, Seattle and London. 16-18.

Yocom, T., and T. Edsall. 1974. Effect of acclimation temperature and heat shock on vulnerability of fry of lake whitefish (Coregonus clupeaformis) to predation. J. Fish. Res. Board Can. 31:1503-1506.

Young, V., and W. Robinette. 1939. Study of the range habits of elk on the Selway Game Preserve. Bull. 34. Moscow: Univ. Idaho.

Zaroban, D., M. Mulvey, T. Maret, R. Hughes, and G. Merritt. 1999. Classification of species attributes for Pacific Northwest freshwater fishes. Northwest Science 73:81-93.

Zeiner, D., W. Laudenslayer Jr., K. Mayer, and M. White (Eds.) 1990. California's wildlife, Vol. 2, Birds. Calif. Dep. Fish and Game, Sacramento, CA.

Zimmerman, J. 1997. Avian community responses to fire, grazing, and drought in the tallgrass prairie. Pp 167-180 in F.L. Knopf and F.B. Samson (editors). Ecology and conservation of Great Plains vertebrates. Springer-Verlag. New York, NY.

Zimmerman, M. 1999. Food habits of smallmouth bass, walleyes, and northern pikeminnow in the lower Columbia river basin during outmigration of juvenile salmonids. Transactions of the American Fisheries Society 128:1036-1054.

_____, and R. Parker. 1995. Relative density and distribution of smallmouth bass, channel catfish, and walleye in the lower Columbia and Snake rivers. Northwest Science 69:19-28.

10 Acronyms and Abbreviations

BAIC	Boeing Agricultural Industrial Company
BLM	Bureau of Land Management
BPA	Bonneville Power Administration
BOR	Bureau of Reclamation
BiOP	Biological Opinion
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
Colville Tribes	Confederated Tribes of the Colville Reservation
CRITFC	Columbia River Inter-Tribal Fish Commission
CRMP	Cultural Resources Management Plan
CWA	Clean Water Act
CRP	Conservation Reserve Program
DOE	U. S. Department of Energy
DOI	U.S. Department of the Interior
EA	Environmental Assessment
Ecology	Washington State Department of Ecology
ECP	Eco-regional Conservation Planning
EDT	Ecosystem Diagnostic & Treatment
EIS	Environmental Impact Statement
EMS	Energy Management System
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FERC	Federal Energy Regulatory Commission
FWS	U.S. Fish and Wildlife Service
GIS	Geographic Information System
HCP	Habitat Conservation Plan
HEP	Habitat Evaluation Procedure
HGMP	Hatchery Genetic Management Plan
huc	habitat
IBIS	Interactive Biological Information System
ISRP	Independent Scientific Review Panel
JFC	Joint Fisheries Committee
LFA	Limiting Factors Analysis
LWD	large woody debris
NEPA	National Environmental Policy Act
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPPC	Northwest Power Planning Council
NPCC	Northwest Power and Conservation Council
PA	Programmatic Agreement
PUD	Public Utility District
RC&D	North Central Washington Resource Conservation & Development Council
RM	river mile
SSHIAP	Salmon and Steelhead Habitat Inventory and Assessment Project

SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
TSS	Total Suspended Sediment
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WQI	water quality index
WDFW	Washington Department of Fish and Wildlife
Yakama Nation	Confederated Tribes and Bands of the Yakama Indian Nation
YCT	U.S. Army Yakima Training Center (YTC)
YFRM	Yakama Fisheries Resource Management

11 Appendices

Appendix A. Lower Mid-Columbia Mainstem including Rock Creek Subbasin Planners and Contributors

Appendix B. Common and Scientific Names Used in Lower Mid-Columbia Mainstem Assessment

Appendix C. Wildlife Species Occurring in the Lower Columbia Middle Subbasin

Appendix D. Rare Plants and Plant Communities of the Rock Creek Watershed Area

Appendix E. Adult Salmon Passage at the Dalles Dam on the Lower Mid-Columbia Mainstem Columbia River from 1977 – 2003

Appendix F. Figures 160 A and B showing Fulton Canyon and Spanish Hollow along with the Hood River Basin (in folder)