

Chapter 5

State(s): Oregon

Recovery Unit Name: Willamette River Recovery Unit

**Region 1
U.S. Fish and Wildlife Service
Portland, Oregon**

DISCLAIMER

Recovery plans delineate reasonable actions that are believed necessary to recover and protect listed species. Plans are prepared by the U.S. Fish and Wildlife Service and, in this case, with the assistance of recovery unit teams, contractors, State and Tribal agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Recovery plans do not necessarily represent the views or the official positions or indicate the approval of any individuals or agencies involved in the plan formulation, other than the U.S. Fish and Wildlife Service. Recovery plans represent the official position of the U.S. Fish and Wildlife Service *only* after they have been signed by the Director or Regional Director as *approved*. Approved recovery plans are subject to modification as dictated by new findings, changes in species status, and the completion of recovery tasks.

Literature Cited: U.S. Fish and Wildlife Service. 2002. Chapter 5, Willamette River Recovery Unit, Oregon. 96 p. *In:* U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

ACKNOWLEDGMENTS

Two working groups are active in the Willamette River Recovery Unit: the Upper Willamette (since 1989) and Clackamas Bull Trout Working Groups. In 1999, these groups were combined, and, along with representation from the Santiam subbasin, comprise the Willamette River Recovery Unit Team.

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WILLAMETTE RIVER RECOVERY UNIT CHAPTER OF THE BULL TROUT RECOVERY PLAN

EXECUTIVE SUMMARY

CURRENT SPECIES STATUS

The Fish and Wildlife Service issued a final rule listing the Columbia River population of bull trout as a threatened species on June 10, 1998 (63 FR 31647). The Willamette River Recovery Unit (often called the Willamette Recovery Unit in this chapter) forms part of the range of the Columbia River population. The Willamette Recovery Unit encompasses the Willamette River basin, a major tributary to the Columbia River. The Willamette River flows through Portland, Oregon, before entering the Columbia River at about river kilometer 140. The Willamette River drains part or all of 10 counties—an area of approximately 31,080 square kilometers, almost one-eighth of Oregon’s total area.

The Willamette Recovery Unit Team identified one core area, the Upper Willamette River core area, and the Clackamas River core habitat. The Clackamas River core habitat does not currently support bull trout populations, but it did historically, and the Recovery Unit Team believes that it has the necessary elements to support reintroduction of bull trout. The Santiam River basin also had historic bull trout populations, but this basin is not considered core habitat at this time because of uncertainties regarding its potential to support bull trout. Identifying adequate amounts and locations of suitable habitat in the Santiam River basin is a research need.

HABITAT REQUIREMENTS AND LIMITING FACTORS

A detailed discussion of bull trout biology and habitat requirements is provided in Chapter 1 of this recovery plan. The limiting factors discussed here are specific to the Willamette Recovery Unit chapter. At the time of listing, the U.S. Fish and Wildlife Service considered dams, forest management, roads, and water quality as threats to bull trout in the Willamette River basin. The construction of impassable dams and culverts is considered a major factor in the decline of the species, blocking

migratory corridors and altering temperature and flow regimes. Habitat degradation, passage barriers, overharvest, chemical treatment projects, and hybridization and competition with nonnative brook trout are possible suppressing factors for bull trout populations in the Willamette River basin. Alteration and degradation of instream habitat resulting in loss of instream structure, pools, and side-channel habitats are identified as limiting bull trout populations in the McKenzie and Middle Fork Willamette River basins. Causal mechanisms can be both manmade and natural and are difficult to quantify due to a lack of data on historic population abundance and habitat conditions.

Although much of the damage is historical and although current policies and practices are more protective of aquatic resources, the legacy effects of past events are still evident. What can be restored naturally—for example, riparian cover and recruitment of large woody debris—will require many years. In other instances where change may not be reversible—for example, impassable dams—other solutions will be required to address the threats to bull trout survival and persistence.

RECOVERY GOALS AND OBJECTIVES

The goal of the bull trout recovery plan is to **ensure the long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed throughout the species' native range so that the species can be delisted**. To achieve this goal, the following objectives have been identified for bull trout in the Willamette Recovery Unit:

- ▶ Maintain current distribution of bull trout and restore distribution in previously occupied areas within the Willamette Recovery Unit.
- ▶ Maintain stable or increasing trends in abundance of adult bull trout.
- ▶ Restore and maintain suitable habitat conditions for all bull trout life history stages and forms.
- ▶ Conserve genetic diversity and provide opportunity for genetic exchange.

RECOVERY CRITERIA

Recovery criteria for the Willamette Recovery Unit reflect the stated objectives, evaluation of population status, and recovery actions necessary to achieve the overall goal.

- 1. Distribution criteria will be met when bull trout are distributed among five or more local populations in the recovery unit: four in the Upper Willamette River core area and one in the Clackamas River core habitat.**

In a recovered condition, the Upper Willamette River core area would include local populations in the mainstem McKenzie River (connectivity with the Trail Bridge local population would need to be established), South Fork McKenzie River, upper Middle Fork Willamette River, and Salt Creek/Salmon Creek/North Fork Middle Fork Willamette River complex. Core habitat in the Clackamas River basin would also contain one or more local populations in a location that has yet to be identified. Feasibility analyses are needed to assess the potential for reintroducing bull trout into historic habitat in the Middle Fork Willamette River basin (Salt Creek, Salmon Creek, and North Fork Middle Fork Willamette River watersheds) and into the Clackamas River core habitat. Additional population studies and a better understanding of bull trout fidelity to their natal streams are needed to further define local populations in the recovery unit.
- 2. Abundance criteria will be met when estimated abundance of adult bull trout is from 900 to 1,500 or more individuals in the recovery unit, distributed in each core area as follows: 600 to 1,000 in the Upper Willamette River core area and 300 to 500 in the Clackamas River core habitat.**
- 3. Trend criteria will be met when adult bull trout exhibit stable or increasing trends in abundance in the recovery unit, based on a minimum of 10 years of monitoring data.**
- 4. Connectivity criteria will be met when migratory forms are present in all local populations and when intact migratory corridors among all local**

populations in core areas provide opportunity for genetic exchange and diversity. For the Upper Willamette River core area, meeting connectivity criteria would require establishing fish passage at Cougar, Trail Bridge, Dexter, Lookout Point, and Hills Creek Dams. In the future, establishing fish passage at dams in the Clackamas and Santiam River basins may be necessary, but currently, there is insufficient information to make that determination.

ACTIONS NEEDED

Recovery for bull trout will entail reducing threats to the long-term persistence of local populations and their habitats, ensuring the security of multiple interacting groups of bull trout, and providing habitat conditions and access to conditions that allow for the expression of various life history forms. Seven categories of actions needed are discussed in Chapter 1; tasks specific to this recovery unit are provided in this chapter.

ESTIMATED COST OF RECOVERY

Total cost for bull trout recovery in the Willamette River Recovery Unit is estimated at \$26 million, spread over a 25-year recovery period. Total costs include estimates of expenditures by local, Tribal, State, and Federal governments and by private business and individuals. These costs are attributed to bull trout conservation but other aquatic species will also benefit. Cost estimates are not provided for tasks which are normal agency responsibilities under existing authorities.

ESTIMATED DATE OF RECOVERY

Time required to achieve recovery depends on bull trout status, factors affecting bull trout, implementation and effectiveness of recovery tasks, and responses to recovery tasks. A tremendous amount of work will be required to restore impaired habitat, reconnect habitat, and eliminate threats from nonnative species. Three to five bull trout generations (15 to 25 years), or possibly longer, may be necessary before identified threats to the species can be significantly reduced and bull trout can be considered eligible for delisting.

TABLE OF CONTENTS

DISCLAIMER	ii
ACKNOWLEDGMENTS	iii
EXECUTIVE SUMMARY	v
TABLE OF CONTENTS	ix
INTRODUCTION	1
Recovery Unit Designation	1
Geographic Description	1
DISTRIBUTION AND ABUNDANCE	9
Status of Bull Trout at the Time of Listing	9
Current Distribution and Abundance	9
REASONS FOR DECLINE	22
Water Quality	22
Dams	23
Forest Management Practices	28
Agricultural Practices	31
Transportation Network	32
Mining	32
Residential Development	33
Fisheries Management	34
Isolation and Habitat Fragmentation	37
ONGOING RECOVERY UNIT CONSERVATION MEASURES	39
State of Oregon	39
Federal Activities	43
Eugene Water and Electric Board	45

RELATIONSHIP TO OTHER CONSERVATION/PLANNING	
/RECOVERY EFFORTS	46
State of Oregon	46
Federal Activities	49
STRATEGY FOR RECOVERY	50
The Role of Artificial Propagation and Transplantation	50
Recovery Goals and Objectives	53
Recovery Criteria	57
Research Needs	60
ACTIONS NEEDED	62
Recovery Measures Narrative	62
IMPLEMENTATION SCHEDULE	71
REFERENCES CITED	81
APPENDIX A. Fish Species	91
APPENDIX B. List of Chapters	96

LIST OF TABLES

Table 1. Average monthly discharge for the months August and January for bull trout basins in the Willamette Recovery Unit.	5
Table 2. Releases of adult spring chinook salmon from the McKenzie and Willamette Hatcheries, 1993 to 1999 (ODFW data).	7
Table 3. Number of bull trout fry and juveniles captured in the downstream migrant trap in Anderson Creek, 1994 through 2001 (Ziller and Taylor 2000; D. Bickford, U. S. Forest Service, pers. comm., 2001a).	15

Table 4. Bull trout fry transferred from Anderson Creek, a McKenzie River tributary, to the Middle Fork Willamette River basin above Hills Creek Reservoir. Adapted from Taylor and Reasoner (2000).	19
Table 5. Changes in Oregon Department of Fish and Wildlife angling regulations to protect bull trout (Ziller and Taylor 2000).	39
Table 6. Changes in management of hatchery-reared rainbow trout implemented by the Oregon Department of Fish and Wildlife to reduce take of bull trout in the upper Willamette River basin (Ziller and Taylor 1999).	40

LIST OF FIGURES

Figure 1. Bull trout recovery units in the United States. The Willamette River Recovery Unit is highlighted.	2
Figure 2. Map of the Upper Willamette River core area, with local populations delineated.	10
Figure 3. Number of bull trout counted at Leaburg Dam on the McKenzie River, 1995 through September 2001 (partial count).	12
Figure 4. Redd counts in Anderson Creek, a tributary to the McKenzie River, 1989 through 2001.	14
Figure 5. Redd counts in Olallie Creek, a tributary to the McKenzie River, 1995 through 2001.	14
Figure 6. Redd counts in the Roaring River, a tributary to the South Fork McKenzie River, 1993 through 2001.	18
Figure 7. Location of core habitat in the Clackamas River basin and of potential core habitat in the Santiam River basin.	21

INTRODUCTION

Recovery Unit Designation

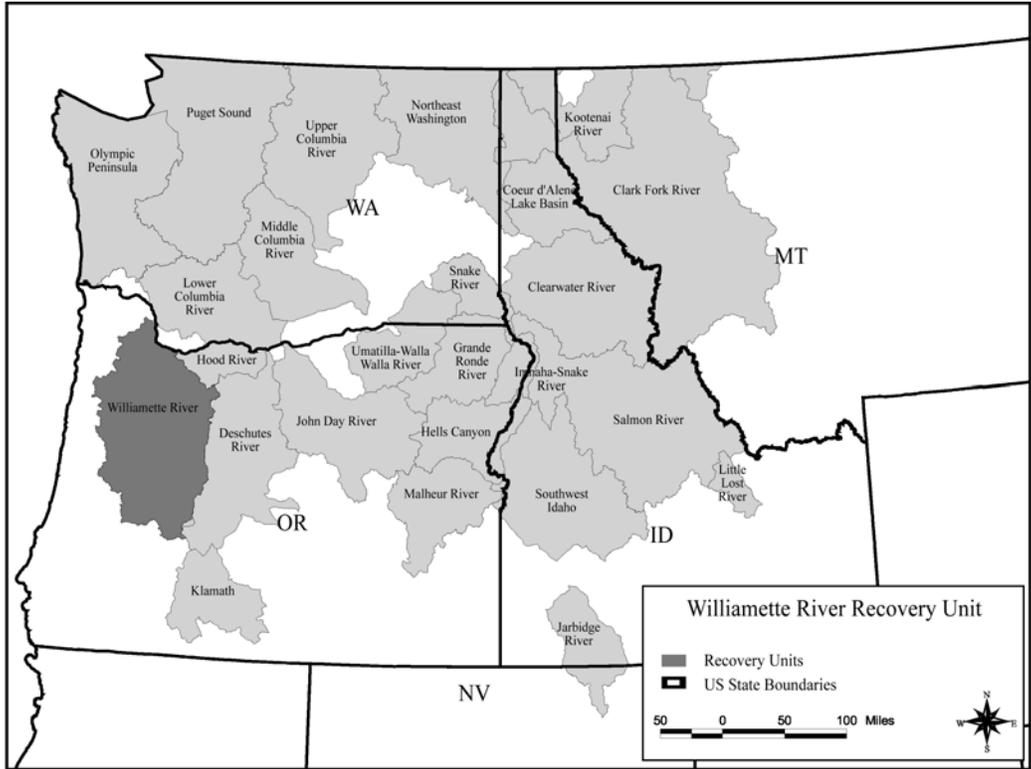
The Willamette River Recovery Unit (often called the Willamette Recovery Unit in this chapter) is one of 22 recovery units designated for bull trout in the Columbia River basin (Figure 1). Designation of the Willamette Recovery Unit is based on the Oregon Department of Fish and Wildlife (Kostow 1995) designation of bull trout populations in the Willamette River as a gene conservation group. This delineation is supported by the genetic analysis conducted by Spruell and Allendorf (1997). Willamette River bull trout are included in the “coastal” group of bull trout populations that includes bull trout of the Lewis River (Washington) (Spruell *et al.* 1998), Hood River (Oregon), and Deschutes River (Oregon) (Spruell and Allendorf 1997). The Willamette River basin also contains many important areas for anadromous salmon and steelhead.

Although bull trout are currently found only in a portion of the upper basin (McKenzie and Middle Fork Willamette River basins), the recovery unit encompasses the entire Willamette River basin, including historic bull trout habitat in the Santiam and Clackamas River basins.

Geographic Description

The Willamette River basin, situated in northwestern Oregon, is a major tributary of the Columbia River, entering at about river kilometer 140. The Willamette River drains part or all of ten counties—approximately 31,080 square kilometers (12,000 square miles), or almost one-eighth of Oregon’s total area. It is bounded on the north by the Columbia River, and on the east, south, and west by the summits of the Cascade Range, the Calapooia Mountains, and the Coast Range, respectively. The north–south length of the basin is about 240 kilometers (149 miles), and its average east–west width is about 120 kilometers (75.6 miles). Principal streams of the basin head at elevations of 1,830 meters (6,004 feet) and

Figure 1. Bull trout recovery units in the United States. The Willamette River Recovery Unit is highlighted.



higher in the bordering Cascade Range. In higher elevations of the Cascades where bull trout occur, precipitation ranges from 229 to 356 centimeters (90 to 140 inches), and snowfall is heavy, with considerable snowpack accumulation. Major tributaries of the Willamette River include the Clackamas (river kilometer 40), Tualatin (river kilometer 45), Molalla (river kilometer 58), Yamhill (river kilometer 88), Santiam (river kilometer 175), Calapooia (river kilometer 193), Marys (river kilometer 212), Long Tom (river kilometer 241), McKenzie (river kilometer 282), Middle Fork Willamette (river kilometer 301), and Coast Fork Willamette (river kilometer 301) Rivers.

Bull trout currently occur in the McKenzie and Middle Fork Willamette Rivers and occurred historically in the Santiam and Clackamas Rivers; all of these rivers originate in the Cascade Mountains. The Willamette Recovery Unit

focuses on these four river basins. The McKenzie River basin drains an area of about 3,367 square kilometers (1,300 square miles), comprising about 11 percent of the Willamette River basin; more than 80 percent of the subbasin is in Lane County, with the remainder in Linn County. The Middle Fork Willamette River basin covers 3,496 square kilometers (1,350 square miles), or about 11 percent of the total Willamette River basin; 94 percent of the basin is in Lane County and 6 percent is in Douglas County. The Clackamas River basin drains an area of about 2,419 square kilometers (934 square miles), or about 8 percent of the Willamette River basin, in Clackamas County. The Santiam River basin drains an area of about 4,732 square kilometers (1,827 miles), or about 15 percent of the Willamette River basin, primarily in Marion and Linn Counties.

Willamette River basin tributaries of the Cascade Mountains flow through three physiographic provinces: the High Cascades, Western Cascades, and Willamette Valley Provinces. The High Cascades Province consists of volcanic landforms with varying degrees of glaciation. Lava flows formed relatively stable plateaus, which are capped by the recent Cascade Range volcanoes. Drainages are generally not yet well developed, and precipitation and snowmelt disperse into highly permeable volcanic deposits. Geologically recent volcanic deposits are subject to large debris flows when saturated by snowmelt (USFS and BLM 1993).

The Western Cascades Province is distinguished from the High Cascades Province by older volcanic activity and longer glacial history. Ridge crests at generally similar elevations are separated by steep, deeply dissected valleys. Complex eruption materials juxtapose relatively stable lava flows and volcanic deposits that weather to thick soils and are subject to large, slow-moving landslides. Unconsolidated alluvial and glacial deposits are subject to streambank erosion, and landslides and are susceptible to increased peak flows. Tributary channels flow at large angles into wide, glaciated valleys (USFS and BLM 1993).

The Willamette Valley Province is a broad structural depression oriented in a north–south direction and rimmed on the west by the Coast Range and on the east by the Cascade Mountains. Elevation on the valley floor increases approximately 80 meters from north to south (from Salem to Eugene). During the

Pleistocene epoch, glacial meltwater filled the valley on at least two occasions. Soils of the valley are derived from these lacustrine (lake) deposits as well as from more recent alluvial deposits (Franklin and Dyrness 1973).

The McKenzie, Middle Fork Willamette, Clackamas, and Santiam Rivers all originate in the High Cascades Province, traverse through the Western Cascades Province, and join the mainstem Willamette River in the Willamette Valley Province. They tend to have relatively steep gradients in the middle to higher elevations and are gently sloped in lower reaches.

The Willamette River basin is characterized by cool, wet winters and by warm, dry summers. Mean monthly air temperatures in the valley range from about 3 to 5 degrees Celsius (37.4 to 41 degrees Fahrenheit) during January to 17 to 20 degrees Celsius (63.6 to 68 degrees Fahrenheit) during August (Wentz *et al.* 1998). Mean annual precipitation in the Willamette River basin ranges from 500 to 1,000 millimeters (20 to 40 inches) in the valley to more than 2,500 millimeters (100 inches) in the Coast Range. About 70 to 80 percent of the annual precipitation falls from October through March, but less than 5 percent falls in July and August (Wentz *et al.* 1998). Most precipitation in the Cascade Mountains falls as snow above 1,524 meters (5,000 feet); however, the Coast Range and Willamette Valley receive relatively little snow. The uplands (Coast Range and Cascade Mountains) receive about 80 percent of the precipitation that falls on the Willamette River basin, and they store much of this water as snow. Snowfall accumulation exceeds 228.6 centimeters (90 inches) in the central Cascades. From late winter to early summer, much of this snow melts, feeding cold, fast-flowing streams.

Stream flow in the Willamette River basin reflects the seasonal distribution of precipitation, with 60 to 85 percent of runoff occurring from October through March, but less than 10 percent occurring in July and August (Wentz *et al.* 1998). Releases from 13 tributary reservoirs are managed for water quality enhancement by maintaining a flow of 170 cubic meters per second (6,000 cubic feet per second) in the Willamette River at Salem during summer months (USACE 1989). Mean annual discharge of the Willamette River near its mouth at

Portland, Oregon, was 917.5 cubic meters per second (32,400 cubic feet per second) during water years 1972 to 1990. Typical monthly flows at Portland ranged from about 226.5 cubic meters per second (8,000 cubic feet per second) in August to about 1,982 cubic meters per second (70,000 cubic feet per second) in December. Recorded extreme flows were 119 cubic meters per second (4,200 cubic feet per second) in July 1978 and 8,013.7 cubic meters per second (283,000 cubic feet per second) in January 1974, although the river reached an estimated peak flow of 13,025 cubic meters per second (460,000 cubic feet per second) during the flood of February 1996 (Wentz *et al.* 1998). Average monthly discharge for the bull trout basins is shown in Table 1.

Table 1. Average monthly discharge for the months August and January for bull trout basins in the Willamette Recovery Unit. Data are from the U.S. Geological Survey (<http://water.usgs.gov/or/nwis/monthly>).

Basin	Gage Location (river kilometer)	Average Monthly Discharge (cubic feet per second)		Drainage Area (square miles)	Period of Record
		August	January		
McKenzie River	Coburg (6)	2,263	9,908	1,337	1945 to 1972
Middle Fork Willamette River	Dexter (27)	1,845	5,004	1,001	1947 to 2000
Clackamas River	Estacada (37)	914	4,200	671	1909 to 2000
Santiam River	Jefferson (16)	1,246	14,420	1,790	1908 to 2000

Uplands (land above 152 meters [500 feet] elevation) are dominated at low- to mid-elevations by Douglas-fir/western hemlock forest and at higher elevations in the Cascade Mountains by subalpine forests and alpine environments. Natural fire was the dominant disturbance on the landscape until the early 1900's, when fire was suppressed. After World War II, the dominant management regimes were clear-cutting, prescribed burning, and planting crop trees on a 50-year rotation. About 60 percent of the upland is Federally owned

and is managed under the Northwest Forest Plan. Forest harvesting has been greatly reduced from former levels under this plan, and more emphasis has been placed on habitat for fish and wildlife. About 40 percent of upland land is privately owned, where forest lands are managed according to the Oregon State Forest Practices Act.

The Willamette Valley is characterized by broad, almost level, alluvial terrain (Franklin and Dyrness 1973). Nearly all land (96 percent) in the Willamette Valley (roughly, lands below 152 meters [500 feet] elevation) is privately owned and has been converted to agriculture or to urban land use. The Willamette Valley had an oak–grass–pine vegetation type following the last ice age, and Native Americans maintained this type by burning. The cessation of fires has led to an increase in conifer intrusion.

Habitats in the valley can be grouped into six main types, all of which have been reduced over the past century. Significant remnants of bottomland forests, bottomland prairies, emergent wetlands, and open-water habitats can still be found because, historically, they were difficult to farm or develop. Parts of these habitats are protected to varying degrees by various State and Federal laws. Upland forests and foothill savannas/prairies have been eliminated, except for a few small parcels, because they occupied land that could be easily converted to high-value crops.

Fish Resources. Many other fish species besides bull trout inhabit the Willamette Recovery Unit. A partial list is shown in Appendix A.

The species most commonly associated with bull trout in the McKenzie River basin include cutthroat trout, rainbow trout, spring chinook salmon, sculpin, and mountain whitefish. Naturally reproducing, nonnative brook trout are widespread in the basin above Trail Bridge Dam, the result of releases by the Oregon Department of Fish and Wildlife in Heart Lake and Clear Lake. Brook trout are also found in the mainstem McKenzie River just downstream of Trail Bridge Dam, and they are abundant in the headwaters of Horse Creek and the

South Fork McKenzie River. In 1998, a bull trout x brook trout hybrid was collected from the mainstem McKenzie River above Trail Bridge Reservoir.

Adult spring chinook are released into the McKenzie River above Trail Bridge Dam, the South Fork McKenzie River above Cougar Dam, and the Middle Fork Willamette River above Hills Creek Reservoir to provide a prey base for bull trout (Table 2). Spring chinook are native to these areas, but migration is blocked by the dams. The adult chinook used for these releases include both hatchery and wild fish that return to McKenzie Hatchery and Dexter Pond.

Table 2. Releases of adult spring chinook salmon from the McKenzie and Willamette Hatcheries, 1993 to 1999 (ODFW data).

Year	McKenzie River Basin			Middle Fork Willamette River Basin			
	Above Cougar Reservoir	Above Trail Bridge Reservoir	Mohawk River	Fall Creek Reservoir	Mosby Creek	North Fork Middle Fork Willamette	Above Hills Creek Reservoir
1993	55						796
1994	0						177
1995	0						522
1996	291						341
1997	1,038	63					956
1998	318	53	156	565	221		1,225
1999	549	40	204	190		578	1,073

Species most often associated with bull trout in the upper Middle Fork Willamette River basin include rainbow trout (native and nonnative), chinook salmon, cutthroat trout, and mountain whitefish. Brook trout, introduced as a result of the high lakes stocking program, are established in the upper reaches of the Middle Fork Willamette River, Wall Creek, North Fork Middle Fork Willamette River, Salt Creek, and Beaver Creek.

Current steelhead runs in the Middle Fork Willamette River are the result of stocking programs begun in the 1950's. Distribution of winter and summer run steelhead occurs downstream of Dexter Dam and in Fall Creek. Fall chinook salmon were introduced after Dexter and Lookout Point Dams were constructed, but a self-sustaining run has not become established. Introduced warmwater species, such as largemouth bass, bluegill, crappie, bullhead catfish, and walleye, and the native cyprinid, Oregon chub, occur primarily downstream of Dexter Dam (Connolly *et al.* 1992).

DISTRIBUTION AND ABUNDANCE

Status of Bull Trout at the Time of Listing

In 1996, the Oregon Department of Fish and Wildlife evaluated the status (risk of extirpation) of the Willamette River bull trout populations and rated them as follows: Middle Fork Willamette River as high risk, South Fork McKenzie River as moderate risk, Anderson Creek/mainstem McKenzie River as moderate risk, Trail Bridge Reservoir as high risk, and the Santiam and Clackamas Rivers as probably extinct (Buchanan *et al.* 1997). In the final listing rule (63 FR 31647), three bull trout subpopulations in the Willamette River basin were identified: (1) McKenzie River and tributaries above Trail Bridge Dam, (2) McKenzie River and tributaries downstream of Trail Bridge Dam, and (3) South Fork McKenzie River and tributaries above Cougar Dam. All three extant populations exhibit a fluvial or adfluvial life history form. Bull trout were thought to be extirpated from the Middle Fork Willamette River, the North and South Forks of the Santiam River, and the Clackamas River.

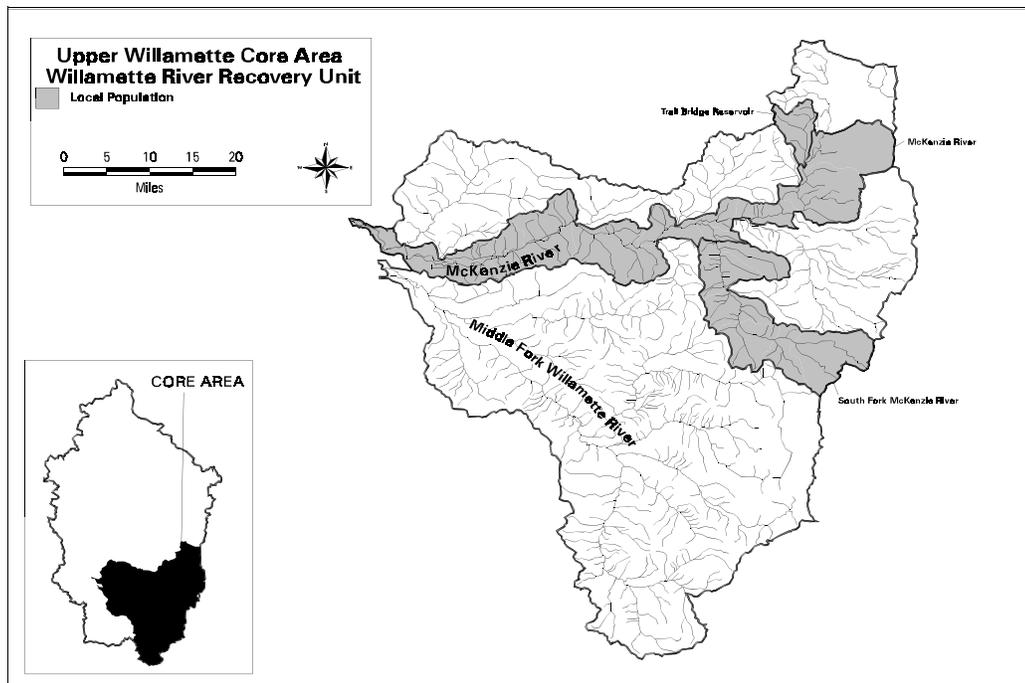
Current Distribution and Abundance

The Willamette Recovery Unit Team identified one core area, the Upper Willamette River core area, and the Clackamas River core habitat. The Clackamas River core habitat does not currently support bull trout populations, but it historically supported bull trout, and the recovery unit team believes that it has the necessary elements to support reintroduction of bull trout. The Santiam River basin also had historic bull trout populations, but is not considered core habitat at this time because of uncertainties regarding its potential to support bull trout.

Upper Willamette River Core Area. The core area encompasses the McKenzie and Middle Fork Willamette River basins and the portion of the Willamette River that connects the two stream systems (Figure 2). Local populations include the mainstem McKenzie River, Trail Bridge, and South Fork McKenzie River. Pending documentation of successful reproduction, a fourth local population may exist on the Middle Fork Willamette River above Hills Creek Dam.

The mainstem McKenzie River local population occurs from the mouth to Trail Bridge Dam and extends into portions of the South Fork McKenzie River, Gate Creek, Blue River, Horse Creek, Separation Creek, Deer Creek,¹ Olallie Creek, and Anderson Creek. A total of 170 kilometers (105.6 miles) of stream habitat has been identified as being used by bull trout in the McKenzie River basin downstream of Trail Bridge Dam (Ziller and Taylor 2000). Most of the population occurs upstream of Leaburg Dam. However, since 1995 when color video equipment was added to the dam, greatly facilitating identification of bull trout, from 4 to 28 bull trout (25.4 centimeters [10 inches] and larger) annually have been observed passing through the fish ladder at this

Figure 2. Map of the Upper Willamette River core area, with local populations delineated.



dam (Figure 3) (EWEB *et al.* 2001; ODFW 2001a). In March 1999, a 74-centimeter

¹ There are two Deer Creeks; both enter the McKenzie River upstream of Leaburg Dam. The Deer Creek referred to in this instance is the farthest upstream, entering the McKenzie River at river kilometer 127 (river mile 79).

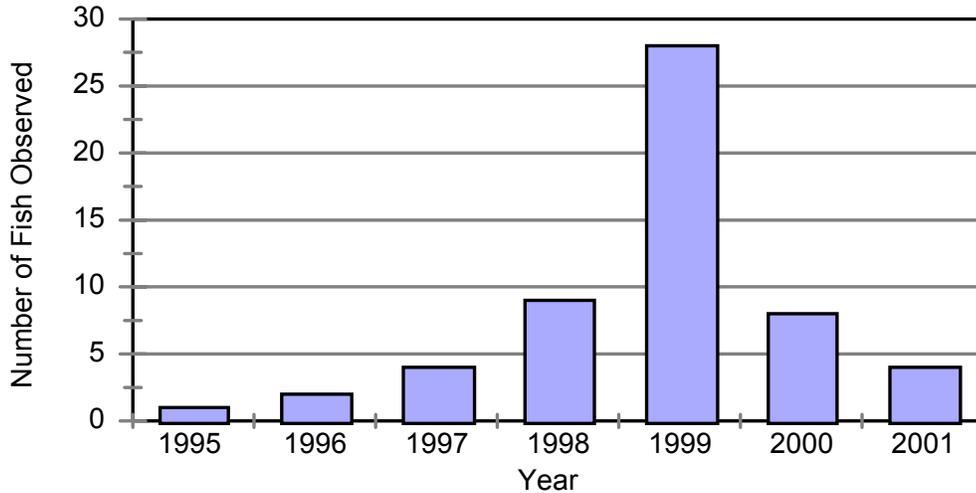
(29-inch) bull trout was captured by Oregon Department of Fish and Wildlife crews while seining near the mouth of the McKenzie River (WRUT, *in litt.*, 1997b). Dams on the Blue River and the South Fork McKenzie River limit upstream movement of the mainstem McKenzie River local population in these tributaries.

Adult bull trout overwinter in the mainstem McKenzie River, distributed throughout the river as far downstream as Hendricks Bridge (river kilometer 38) (WRUT, *in litt.*, 1997a). They occupy large pools, using available large wood and undercut banks for cover (USFS 1995a). Upstream migration begins in April and continues through the summer until September when the fish are found staging in large pools near spawning tributaries (ODFW 2001a). Radio-tagged bull trout entered Anderson Creek in late August or early September. They remained in Anderson Creek for approximately one month and then quickly returned to overwintering sites lower in the river.

Several bull trout returned to the same overwinter sites each year during the period in which they were monitored (Ziller and Taylor 2000). In 1999 in Anderson Creek, data from a passive electronic counter (called a Vaki River Watcher) showed that bull trout migrated upstream and downstream at a higher rate during daylight hours (69 percent and 61 percent, respectively). Peak migration of bull trout through the fish counter in 1999 occurred during the middle of September. Bull trout ranged in size from 18 to 81 centimeters (7 to 31.9 inches) (Ziller and Taylor 2000).

Bull trout habitat in McKenzie River spawning streams is characterized by abundant large wood (instream), high channel complexity, and a mature conifer canopy. Mainstem habitats used by bull trout, in addition to large pools, include side channels, river margins, and tributaries (USFS 1995a).

Figure 3. Number of bull trout counted at Leaburg Dam on the McKenzie River, 1995 through September 2001 (partial count).



Known juvenile bull trout distribution in the mainstem McKenzie River, as determined from night snorkeling, extends at least 8 river miles downstream of Anderson and Olallie Creeks to just downstream of Lost Creek (ODFW 2001a), at approximately river kilometer 118. Data from a screw trap that has been operated seasonally since 1993 and located immediately downstream of the culvert passing under Highway 126 and approximately 0.4 kilometer (0.25 mile) upstream of the mouth of Anderson Creek (Ziller and Taylor 2000) indicate that the majority of bull trout fry (age less than 1 year) and juveniles (age greater than 1 year) migrate from Anderson Creek between February and June (ODFW 2001a). Peak migration occurs from the middle to the end of March (ODFW 2001a). A similar trap was installed in Olallie Creek in 1999 about 50 meters (164 feet) upstream of Highway 126 (Ziller and Taylor 2000).

During snorkel surveys in 1993, juvenile (7.6 to 12.7 centimeters [3 to 5 inches] in length) bull trout were observed in the lower 1.45 kilometers (0.9 miles) of Separation Creek, a tributary to Horse Creek. However, subsequent surveys in 1995

(using electrofishing techniques) and in 1997 (using snorkel and angling techniques) failed to identify spawning areas in Separation Creek (ODFW 1993b; USFS 1997).

The bulk of spawning takes place in Anderson Creek (in approximately 3.8 kilometers [2.4 miles]) and to a lesser extent in Olallie Creek. Access to approximately 3.2 kilometers (2.0 miles) of spawning and rearing habitat in Olallie Creek upstream of Highway 126 was restored in 1995 when a culvert blocking passage was replaced. Spawning has not been documented in other tributaries; for example, Blue River is thought to be used primarily for foraging (EWEB *et al.* 2001). Spawning timing, based on redd counts from 1995 through 1999, showed that spawning peaked in the third week of September (Taylor and Reasoner 2000). In 1999, peak migration of bull trout (upstream and downstream) through the fish counter occurred from September 10 to 17 (Taylor and Reasoner 2000).

Total adult abundance of bull trout is difficult to estimate because of a lack of information, including the following: (1) proportion of adult population spawning in a given year, (2) number of redds per female bull trout (ratio of 2 redds to 1 female bull trout), and (3) sex ratio (ratio during spawning of 1.3 males to 1 female up to 1 male to 2 females) (ODFW 2001a). Using professional judgment and the monitoring data collected to date, local biologists estimate that the total adult bull trout population in the Willamette Recovery Unit is no more than 300 fish. The mainstem McKenzie River local population makes up the bulk of that total abundance. Since 1995, spawning surveys in Anderson and Olallie Creeks show an average of 80 redds per year in Anderson Creek (Figure 4) and redd counts ranging from 6 to 10 in Olallie Creek (Figure 5). In 1999, an electric counter in Anderson Creek indicated that 249 bull trout adults passed upstream and 214 passed downstream (Ziller and Taylor 2000).

An estimate of abundance of juvenile bull trout migrating from Anderson Creek was made using data from the downstream migrant trap on Anderson Creek. Traps are operated four days a week, from early February until the first week in June (Ziller and Taylor 2000). Results are shown in Table 3.

Figure 4. Redd counts in Anderson Creek, a tributary to the McKenzie River, 1989 through 2001. Redd counts prior to 1994 were conducted in the index reach only (up to river kilometer 1.3, shown in clear bars) and should be considered incomplete.

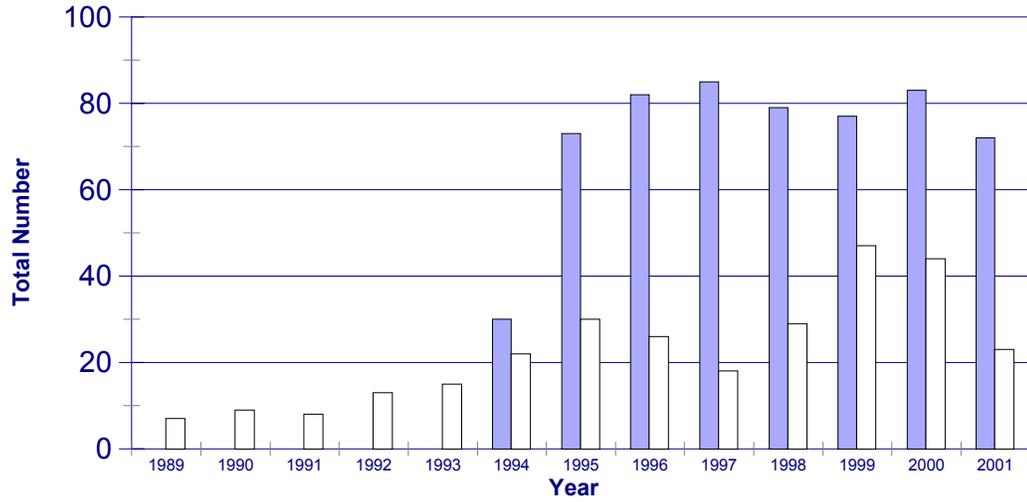


Figure 5. Redd counts in Olallie Creek, a tributary to the McKenzie River, 1995 through 2001.

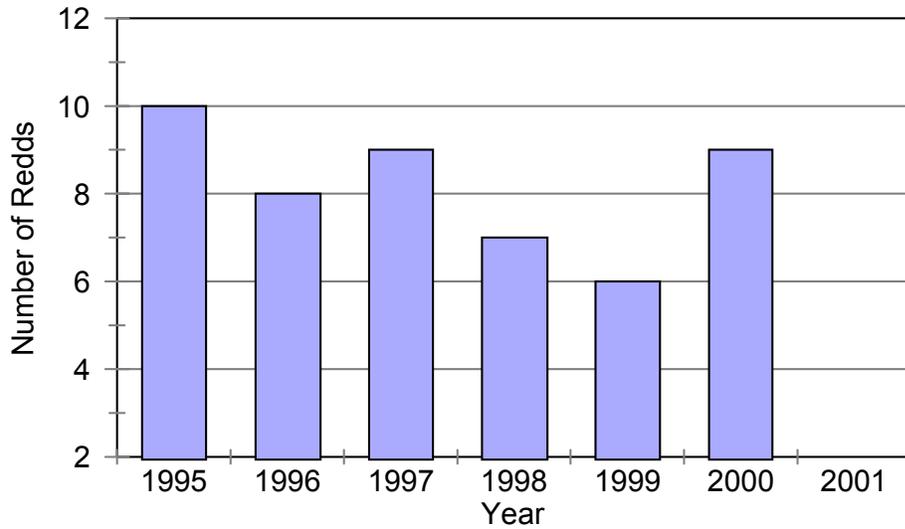


Table 3. Number of bull trout fry and juveniles captured in the downstream migrant trap in Anderson Creek, 1994 through 2001 (Ziller and Taylor 2000; D. Bickford, U. S. Forest Service, pers. comm., 2001a).

Date	Number of fry age 1 or less		Number equal to or greater than age 1	
	Captured	Estimated ^{Capture}	Captured	Estimated ^{Capture}
1994	1,808	5,308	129	403
1995	1,877	5,995	261	785
1996	1,995	5,700	179	550
1997	6,540	21,592	64	215
1998	7,902	23,153	151	453
1999	7,406	21,693	100	263
2000	6,097	17,713	190	553
2001	5,840	9,733	141	235

^a Estimated number of bull trout captured if the trap ran continuously and captured fish at a 60 percent rate of efficiency.

In 1999, densities of juvenile bull trout were estimated in 2.6 kilometers (1.62 miles) of Anderson Creek by using the modified Hankin and Reeves (1988) protocol. An average of 1.8 juvenile (age 1 to 2 years or more) bull trout per unit were observed in 60 habitat units. Pocket units had the highest observed densities (9.7 per 100 square meters), while the lowest densities were observed in fast-water units (0.8 per 100 square meters) (Taylor and Reasoner 2000).

The Trail Bridge local population occurs in Trail Bridge Reservoir upstream to Tamolitch Falls, a natural barrier. The Trail Bridge pool, the mainstem McKenzie River to Tamolitch Falls, and the lower Smith River provide foraging and rearing habitat. Spawning and rearing habitat consists of Sweetwater Creek and the mainstem McKenzie River above the Trail Bridge pool (USFS 1997).

Spawning occurs in the mainstem McKenzie River upstream of Trail Bridge Reservoir in about 1.1 kilometers (6.8 miles) of available habitat. In 1992, passage restoration in Sweetwater Creek (tributary to Trail Bridge Reservoir) through a

blocked culvert under Highway 126 was completed, making 2.4 kilometers (1.49 miles) of additional spawning and juvenile rearing habitat accessible (Ziller and Taylor 2000). Fry transfers from Anderson Creek into Sweetwater Creek between 1993 and 1999, ranging from 308 to 1,889 fry annually, were designed to help reestablish spawning in this tributary. In 1999, five adults were video-recorded ascending into Sweetwater Creek from Trail Bridge Reservoir, and in 2001, 11 adults were recorded (Bickford, pers. comm. 2001b). Redds were first observed in 2000 when 2 were counted. In December 2001, 4 bull trout juveniles measuring 60 to 70 millimeters (2.36 to 2.76 inches) in length were observed during snorkel surveys (USFS 2001).

Counting bull trout redds in the McKenzie River upstream of Trail Bridge is complicated by the presence of chinook salmon redds. However, biologists estimated zero to 12 bull trout redds in this reach since they began spawning surveys in 1994 (Ziller and Taylor 2000). The population probably has fewer than 20 adults spawning each year (ODFW 2001a).

Bull trout redds (two) were first observed in Sweetwater Creek in 2000, and one redd has been counted so far during surveys in 2001 (D. Bickford, pers. comm., 2001b). However, no bull trout fry have been positively identified during two survey efforts (ODFW 2001a).

The third bull trout local population occurs in the mainstem South Fork McKenzie River upstream of Cougar Dam to approximately the wilderness boundary and also the lower portions of French Pete Creek and Roaring River—a total of 29.3 kilometers (18.2 miles) of habitat. Spawning and juvenile rearing are known to occur only in Roaring River, a large spring-fed tributary of the South Fork McKenzie River, or 5 kilometers (3 miles) of the total habitat of the local population (Ziller and Taylor 2000).

Radio-tagging four fish from 1997 through 1999 determined that bull trout reside in Cougar Reservoir until the end of April and move into the South Fork McKenzie River in early May. Two tagged fish entered Roaring River in late August and early September, presumably to spawn, and had reentered the reservoir by the

middle of October (Ziller and Taylor 2000). A passive electronic counter installed in Roaring River in 1999 counted 41 fish passing upstream (66 percent) at night, while most downstream passage (71 percent) occurred during daylight hours. Most bull trout (83 percent) passing the counter migrated into Roaring River during the first two weeks in September. Migration peaked in late September and early October and was complete by early October. The average length of fish passing upstream was 42 centimeters (16.5 inches) and ranged from 21 to 58 centimeters (8.3 to 23 inches) (Ziller and Taylor 2000). In 2000, 81 bull trout were counted migrating up Roaring River (ODFW 2001a).

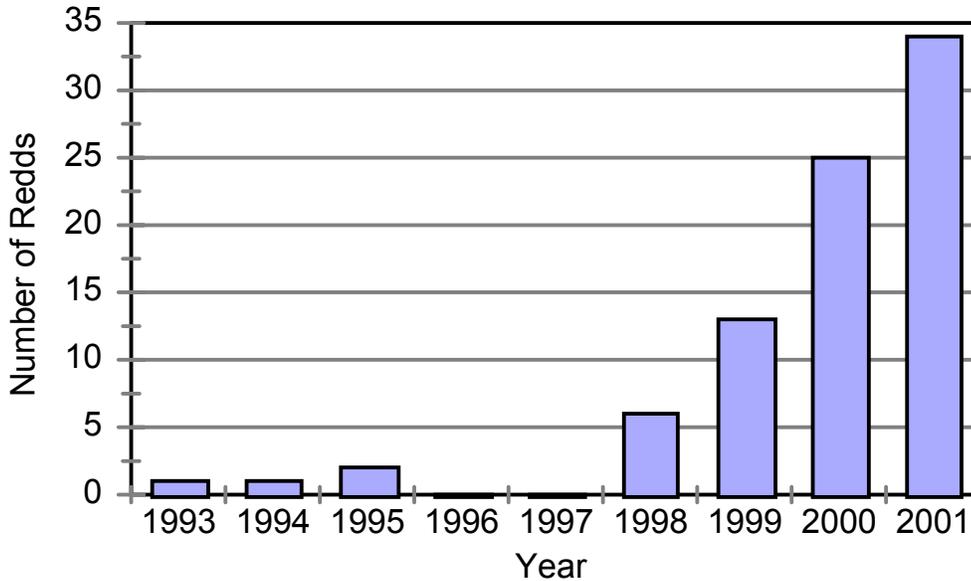
Redd counts in Roaring River showed a sharp increase over the past four years (Figure 6). The use of the radio tags and the Vaki counter has improved the ability to pinpoint timing and location of spawning in this very turbulent stream. The Oregon Department of Fish and Wildlife estimates the adult population of the South Fork McKenzie River at 80 to 100 adults (ODFW 2001a). In 1999, the estimated number of bull trout per redd was 3.2 in Roaring River.

Historic distribution in the Middle Fork Willamette River local population included the mainstem Middle Fork Willamette River, the North Fork Middle Fork Willamette River, Salt Creek, Swift Creek, Staley Creek, and Hills Creek Reservoir (ODFW 2001a).

In spite of extensive electrofishing and snorkeling survey efforts between 1993 and 1997 in approximately 400 kilometers (248.5 miles) of streams in the Middle Fork Willamette River and contiguous springs, bull trout were not located (ODFW and USFS 1998). Personnel with the Oregon Department of Fish and Wildlife and the U.S. Forest Service snorkeled most of the pools in the Middle Fork Willamette River from Paddy's Valley to Staley Creek, as well as much of Swift Creek, but no bull trout were found (ODFW 2001a). Nevertheless, persistent reports from anglers suggest that a few bull trout may remain in the basin. As late as 1990, a bull trout was documented in a photograph taken at the head of the middle fork arm of Hills Creek Reservoir. The most recent reliable report was by an angler who caught a subadult in early June 2000 in the Middle Fork Willamette below Hills Creek Dam (river kilometer 66). The origin of the fish is unknown, although it was possibly one of the 178 fry released in

upper Middle Fork Willamette River tributaries in 1997 (see discussion below) (Ziller and Taylor 2000).

Figure 6. Redd counts in the Roaring River, a tributary to the South Fork McKenzie River, 1993 through 2001.



The Oregon Department of Fish and Wildlife assumed that a few bull trout remained in the basin and, in 1997, implemented a plan to restore bull trout to the Middle Fork Willamette River above Hills Creek Reservoir. Between 1997 and 2000, a total of 6,439 bull trout fry from Anderson Creek, approximately 25 to 35 millimeters (0.98 to 1.4 inches) in length, were released into seven sites in the Middle Fork Willamette River basin (Table 4) (Ziller and Taylor 2000). Spring-fed portions of the Middle Fork Willamette River and tributaries above Hills Creek Reservoir still appear to contain suitable spawning and rearing habitat for bull trout (ODFW 2001a).

Table 4. Bull trout fry transferred from Anderson Creek, a McKenzie River tributary, to the Middle Fork Willamette River basin above Hills Creek Reservoir. Adapted from Taylor and Reasoner (2000).

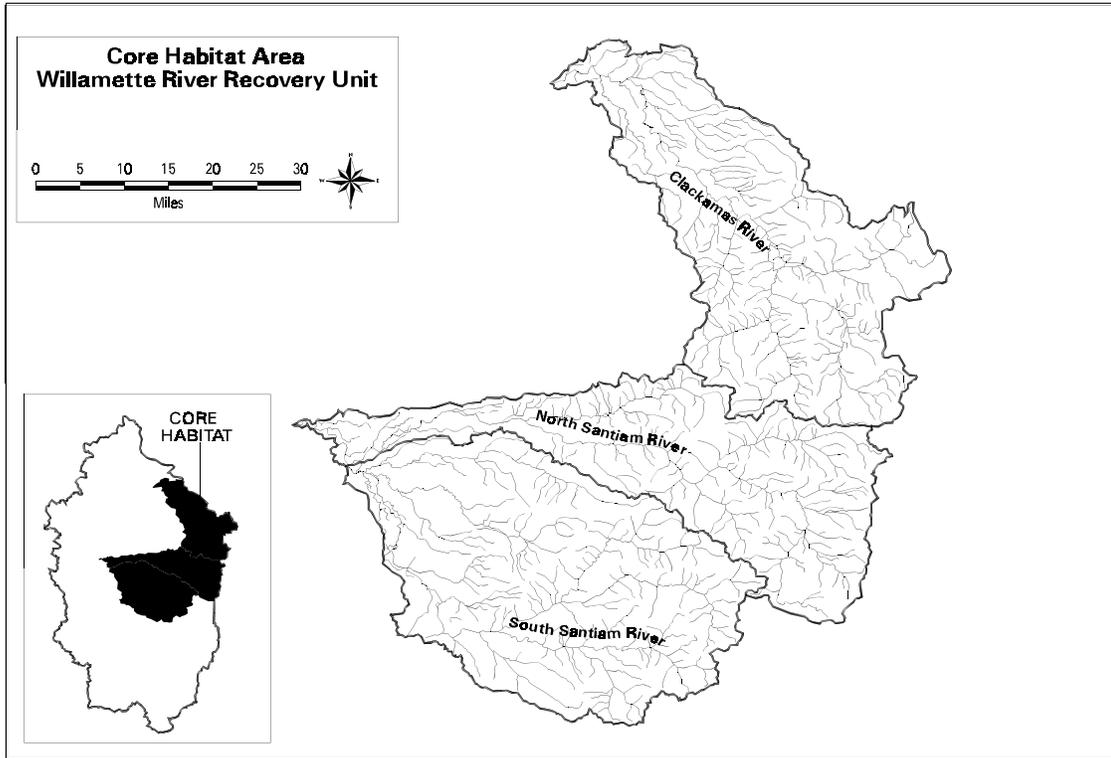
Year	Location								Total
	Iko	Shadow	Chuckle	Indigo	Swift	Skunk	Found	Bear	
1997			96	26		56			178
1998	938	150	411						1,499
1999	1,000	148	302		526				1,976
2000	1,075	53	349	204	822		285	673	2,788
2001	418		269		96				1,456
Total	3,431	351	1,427	230	1,444	56	285	673	7,897

Monitoring of the reintroduction effort by personnel of the Oregon Department of Fish and Wildlife and the U.S. Forest Service has shown that all locations that received more than 50 fish have juvenile bull trout present. A census at Iko Springs (a key release site at river kilometer 116) in June 2000 counted 67 juvenile bull trout in three age classes. One month later, during a snorkel survey in the Middle Fork Willamette River downstream of Iko Springs, 8 bull trout were observed; they were possibly outmigrants from Iko Springs (Ziller and Taylor 2000). In 2001, personnel of the Oregon Department of Fish and Wildlife night-snorkeled the Middle Fork Willamette River to determine the distribution and abundance of juvenile bull trout. They found juvenile bull trout inhabiting 8.85 kilometers (5.5 miles) of the Middle Fork Willamette River adjacent to the release sites (ODFW 2001a).

The current population of bull trout in the Middle Fork Willamette River is believed to be, at most, a handful of adults (ODFW 2001a). The population size that the Middle Fork Willamette River can support is not known, but local biologists believe the potential is similar to that of the South Fork McKenzie River (ODFW and USFS 1998). Juvenile abundance is estimated at approximately 250 individuals, based on monitoring at reintroduction sites (ODFW 2001a).

Clackamas River Core Habitat. The Clackamas River core habitat encompasses the Clackamas River basin (Figure 7). Currently, no bull trout are in this core area, but it did support a historic population in both the Santiam and Clackamas Rivers. The last documented bull trout observations in these systems were in 1945 (North Santiam), 1953 (South Santiam), and 1960 (Clackamas) (Goetz 1989). Massey and Keeley (1996) reported two instances of bull trout being caught in the 1970's. A 1992 survey of the upper mainstem Clackamas River (river kilometer 79 to 85), the Collawash River (river kilometer 6.45 to 13), and the East Fork Collawash River (river kilometer 0 to 3.9) by U.S. Forest Service and Oregon Department of Fish and Wildlife personnel failed to find bull trout (Eberl and Kamikawa 1992). Additional surveys in 1998 and 1999 failed to find bull trout in the upper mainstem Clackamas River (river kilometer 123.8 to 124.6) and tributaries (Cub, Berry, Farm, Dickey, Lemiti, and Squirrel Creeks), two tributaries of the Oak Grove Fork (Shellrock and Crater Creeks), and two tributaries (East Fork Collawash River and Elk Lake Creek) in the mainstem

Figure 7. Location of core habitat in the Clackamas River basin and of potential core habitat in the Santiam River basin.



Collawash River (river kilometer 9.7 to 10.7) (Zimmerman 1999). Based on the size of bull trout recorded in creel records dating from the 1940's and 1960's and on the locations where the fish were caught, these populations probably had a fluvial life history. No estimates of historic abundance for the Clackamas and Santiam basins are available.

Goetz (1989) also reported that a bull trout in the Long Tom River appeared in creel records in 1962. However, the Long Tom River probably never supported a bull trout population because of the low elevation of its headwaters and subsequent lack of very cold water required by bull trout for spawning and rearing. This finding suggests that bull trout may have used the mainstem Willamette River as a foraging area.

REASONS FOR DECLINE

At the time of listing, the U.S. Fish and Wildlife Service considered dams, forest management (harvest), roads, and water quality as threats to bull trout in the Willamette River basin (USFWS 1998a). The construction of impassable dams and culverts is considered a major factor in the decline of bull trout (Wevers *et al.* 1992; Goetz 1994) because migratory corridors were blocked and temperature and flow regimes were altered. Ratliff and Howell (1992) list habitat degradation, passage barriers, overharvest, chemical treatment projects, and hybridization and competition with nonnative brook trout as possible suppressing factors for bull trout populations in the Willamette River basin. Alteration and degradation of instream habitat, resulting in loss of instream structure, pools, and side-channel habitats are identified as limiting bull trout populations in the McKenzie and Middle Fork Willamette River basins (ODFW 1993a; Unthank and Sheehan 1994). Causal mechanisms can be both manmade and natural and are difficult to quantify because data on historic population abundance and habitat conditions are lacking.

Although much of the damage is historical and although current policies and practices are more protective of aquatic resources, the legacy effects of past events are still evident. What can be restored naturally—for example, riparian cover and recruitment of large woody debris—will require many years. In other instances where change may not be reversible—for example, impassable dams—other solutions will be required to address the threats to bull trout survival and persistence.

Water Quality

Impacts resulting from cumulative effects of land use activities are reflected in a river's water quality and aquatic fauna. Although water quality in the McKenzie and Middle Fork Willamette Rivers is considered excellent and ranks high compared with the water quality of other rivers in Oregon (Cude 2001; EWEB *et al.* 2001), segments of both rivers are listed as water quality limited for temperature according to the Clean Water Act 303 (d) list (<http://waterquality.deq.state.or.us/wq/303dlist/Download303d.htm>). Both the mainstem McKenzie River, from the confluence of the South Fork McKenzie River

upstream to Trail Bridge Reservoir, and Horse Creek, from the mouth to Eugene Creek, exceed the Oregon bull trout standard (10 degrees Celsius [50 degrees Fahrenheit]) in the summer. The bull trout standard is conservative to protect spawning and juvenile rearing habitat and was established based on the best available information at the time. Neither of the river segments currently support bull trout spawning, although Horse Creek may be used by juveniles. Whether temperature is limiting bull trout rearing in these segments is not known. Segments of the mainstem McKenzie River and its tributaries do not meet criteria for salmonid spawning (12.8 degrees Celsius [55 degrees Fahrenheit]) and rearing (17.8 degrees Celsius [64 degrees Fahrenheit]), especially during the summer. A section of the Middle Fork Willamette River that is potentially important to bull trout (from Hills Creek Lake to Staley Creek) is also listed because of exceeding temperature criteria for rearing salmonids in summer.

At this time, the McKenzie River is not considered limited because of sediment, although sedimentation is raised as a major issue during interagency consultation discussions. The lengthy incubation time and sensitivity of bull trout eggs while in the gravel make them highly susceptible to suffocation from sediment inputs. The McKenzie River's ability to rapidly flush out sediments may mask subtle changes that could affect bull trout but that may not be detectable with current methodologies.

Dams

Major barriers to bull trout moving upstream in the McKenzie River basin include Cougar Dam on the South Fork McKenzie River and Trail Bridge Dam on the mainstem McKenzie River. Built without effective fish passage, these structures prevent genetic interchange among the McKenzie River bull trout populations and may, therefore, affect their long-term persistence. Smith Dam is also a passage barrier to the Trail Bridge bull trout population, reducing habitat available to bull trout in this watershed above the dam. Hills Creek, Lookout Point, and Dexter Dams, all built without fish passage, have limited bull trout migration in the Middle Fork Willamette River basin.

Juvenile spring chinook are believed to be an important prey for bull trout. Cougar Dam and Trail Bridge Dam eliminated spring chinook from spawning and rearing in the upper South Fork McKenzie River and the upper McKenzie River, respectively, for many years. The absence of spring chinook may have limited the production potential of the bull trout populations. Dexter Dam blocked spring chinook from migrating to the upper Middle Fork Willamette River. Prior to construction of Dexter and Lookout Point Dams, the Hines Lumber Company mill at river kilometer 2 on the North Fork of the Middle Fork Willamette River blocked upstream migration of spring chinook. It had a fishway, but the structure was inadequate (Hutchison *et al.* 1966). This mill was removed in 1995 (J. Ziller, pers. comm., 2001).

Hydroelectric facilities in the upper Willamette River subbasin are potential sources of mortalities to downstream-migrating bull trout and, in some cases, pose risk for fish migrating upstream. The Leaburg-Waltermville project, Cougar Dam and its water temperature-control project, the Bigelow Project, Trail Bridge Dam, and Hills Creek Dam are discussed below.

Leaburg-Waltermville project. Chinook fry and smolts currently experience a low level of mortality when they pass through the Leaburg roll gates, although alternative passage routes are available to them, for example, the left-bank fish ladder and the power canal intake screen bypass facility (EWEB *et al.* 2001). Bull trout use of the roll gates and any subsequent mortality are unknown. Waltermville intake is currently unscreened, and entrainment into the turbines is a potential threat to bull trout, although there is no data indicating that bull trout are using the power canal (EWEB *et al.* 2001).

Cougar Project. Downstream passage may occur through the turbines or regulating outlets. Of three radio-tagged bull trout recovered after passing through the facility, two showed signs of injury. According to one study, mortality rates estimated for juvenile chinook salmon were about 7 percent for the turbine route and 32 percent for the regulating outlet route (ODFW 2000). This study also determined that mortality increased with fish size. Bull trout mortalities can be expected at Cougar Dam for downstream migrants. Bull trout exiting the dam via the spill gates would probably encounter elevated total dissolved gas levels, from 97.8 to 124.1 percent of

saturation, near the base of the dam. The State of Oregon water quality criterion for total dissolved gas downstream of dams is a maximum not to exceed 110 percent of saturation relative to atmospheric pressure (OAR 340-41-445 [2][n][A]). Effects on bull trout have not been evaluated.

Bigelow Hydroelectric Project. This run-of-the-river (a dam that does not hold water longer than a 24-hour period) project is not equipped with fish passage facilities of any kind. Although there are no data that indicate bull trout are being impacted by the project, there is risk of mortality to migrating bull trout. No bypass system prevents downstream migrants from entering the power plant, and no tailrace barrier prevents upstream migrants from swimming into the tailrace and subsequently into the draft tube (NMFS and USFWS 1999).

Trail Bridge Powerhouse. The turbine intake is unscreened, and bull trout may be entrained and killed in the turbines. If fish survive passage through the turbines, they could be lost to the Trail Bridge local population. In 1998, Eugene Water and Electric Board staff sampled nine fish from a screw trap; one was a dead juvenile chinook salmon, and none were bull trout (EWEB *et al.* 2001).

Hills Creek Powerhouse. Biologists observed mortalities in juvenile spring chinook in the turbine (59 percent) and regulating outlets (32 percent) at Hills Creek Dam on the Middle Fork Willamette River (D. Larson, U.S. Forest Service, pers. comm., 2000). Bull trout attempting to migrate through Hills Creek Dam would probably experience some mortality either going through the turbines or out the regulating outlets. The drop from the regulating outlets to the river is 53 meters (175 feet).

Aquatic habitat has been degraded by dam construction and operation in the McKenzie and Middle Fork Willamette River basins through altering flow and temperature regimes and interrupting natural movement patterns of sediment and large woody material. Impacts to bull trout are from loss of pool habitat for overwintering adults and loss of side-channel habitat important to juveniles. Loss of these habitat elements in the lower mainstem McKenzie and Middle Fork Willamette Rivers has

also impaired anadromous species production, with consequences to bull trout through loss of their historic prey base.

Temperature regimes downstream of Cougar, Blue River, and Hills Creek Dams are now cooler in spring and early summer and warmer in late summer and fall than they were prior to dam construction (Minear 1994; USACE 2000). The reduced production of spring chinook that resulted from the altered temperature regime affects bull trout through loss of available prey species (USACE 2000). Temperature data are not available for Smith River downstream of Smith Dam to assess changes resulting from dam operation (EWEB *et al.* 2001).

Flood control is a major purpose of the dams of the U.S. Army Corps of Engineers in the Willamette River basin. The resulting reduction in peak flows in the McKenzie River from about 1,132.7 cubic meters per second (40,000 cubic feet per second) to about 934.46 cubic meters per second (33,000 cubic feet per second) (USACE 2000) has reduced the rivers' ability to move bedload. Dams also reduce inputs of sediment and large wood and, therefore, deprive the rivers of building materials that, coupled with peak flow events, create and rework habitat elements important to fish, for example, side channels and scour pools. Runyon (2000) estimated a 59 percent reduction in annual suspended sediment load compared with the load before reservoirs were constructed. Logs trapped behind dams are purposefully removed and generally lost to the river system. Minear (1994) attributed the loss of pools in the McKenzie River above Leaburg Dam to reduced peak flows, channel straightening, and removal of large woody debris. Loss of habitat complexity in the less confined reaches of the lower McKenzie River was also attributed to reduced peak flows resulting from construction of Cougar and Blue River Dams and to bank riprapping (EA 1991). Reduced length and width of side-channel habitats in the mainstem South Fork McKenzie River downstream of Cougar Dam were attributed, in part, to reduced peak flows and loss of large wood contributions as a result of the dam (USFS 1994). The McKenzie River downstream of Dearhorn Park, between the Leaburg and Walterville projects, had many islands and shifting channels prior to flood control and the extensive riprapping (EA 1991) that was installed to protect banks from flooding (USACE 2000). Impacts to downstream populations of bull trout—for example, in the Blue and South Fork McKenzie Rivers—resulting from

reservoir operations during drawdown (*e.g.*, water level fluctuations, increased turbidity) are not well understood and should be investigated.

The Santiam River basin contains numerous dams that would act as passage barriers to bull trout and would need to be addressed if bull trout were reintroduced into this basin. U.S. Army Corps of Engineers flood control facilities on the North Santiam River include Detroit and Big Cliff Dams, both constructed without fish passage. Diversions at the Stayton and Minto Dams may not be passage barriers, but could delay migration. Foster and Green Peter Dams on the South Santiam River have similar effects. However, the South Santiam River may have historically been used by bull trout more for foraging than for spawning and early rearing (W. Somes, U.S. Forest Service, pers. comm., 1999). Anadromous runs of chinook and steelhead are maintained through hatchery programs in the North Santiam River downstream of Big Cliff Dam, the Little North Santiam River, and the South Santiam River downstream of Foster Dam.

Dams on the mainstem Clackamas River and its tributaries would present migration challenges to bull trout if they were reintroduced into this basin. River Mill Dam has a fish ladder, but it needs improvement to pass anadromous species. Farraday Dam (formerly Cazadero Dam) has a 2.74-kilometer-long (1.7 miles) ladder (North Fork fishway) that provides passage past both Farraday and North Fork Dams. North Fork Dam has a collection facility that collects downstream migrants, which are then passed into a pipeline that takes them below River Mill Dam. Downstream migrants may also leave North Fork Reservoir via the spillway during high flows, but such migrants may experience high mortality rates as they pass Farraday and River Mill powerhouses, which are not equipped with juvenile bypass facilities (Murtagh *et al.* 1992).

These dams were not originally equipped with fish passage when built. Anadromous species, and probably bull trout, were cut off from upper portions of the watershed for approximately 20 years. River Mill Dam had a ladder installed in 1939, and downstream passage was provided in the late 1950's. Whether facilities designed for anadromous species will be sufficient to safely pass bull trout is not known (T. Horning, U.S. Forest Service, pers. comm., 1999).

Forest Management Practices

Forest management practices include timber harvest and associated road construction. Recreation development and management on public lands are also included in this section as most of the Federal land is in the forested habitat.

Timber harvest, the dominant land use in the upper Willamette River subbasin, dates from the late 1800's and began along the lower reaches of the McKenzie River (Weyerhaeuser 1994, 1995). Log drives on both mainstems (from Leaburg downstream on the McKenzie River and from the North Fork Middle Fork downstream on the Middle Fork Willamette River) were used to convey logs to mills located at the cities of Coburg and Eugene, Oregon, until about 1912 (DSL 1983). Loggers took advantage of the high spring flows to move large log rafts downstream unassisted by splash dams (DSL 1983). Log drives in the Middle Fork Willamette River upstream of Oakridge have been documented, and there is some evidence that splash dams were created to float the logs prior to releasing them to the stream by blowing up the dams (Unthank and Sheehan 1994). Truck logging dates from the 1940's (Weyerhaeuser 1995), and by 1950, harvest had extended into portions of the upper McKenzie River subbasin (USFS 1995a). By the 1960's (based on road construction built to access timber), harvest extended into the upper Middle Fork Willamette River subbasin (USFS 1996). Harvest activities peaked in the 1980's, and by the 1990's had decreased significantly on public lands due to more stringent policies governing management of public lands, such as the Willamette National Forest Plan and the Northwest Forest Plan (USFS 1995a). Removing large wood from streams and harvesting by clear-cutting were accepted forest practices from the mid-1970's until the 1980's on the National Forest (USFS 1995b). Similar actions were recommended on private timberlands prior to revision of the Oregon Forest Practices Act in 1994 (Weyerhaeuser 1995).

Impacts to bull trout habitat that are due in part to historic harvest in riparian areas include loss of large wood and its contributions to habitat complexity, instream structure, and pool formation; increases in water temperature from loss of riparian canopy; and mobilization of sediments during high flows (Chamberlain *et al.* 1991). Loss of pools and instream structure were identified as possible limiting factors to

bull trout in the mainstem McKenzie River, the South Fork McKenzie River below Cougar Reservoir, Deer Creek, and Horse Creek (ODFW 1993a). Water temperature impacts were identified in Deer Creek and in the South Fork McKenzie River upstream of Cougar Reservoir (ODFW 1993a). Loss of pool habitat and available cover and the alteration of temperature regimes are possible limiting factors in the upper Middle Fork Willamette subbasin (Unthank and Sheehan 1994). Increased temperature in the mainstem and tributaries to the Middle Fork Willamette River are attributed to riparian harvest (ODFW 1993a; Unthank and Sheehan 1994). Stream surveys in 1992 revealed decreases in primary pool habitat in the Middle Fork Willamette River since surveys of those habitats were conducted in 1937 (Unthank and Sheehan 1994).

Data on fine sediment in substrates and in nutrient and food web systems were not collected during the 1992 survey, so impacts from sedimentation on bull trout have not been evaluated. Increases in sediment can result from slope failure associated with harvest and road building (Lyons and Beschta 1983) and from debris torrents that introduce large volumes of sediment into the stream system during high flow events. Landslides occurred more frequently in clear-cut and roaded areas than in forested areas without roads (Lyons and Beschta 1983), thereby increasing the amount of sediment available for transport to streams in those areas. Significant increases in channel width and aggradation at the junctions of several streams in the Middle Fork Willamette River above Hills Creek Reservoir were noted after a flood in 1964 (Lyons and Beschta 1983). Increases in channel width and areas of exposed cobble and gravel bars were evident from aerial photographs taken of the South Fork McKenzie River between 1939 and 1990; the number of side channels also decreased during the same period (USFS 1994). The 1964 flood had a major impact on the South Fork McKenzie River above the dam, changes were similar to those observed in the Middle Fork Willamette River.

In addition to the direct loss of large wood from harvest, logs transported and redeposited downstream during high flow events, such as the 1964 flood, are traditionally removed for firewood, to reduce navigation hazards in the McKenzie River (in this instance), and to protect hydroelectric facilities (Minear 1994; Weyerhaeuser 1995; Runyon 2000). Except where logs have been salvaged for use in

aquatic restoration projects (Runyon 2000), they are lost to the stream system. Aggressive salvage of large wood from the main channel and side channels of the South Fork McKenzie River above the reservoir from 1964 through the early 1980's may have caused the river to abandon side channels (USFS 1994).

Some road culverts in the Middle Fork Willamette River have been identified as barriers to bull trout (USFS 1996). Road culverts on Olallie and Sweetwater Creeks in the McKenzie River basin prevented access to upstream spawning and rearing habitat until they were replaced.

Some uncertainty exists regarding the long-term security of bull trout habitat because critical spawning and rearing habitat in the McKenzie and Middle Fork Willamette River basins in the Willamette National Forest is designated as land where timber harvest will continue. Provisions of the Northwest Forest Plan should be adequate to prevent future habitat degradation, and past damage will heal as the forest regenerates and as projects to improve instream habitat, fish passage, and overall watershed health are completed.

The Santiam River system has been affected in various ways by forest management practices. The removal of streamside vegetation has increased the amount of sunlight hitting streams, thereby increasing temperatures in some areas above what is suitable for good bull trout spawning and early rearing habitat. Vegetation removal has also reduced the potential amount of large wood that could enter streams and renew habitat complexity. Soil-disturbing land management activities has created conditions such that disturbed soil can be mobilized by storm events and enter streams as suspended sediment, thereby reducing habitat quality and stream biotic production. Stream channels have been cleared of trees to reduce the risk of flood damage to bridges and culverts. Road building in conjunction with harvest activities produced sediment, impacted streams because of their proximity, and created migration barriers at improperly constructed stream crossings (Somes, pers. comm., 1999). Assessments of potential bull trout habitat need to include passage considerations at culverts and other stream crossings.

As within the rest of the bull trout subbasins, aquatic habitat has been degraded in the Clackamas River basin by timber harvest in the riparian zone, harvest by clear-cutting, removal of large wood from stream channels, and road building (Murtaugh *et al.* 1992). Increased sediment loading throughout much of the lower subbasin has decreased stream habitat quality, as well as increased stream temperatures and decreased stream channel stability. Road building and recent regeneration harvesting of forest stands affects hydrologic function and alters peak flows; in some areas of the watershed, the road network exceeds the road density thresholds (road miles per square mile) that the Forest Plan standards currently allow (Horning, pers. comm., 1999). Prior to the Northwest Forest Plan, many riparian corridors were harvested of old-growth timber, and salvage logging after the 1964 flood further reduced large wood available to streams. Many years will need to pass before these areas produce trees of suitable size to contribute to large wood recruitment in streams (Horning, pers. comm., 1999). In addition, legacy effects remain where stream crossings do not provide adequate passage at stream culverts, although all anadromous streams have fish passage today (Horning, pers. comm., 1999). Assessments of potential bull trout habitat need to include passage considerations at culverts and other stream crossings.

Agricultural Practices

Most of the land used for agriculture occurs in the lower reaches of all four bull trout subbasins. However, only the McKenzie River supports bull trout migration and overwintering in areas that are likely to be impacted by agricultural activities. According to Runyon (2000), higher densities of farmland (cultivated fields and orchards) near the river occur between Hendricks Bridge (river kilometer 39) and Hayden bridge (river kilometer 24), and such farmland is less abundant today than in 1944. High levels of fecal coliform, total phosphorus, ammonia and nitrate nitrogen, biological oxygen demand (measure of oxygen required to decompose waste), and total solids impact water quality recorded at Coburg Road (river kilometer 11.45) and the Mohawk River during periods of extended precipitation and high flows (Cude 2000). Some of these materials are attributable to agricultural runoff, but some are also from urban areas. Impacts to bull trout are unknown.

Transportation Network

Major State highways follow the mainstem rivers in all four bull trout subbasins in the Willamette Recovery Unit: Highway 58 along the Middle Fork Willamette River and its tributary Salt Creek, Highway 242 along the McKenzie River, Highway 20 along the South Santiam River, Highway 22 along the North Santiam River, and Highway 224 along the Clackamas River from Estacada to the confluence of Oak Grove Fork. Access over the crest of the Cascade Mountains is provided by Highways 58 and 22.

Risks to bull trout in the McKenzie River subbasin, and potentially to the other subbasins as bull trout are successfully reintroduced, include the potential for spills of hazardous or toxic materials resulting from highway accidents. Road maintenance operations along Highway 126 (*e.g.*, brush and “hazard tree” removal) remove large wood and shade elements and may cause short-term turbidity. Applying cinders to road surfaces adjacent to streams for winter driving traction may inundate redds and could affect habitat through minor aggradation, pool filling, and channel widening (R. Rivera, U.S. Forest Service, pers. comm., 2001).

Historic effects from development of the transportation network in the McKenzie River subbasin remain and may limit habitat in the lower mainstem. Loss of riparian conifers to road construction and other development in the flood plain reduced potential contributions of large wood to the channel (Minear 1994). Levees and riprap have been constructed along more than 17 kilometers (11 miles) of river bank in the lower McKenzie River for flood control (USACE 1989). These structures disconnect the river from its floodplain and, over time, could gradually isolate side-channel habitats, thereby reducing off-channel habitats that are important for anadromous salmonids (Minear 1994). Bull trout may be affected by loss of anadromous prey species that would use these habitats.

Mining

Mining for gold, silver, and copper occurred from the late 1800's to the early 1900's in four mining districts on the Willamette National Forest: Blue River, Fall

Creek, North Santiam, and Quartzville. Although these areas are small isolated pockets with questionable ore potential, some recreational mining now takes place in the Little North Santiam and Quartzville areas (USFS 1990). Mining projects along Blue River, most of which were tapped out by 1912 (USFS 1994), affected the river and probably the McKenzie River downstream (N. Armantrout, Bureau of Land Management, pers. comm., 2001). Although commercial gravel mining occurs in the lower McKenzie River, it is not considered a threat to bull trout at this time.

Residential Development

This section includes urbanization in general since the lower mainstems of the Clackamas, McKenzie, and Middle Fork Willamette Rivers have been affected by substantial development, both industrial and residential. Summer home communities and individual dwellings built near streams in the Santiam River basin occur in the North Santiam River watershed. Impacts to bull trout are from alterations to aquatic habitat and potential impacts from periodic inputs of pollutants during storms (see previous discussions in the sections on Transportation Networks and Agricultural Practices).

Runyon (2000) identified old, failing septic systems as a potential water quality problem in the lower McKenzie River because on-site alternatives are limited due to thin soils, small lot sizes, a high water table, and porous soils. A total of 474 river-front houses were counted between the Interstate 5 bridge and Quartz Creek bridge (Runyon 2000), a distance of approximately 48 kilometers (29.8 miles). Elevated levels of fecal coliform detected at monitoring stations at Coburg Road and Mohawk River during storm events may have resulted from failing septic systems and livestock operations (Runyon 2000). Additional testing is necessary to assess impacts from residential septic systems.

The only major, permitted, industrial point-source discharges into the McKenzie River are from the Weyerhaeuser Company facilities in Springfield. Several outfalls discharge treated wastewater or cooling water into the river between river kilometer 22 and river kilometer 24. Temperature limits on discharged water are either 38 degrees Celsius (100.4 degrees Fahrenheit) or 44 degrees Celsius (111.2

degrees Fahrenheit), depending on the location. A brief review of monitoring reports for February and May 2001 showed that temperature maximums did not exceed 24 degrees Celsius (75.2 degrees Fahrenheit) or 30 degrees Celsius (86 degrees Fahrenheit), respectively. The closest downstream ambient monitoring site is at Coburg Road, approximately 11.3 kilometers (seven miles) downstream from the outfalls and the Mohawk River confluence. The temperature standard through this reach from September 1 through May 31 is 12.8 degrees Celsius (55 degrees Fahrenheit). The temperature standard was violated 21 percent of the time during the 1999 water year; the area would not be considered water quality limited for temperature unless the standard were violated 25 percent of the time. In comparison, the temperature standard was violated 4 percent of the time at the closest upstream monitoring site at Hendricks Bridge, at approximately river kilometer 39 (Cude 2000). The effects of plant effluent discharges on bull trout that may be foraging or overwintering in the lower river is unknown.

Fisheries Management

At this time, there are no significant fish diseases in the recovery unit that threaten existing bull trout populations. However, whirling disease has been reported recently at a private trout farm in the Clackamas River basin (ODFW, *in litt.*, 2001). Whirling disease has been present since the 1980's in the Grande Ronde basin, which also has several populations of bull trout. But bull trout have not shown signs of the disease.

Bull trout may be inherently resistant to some diseases that are more devastating to other salmonids. In challenge cost-share studies conducted by Oregon State University researchers, Metolius River (Deschutes Recovery Unit) bull trout exposed to high and low doses of the infectious stages of *Myxobolus cerebralis* (causative agent in whirling disease) showed no signs of infection as measured by the presence of spores (clinical disease signs). Rainbow trout exposed simultaneously showed high infection prevalence and disease severity. Metolius River bull trout exposed to *Ceratomyxa shasta*, a myxosporean parasite that attacks the digestive system, did not show signs of infection (Bartholomew 2001). Disease studies conducted on bull trout from the Deschutes River basin showed them to be relatively

resistant to all strains of infectious hematopoietic necrosis virus. Bull trout had detectable levels of antigen to *Renibacterium salmoninarum* (bacterial kidney disease) but no evidence of the disease.

Overharvest and stocking programs may have limited bull trout production in the Willamette River basin. Prior to 1990, anglers fishing in the McKenzie and Middle Fork Willamette Rivers and their tributaries could legally catch and keep five trout per day (native rainbow trout, native bull trout, stocked catchable rainbow trout, or nonnative brook trout were all listed as trout in this system). Bull trout harvest is now prohibited, and additional gear restrictions for other species have been implemented, but have not been fully evaluated for their effectiveness in protecting bull trout. In the mainstem McKenzie River from Hayden Bridge upstream to Blue River, bait is allowed between April 17 and October 31 (ODFW 2001b). Bait is allowed in lakes and reservoirs, except for Trail Bridge, which was restricted to artificial flies and lures in 2001. Use of bait may pose some risk to bull trout, but little or no angling activity occurs during the time bull trout are present in these areas.

Bull trout in the upper Willamette River basin are vulnerable to overharvest and poaching because of the small number of spawning fish, the limited areas where they spawn, and misidentification by anglers (ODFW 1993a). Areas with easy access and numerous dispersed campsites, such as the South Fork McKenzie River above Cougar Reservoir, Horse Creek, the mainstem McKenzie River, and the Middle Fork Willamette River, receive greater angling pressure, which increases the potential for illegal take of bull trout. Ongoing education of anglers and the public about bull trout is needed to protect bull trout and their habitat.

Since before the 1960's, brook trout have been released into high lakes in the Cascade Mountains and have become self-sustaining in some of these lakes. There is a large population of brook trout in Trail Bridge Reservoir, and hybridization is a clear concern. Brook trout are well established in the watershed above this Trail Bridge Reservoir bull trout population, and abundant brook trout in the reservoir are strong competition for bull trout, although predator-prey relationships in the reservoir have not been studied. There is potential for hybridization and/or competition with brook trout in the mainstem McKenzie River just downstream of Trail Bridge

Reservoir and in the Horse Creek watershed, and hybridization may already be occurring. U.S. Forest Service surveyors reported a bull trout x brook trout hybrid in Horse Creek during snorkeling operations in 1992 and in the mainstem McKenzie River above Trail Bridge Reservoir in 1998. Brook trout have been present in the headwaters of the South Fork McKenzie River for many years but have not expanded their range to overlap with bull trout. Brook trout distribution in the Middle Fork Willamette River extends downstream as far as the mouth of Tumblebug Creek as a result of lake stocking (WRUT, *in litt.*, 1997a). Brook trout are also found in lakes in the Swift Creek and Bear Creek drainages and in Beaver Creek (ODFW and USFS 1998), Wall Creek, North Fork Middle Fork Willamette River, and Salt Creek (Connolly *et al.* 1992). Brook trout do not inhabit the bull trout release areas, and bull trout are prevented from expanding upstream by several natural barriers (ODFW and USFS 1998).

Chemical treatment of the Middle Fork Willamette River above and below Hills Creek Dam and tributaries above the dam was carried out in 1960 to remove nongame fish before closing the dam. Most bull trout were probably eliminated in the treatment area, and the remaining population level is probably small enough to have resulted in a serious genetic bottleneck (ODFW 1993a).

Risks to bull trout reintroduced into the Santiam River basin include 1) overharvest from misidentification and deliberate poaching and 2) hybridization and competition with brook trout. Brook trout have been introduced into dozens of lakes in the North Santiam River basin. In various places, they have strayed from the lakes and are residing in outlet streams. Surveys have generally not found them very far from the lakes where they were stocked, though in some instances decades have passed since the original stocking. Any proposal for reintroducing bull trout into the North Santiam River should consider the present distribution of brook trout in the basin (Somes, pers. comm., 1999).

Harvest appears to have been a major factor in eliminating bull trout from the Clackamas River basin before the existing protective regulations were implemented. The Clackamas River receives heavy angling pressure and is close to the Portland

metropolitan area, factors that could be important in the future if bull trout are reintroduced (Horning, pers. comm., 1999).

Brook trout are generally restricted to small headwater streams, often above falls that are barriers to anadromous fish migration; they would have little opportunity to impact bull trout (Horning, pers. comm., 1999). Brook trout are also found in Timothy Lake and the Oak Grove Fork of the Clackamas River, although they are no longer stocked in these waters. They reproduce naturally in tributaries flowing into Timothy Lake (Murtagh *et al.* 1992). Brown trout found in the Oak Grove Fork of the Clackamas River are descendants of fish planted there under past hatchery programs (Murtagh *et al.* 1992).

Isolation and Habitat Fragmentation

Bull trout populations in the Willamette Recovery Unit are exposed to a greater risk of extinction because of their small population size and physical isolation by dams. Dams act as barriers preventing gene flow from the mainstem McKenzie River local population to the local populations above the dams and inhibit gene flow from the local populations above the dams to the mainstem McKenzie River local population. Bull trout that survive passing downstream at the dams are lost to the local populations above the dams. Bull trout in the Willamette Recovery Unit are below the numbers that, in current population theory, are thought to represent a viable population (minimum of 1,000 adult spawning individuals) to minimize inbreeding effects and maintain an ability to adapt to changing environmental conditions (Rieman and Allendorf 2001). Maximizing adult bull trout abundance in the local populations is essential for their long-term genetic health. However, even if populations were in a recovered state, restricted amounts of suitable habitat because of not restoring opportunities for passage may limit attainment of what would be considered viable numbers in each bull trout local population. Restoring opportunities for passage increases the overall fitness by allowing for genetic interchange among the local populations and by renewing adult numbers in local populations behind dams.

The spawning area of the McKenzie River bull trout local population downstream of Trail Bridge Dam is currently limited to approximately 5 stream kilometers (3 miles) in two streams, both located within a 1.6-kilometer (1-mile) radius. This condition increases the risk of extirpation for this population from a human or natural disturbance, such as a wildfire or chemical spill at the Highway 126 crossings (USFS 1995a). Establishing viable populations in historic habitat in the Clackamas, Santiam, and Middle Fork Willamette Rivers spreads the risk of extinction due to a catastrophe and provides a donor source for recolonization. Reintroduction into the Middle Fork Willamette River basin has begun (see discussion in the section on Distribution and Abundance), while assessments for suitability to support viable bull trout populations need to be completed for the Clackamas River basin and initiated for the Santiam River basin.

ONGOING RECOVERY UNIT CONSERVATION MEASURES

Efforts to recover bull trout and other native species are ongoing in the Willamette Recovery Unit, with a high level of cooperation occurring between fishery entities on various projects. Spawning surveys have been a cooperative effort for many years. The McKenzie River basin has an active local watershed group dedicated to finding workable solutions to restoring native fish runs. The following list of activities is by no means complete, but is representative of ongoing efforts within the Willamette Recovery Unit.

State of Oregon

Angling regulations have been changed to protect bull trout (Table 5), including closure to angling for bull trout and catch and release of trout in all streams in the Willamette Zone (which is comparable to the Willamette River basin).

Table 5. Changes in Oregon Department of Fish and Wildlife angling regulations to protect bull trout (Ziller and Taylor 2000).

Year	Location	Regulation Change
1991	Willamette River basin	Taking bull trout prohibited
1992	McKenzie River (mainstem and South Fork)	All wild trout must be released
1994	McKenzie River (river kilometer 105 to 133)	Artificial flies and lures only
1997	South Fork McKenzie River	Artificial flies and lures only
	Trail Bridge Reservoir	All wild trout must be released
	Middle Fork Willamette River (above Hills Creek Reservoir)	All wild trout must be released; artificial flies and lures only
2001	Most of McKenzie River tributaries and Trail Bridge Reservoir	All wild trout must be released; Artificial flies and lures only

The Oregon Department of Fish and Wildlife has reduced or eliminated trout stocking programs (Table 6). Brook trout are no longer stocked in high lakes in the McKenzie and Middle Fork Willamette River basins. No hatchery trout are released

in the mainstem McKenzie River above Blue River or in the South Fork McKenzie River. Surplus hatchery chinook are released above the dams to improve nutrients to the system, provide additional fishery opportunities, and provide a food source for bull trout.

Table 6. Changes in management of hatchery-reared rainbow trout implemented by the Oregon Department of Fish and Wildlife to reduce take of bull trout in the upper Willamette River basin (Ziller and Taylor 1999).

Year	Location	Action
1988	McKenzie River (river kilometer 0 to 24)	Rainbow trout stocking discontinued
1994	McKenzie River (river kilometer 105 to 133)	Rainbow trout stocking discontinued
1997	South Fork McKenzie River	Rainbow trout stocking discontinued

The Oregon Department of Fish and Wildlife made changes to in-the-stream work periods to better address bull trout needs.

The Oregon Department of Fish and Wildlife has developed and distributed bull trout identification posters. Posters picturing a bull trout, essential identification attributes, information on the status of bull trout, and telephone numbers to report any bull trout caught have been placed in important angling areas. Permanent, large metal signs will be erected in the McKenzie and Middle Fork Willamette River basins to raise awareness of bull trout. Increased enforcement to reduce poaching is ongoing through the Oregon State Police Cooperative Enforcement Program, and bull trout are given a high priority for protection through an action plan to increase enforcement officers' contacts with anglers in areas frequented by bull trout (Ziller and Taylor 1999).

The Oregon Department of Fish and Wildlife has a section 6 cooperative agreement with the U.S. Fish and Wildlife Service. Funding through section 6 has helped fund assistance with spawning surveys. A proposal to fund the creel census at Trail Bridge Reservoir has been submitted to the U.S. Fish and Wildlife Service for funding in fiscal year 2002.

An Oregon Department of Fish and Wildlife project to monitor distribution, population trends, and habitat use of bull trout populations in the McKenzie and Middle Fork Willamette River basins and to implement rehabilitation of bull trout in the Middle Fork Willamette River basin has been occurring since 1994. The project is funded by the Bonneville Power Administration through the Northwest Power Planning Council's Fish and Wildlife Program (Project No. 9405300). This project has resulted in the collection of most of the current information we have on bull trout distribution and abundance in the McKenzie and Middle Fork Willamette River basins. Through this project, and along with the participation of the Willamette Recovery Unit Team members, several restoration projects have been completed, including culvert replacements in Sweetwater Creek in 1992 and in Olallie Creek in 1995.

Sweetwater Creek is a designated key watershed, where habitat is protected from land use effects by the Northwest Forest Plan. Bull trout fry from Anderson Creek were, over a period of a few years, transplanted into Sweetwater and Olallie Creeks to reestablish bull trout in those streams. In 1998, the Oregon Department of Fish and Wildlife began transplanting fry from Anderson Creek into the upper Middle Fork Willamette River subbasin above Hills Creek Reservoir to restore extirpated or depleted bull trout populations in the Middle Fork Willamette River basin (Taylor and Reasoner 2000).

Another Oregon Department of Fish and Wildlife project funded by Bonneville Power Administration (Project No. 9405400) has resulted in the genetic analysis of Oregon bull trout, including samples from the McKenzie River populations. This research established the genetic baseline for Oregon bull trout and confirmed the Oregon Department of Fish and Wildlife's designation of Willamette River bull trout as a separate gene conservation group (Spruell and Allendorf 1997).

In 1995, the Oregon Department of Fish and Wildlife hired a bull trout coordinator to complete a statewide bull trout status assessment, map bull trout

distribution, and develop conservation strategies for bull trout. When bull trout were listed, the effort shifted to recovery planning.

In 1993, the Oregon Department of Fish and Wildlife began releasing excess hatchery adult and juvenile spring chinook into the South Fork McKenzie River above Cougar Dam and into the upper Middle Fork Willamette River above Hills Creek Dam to provide nutrients to the system and food for bull trout. Releases are made periodically when excess hatchery fish are available. In 1997, adult fish were released into the mainstem McKenzie River above Trail Bridge Reservoir.

Beginning in 2001, the U.S. Army Corps of Engineers is helping to fund Oregon Department of Fish and Wildlife research investigations to better understand movement and habitat use patterns of bull trout in the South Fork McKenzie River above Cougar Dam and to develop a plan to minimize impacts of construction of the Cougar Reservoir Temperature Control Project. Drafting (removal of water) of the reservoir, as required for construction of the facility, may adversely affect bull trout. The goal of the research project is to ensure that the bull trout population is protected during construction of the temperature-control project (ODFW 2000). Work completed in 2001 included the following: trapping and fitting adult bull trout with radio tags (15 total with 13 still accounted for as of October 2001); tagging juveniles and adult bull trout (total of 72 fish) with passive integrated transponders (commonly known as "PIT tags"); setting a trap net in Cougar Reservoir; setting minnow traps in the South Fork McKenzie River system to trap juveniles; tagging juveniles (9 juvenile bull trout were captured; 2 had been PIT-tagged previously); installing and operating a rotary screw trap in Roaring River to monitor juvenile movement and an 8-foot rotary screw trap in the tailrace of Cougar Reservoir to monitor movement of fish through the turbines; conducting redd surveys on September 6 and 27 and in early October; and installing and operating a Vaki fish counter in Roaring River from August through October to enumerate adult bull trout migrating to and from spawning areas (Wade 2001).

Federal Activities

The Willamette National Forest has completed a variety of habitat projects that will benefit bull trout: construction of buck side channels to improve rearing habitat in the upper mainstem McKenzie River; culvert projects in Ollallie and Sweetwater Creeks; placement of large wood in Anderson Creek; buck side channel construction in South Fork McKenzie River above Cougar Reservoir and in Roaring River to provide additional cover, nutrient capture, and prey items and to improve bull trout production; and a habitat enhancement project at Gate Creek to improve bull trout foraging habitat (USFWS 1998b; Ziller and Taylor 2000). In addition, Willamette National Forest staff has assisted Oregon Department of Wildlife staff with producing and distributing “Please Release Me” posters at campgrounds and other high-use areas and in reintroducing bull trout in the Middle Fork Willamette River. The Giustina Land Exchange will contribute to cumulative improvements in bull trout habitat by increasing the acreage of riparian habitat that is managed by the Willamette National Forest and that has protections under the Northwest Forest Plan (USFWS 1998c). Harvest in riparian zones has been severely restricted under the amended Northwest Forest Plan, a restriction that should increase the dominance of conifer communities (USFS 1994) and their future contribution to instream large woody material. Habitat improvement projects in the Middle Fork Willamette River include placing logs, root wads, and boulder structures in the mainstem river from the mouth of Echo Creek to the mouth of Found Creek to increase pool habitat and add habitat complexity. Structural elements were added in the mainstem and side channels at Secret Campground and Sacandaga Campground to increase complexity and provide rearing habitat, and large wood was added to the lower reaches of Youngs Creek, Estep Creek, and Pine Creek to improve fish passage (ODFW and USFS 1998). The U.S. Forest Service plans to place additional spawning gravel in four of the release sites to improve spawning habitat (ODFW 2001a).

During section 7 consultation on continuing operation of their 13 dams and reservoirs in the Willamette River basin, the U.S. Army Corps of Engineers discussed the need for restoration of riparian areas and floodplains. This work

would most likely take place primarily in the upper mainstem Willamette River and attempt, among other activities, to recapture side channel areas. Other areas within the Willamette River basin affected by U.S. Army Corps of Engineers activities, for example, below Cougar Dam, could also be potential project sites. While the exact nature and scope of the restorative work are yet to be determined, such work will include restoring elements of natural ecosystem processes, such as channel complexity and large wood components, and considering ecosystem processes, such as sediment and flow dynamics, as they relate to habitat abundance and diversity. The Willamette Action Team for Ecosystem Restoration, which will be established as a requirement under the Willamette River basin Biological Opinion, will determine the overall goals and objectives, the priority actions and areas, and the individual project scopes and details for the Willamette River riparian area and floodplain restoration program (C. Willis, U.S. Army Corps of Engineers, pers. comm., 2001).

The U.S. Army Corps of Engineers is in the process of constructing a temperature-control project at Cougar Reservoir to regulate water temperatures of water leaving the reservoir, primarily for the benefit of spring chinook. Benefits to bull trout would be in improved spawning and rearing of spring chinook, a prey species, as temperatures are regulated to mimic pre-reservoir conditions. A similar project is also being proposed for Blue River Reservoir.

The U.S. Army Corps of Engineers is studying 10 alternatives for fish passage (for chinook and bull trout) at Cougar Reservoir. Seven alternatives showed promise, although more must be known about the behavior of the target fish species and about the specific biological goals for the South Fork McKenzie River (CH2M HILL 1999).

Relicensing for Portland General Electric hydroelectric projects in the Clackamas River basin is in progress, with the application to the Federal Energy Regulatory Commission due in 2001. Bull trout needs have been discussed, and a new ladder at River Mill Dam is scheduled for construction in 2005.

Eugene Water and Electric Board

The Eugene Water and Electric Board has proposed modifications to the Leaburg-Waltermville Project that are expected to improve passage conditions for chinook and bull trout. A feasibility study will be conducted to study fish passage under the roll gates. Raising the Leaburg Lake level may provide a benefit to bull trout by increasing overwintering habitat. Other conservation measures proposed as part of their relicensing application to the Federal Energy Regulatory Commission include establishing a land trust program to include a \$500,000 grant to the McKenzie River Trust for purchase of land and/or conservation easements and increasing interim instream flows downstream of Leaburg Dam (until construction of the Waltermville intake screen and bypass facility are completed). Proposed studies include (1) evaluating opportunities to enhance habitat condition downstream of the Carmen-Smith Project and Trail Bridge Dam; (2) investigating stranding potential at Trail Bridge Reservoir associated with project operating regimes; (3) analyzing and evaluating opportunities and constraints to joining the two bull trout subpopulations above and below Trail Bridge Dam; (4) evaluating entrainment and mortality and possible deterrent devices at turbine intakes; (5) studying bull trout habitat enhancement for Trail Bridge bull trout, focusing on the potential to improve habitat conditions in Sweetwater Creek, the Smith River upstream of Trail Bridge Reservoir, and the mainstem McKenzie River; and (6) studying bull trout abundance above Trail Bridge Dam (EWEB *et al.* 2001).

RELATIONSHIP TO OTHER CONSERVATION EFFORTS

State of Oregon

On January 14, 1999, Governor Kitzhaber expanded the Oregon Plan for Salmon and Watersheds (Oregon 1997) to include all at-risk wild salmonids throughout the State through Executive Order 99-01. The goal of the Oregon Plan is to “restore populations and fisheries to productive and sustainable levels that will provide substantial environmental, cultural, and economic benefits.” Components of this plan include 1) coordinating of efforts by all parties, 2) developing action plans with relevance and ownership at the local level, 3) monitoring progress, and 4) making appropriate corrective changes in the future. The plan is a cooperative effort of State, local, Federal, Tribal, and private organizations and individuals.

The Oregon Department of Fish and Wildlife and the Oregon Water Resources Department have established priorities for restoring streamflow as part of the Oregon Plan for Salmon and Watersheds (Measure IV.A.8). The Oregon Department of Fish and Wildlife has prioritized streamflow restoration needs by ranking biophysical factors, water use patterns, and the extent that water limits fish production in a particular area. The watermasters of the Oregon Water Resources Department will incorporate these priorities into their field work activities as a way to implement flow restoration measures. The priorities for streamflow restoration needs will also be used by the Oregon Watershed Enhancement Board as one criterion in determining funding priorities for enhancement and restoration projects. Watershed councils and other entities may also use the needs priorities as one piece of information to determine high-priority restoration projects. Streams occupied by bull trout in the recovery unit are included in the highest priority designation for streamflow restoration (NWPPC 2001).

The McKenzie Watershed Council has been in existence since 1993 and is one of many local watershed councils operating in the Willamette River basin. Watershed councils generally identify baseline conditions in their

watersheds, including assessing watershed conditions, identifying problems, and making recommendations or identifying solutions to problems. The McKenzie River watershed assessment has been completed for the McKenzie Watershed Council and includes recommendations for high-priority actions in education, conservation, restoration, institutional change, and monitoring (Runyon 2000).

Opportunities to convert existing out-of-stream flows to instream flows in Oregon are available through a variety of legislatively mandated programs administered by the Oregon Water Resources Department, including transfers of type and place of use (ORS 536.050[4]), voluntary written agreement among water users to rotate their use of the supply to which they are collectively entitled (ORS 540.150 and OAR 690-250-0080), allocation of “conserved water” to instream use (ORS 537.455 to 537.500), lease of all or a portion of consumptive water rights to instream purposes (ORS 537.348, OAR 690-77-070 to 690-77-077), exchange of a water right for an instream purpose to use water from a different source (stored water, surface or groundwater) (ORS 540.533 to 540.543), and substitution of a groundwater right for a primary surface water right (ORS 540.524). The Oregon Water Trust provides purchase of water rights from willing landowners for conversion to instream water rights.

The Oregon Department of Environmental Quality oversees the Willamette River total maximum daily load process. This process will lead to development of a Water Quality Management Plan to address forest, agricultural, urban, and transportation sources of water quality impairment (<http://waterquality.deq.state.or.us/wq/TMDLs/TMDLs.htm>).

The Agricultural Water Quality Management Program, established through Senate Bill 1010 (ORS 568.900 through 568.933), addresses water pollution associated with agricultural lands and activities and will be incorporated into plans that are drafted as part of the total maximum daily load process.

Total maximum daily loads and water quality management plans for the Willamette River basin (including the McKenzie, Middle Fork Willamette, Santiam, and Clackamas Rivers) are expected to be completed in 2003. Available data have been analyzed, and additional field monitoring is ongoing at this time. The Willamette National Forest has completed the Water Quality Restoration Plan for the upper McKenzie River watershed, which has been sent to the Oregon Department of Environmental Quality as part of the process (Rivera, pers. comm., 2001) (<http://www.deq.state.or.us/wq/Willamet/WillMonthlyRpt0801.pdf>).

In mid-1996, the Oregon Department of Transportation and the Oregon Department of Fish and Wildlife entered into a contract that committed the Oregon Department of Fish and Wildlife to inventory, assess, and prioritize for repair all culverts associated with State- and County-owned roadways in the coastal river basins. These surveys did not include private (*i.e.*, on forestlands, residential property, and other private lands), Federal, or city roads. The contract was subsequently amended several times to include all river basins in the State (Mirati 1999).

Federal Activities

As part of the Pacific Northwest Electric Power Planning and Conservation Act of 1980, the Bonneville Power Administration has the responsibility to protect, mitigate, and enhance fish and wildlife resources affected by operation of Federal hydroelectric projects in the Columbia River and its tributaries. The Northwest Power Planning Council develops and implements the Columbia River Basin Fish and Wildlife Program that is implemented by the Bonneville Power Administration, U.S. Army Corps of Engineers, U.S. Bureau of Reclamation, and Federal Energy Regulatory Commission. Coordination of Bonneville Power Administration's responsibilities for protecting, mitigating, and enhancing fish and wildlife resources and incorporation of recommendations by the Northwest Power Planning Council occur in part through the development of subbasin summaries. These summaries identify status of fish and wildlife resources, limiting factors, and recommended actions at the subbasin level.

The draft Willamette subbasin summary (NWPPC 2001) encompasses the Willamette Recovery Unit and is consistent with bull trout recovery planning efforts to identify limiting factors. The draft Willamette subbasin summary identifies impassable dams and culverts, introduction of nonnative species, water diversions, chemical treatment (Middle Fork Willamette River), and loss of prey species contributing to the decline of bull trout. The overall fisheries goal of the draft Willamette subbasin summary, as expressed in the numerous existing planning efforts in the basin, is "to protect and restore species and habitat through an integrated, ecosystem-based approach that respects local, tribal, and regional needs and targets strategic investment for environmental results." Recovery goals and objectives for bull trout that were developed by the Willamette Recovery Unit Team were incorporated into the subbasin summary. The Willamette Recovery Unit Team will continue to use this planning process to identify and seek funding for projects to aid bull trout recovery.

STRATEGY FOR RECOVERY

A core area represents the closest approximation of a biologically functioning unit for bull trout. The combination of core habitat (*i.e.*, habitat that could supply all the necessary elements for the long-term security of bull trout, including for both spawning and rearing, as well as for foraging, migrating, and overwintering) and a core population (*i.e.*, bull trout inhabiting a core habitat) constitutes the basic core area upon which to gauge recovery within a recovery unit. Within a core area, many local populations may exist. One core area was defined for the Willamette Recovery Unit: the Upper Willamette River core area. The Clackamas River is considered to represent core habitat because it currently does not contain any known local populations. The Santiam River basin may represent core habitat, but further analysis is needed to assess current habitat conditions.

To recover bull trout in the Willamette River Recovery Unit, securing the existing local populations in the McKenzie River and augmenting populations in the Middle Fork Willamette River will be necessary. As these populations become more secure, they are expected to expand their seasonal distribution farther into the mainstem Willamette River for foraging, migrating, and overwintering. As passage issues are resolved, migratory access may become possible between the Middle Fork Willamette and McKenzie Rivers.

Clackamas River Core Habitat. The Clackamas River basin has been identified as a potential area for reintroducing bull trout. Reestablishing bull trout in the Clackamas River core habitat will improve the long-term outlook for bull trout recovery in the Willamette Recovery Unit. As noted earlier, the two known spawning streams in the mainstem McKenzie River are very near one another, so another core area in the Clackamas River basin—one that is farther from the other two—would help safeguard bull trout persistence in the Willamette Recovery Unit by spreading potential extinction risks.

The Role of Artificial Propagation and Transplantation

As described in Chapter 1, section 3(3) of the Endangered Species Act lists artificial propagation and transplantation (or reintroduction) as methods that may be used for the conservation of listed species. While transplantation has played an important role in the recovery of other listed fish species, the overall recovery strategy for bull trout in the Willamette Recovery Unit, where possible, will emphasize identifying and correcting threats affecting bull trout and bull trout habitats. If transplantation is determined to be necessary for bull trout recovery within the Willamette Recovery Unit and if a feasibility study identifies streams capable of supporting bull trout, the joint policy of the U.S. Fish and Wildlife Service and the National Marine Fisheries Service regarding controlled propagation of listed species will be followed (65 FR 56916). Also, an appropriate plan would need to be approved to consider the effects of transplantation on other species, as well as on the donor bull trout populations. Transplanting listed species must be authorized by the U.S. Fish and Wildlife Service through a 10(a)(1)(A) recovery permit, and methods must meet applicable State fish-handling and disease policies.

In streams within the Clackamas River core habitat and the Santiam River basin, bull trout may or may not be present in habitat that historically contained reproducing populations. These streams are considered candidate locations for transplantation activities.

Though every effort should be made to recover a species in the wild before implementing transplantation, in the Clackamas River core habitat and the Santiam River basin, natural recolonization may not be a viable solution to enhance the existing abundance and distribution of bull trout. While bull trout may respond to habitat improvements in occupied and unoccupied streams, successful recovery will probably require a transplantation program.

Recent behavioral and genetic studies of bull trout support artificial propagation programs. These studies report that bull trout exhibit a high degree of fidelity to natal streams (James *et al.*, *in litt.*, 1998; Spruell *et al.* 2000;

Hvenegaard and Thera 2001). Strong fidelity for natal streams does not mean that fish movement between adjacent populations or adjacent basins does not occur, but such fidelity may mean that gene flow and colonization or recolonization of unoccupied habitat may take more than several generations. Therefore, to achieve recovery in the time frame that is specified in Chapter 1 and in this Willamette Recovery Unit chapter, some form of reintroduction may be necessary. If the current Willamette River bull trout populations have been isolated and functioning at low abundance for a long period of time, such a program may be necessary to immediately increase the number of individual fish in the core area and to infuse new genetic material into existing populations to avoid loss of alleles and heterozygosity (Spruell *et al.* 1999). Before implementation of any reintroduction program, a feasibility study would be completed to identify streams with the greatest potential to support local populations of bull trout and to identify the best available source of genetic material.

The Willamette Recovery Unit Team recommends the following: (1) identify and correct threats in the upper Middle Fork Willamette River, the Clackamas River core habitat, and the Santiam River basin, if these areas are determined to contain adequate bull trout habitat, to increase bull trout densities and to allow natural population expansion to occur within streams that have evidence of recruitment; (2) consider a reintroduction program within the Upper Willamette River core area and the Clackamas River core habitat if a feasibility study indicates that this option is the best option for recovery; and (3) recognize that, even if threats are identified and corrected in the Upper Willamette River core area and the Clackamas River core habitat, natural recolonization of bull trout in streams that once supported a local population may take an extended amount of time. In this case, supplementation or transplantation may be the best option. For this option, a feasibility study would need to be completed to identify streams with the greatest potential to support local populations. Supplementation or transplantation would then occur concurrently with other restoration and recovery activities

Recovery Goals and Objectives

The goal of the bull trout recovery plan is to **ensure the long-term persistence of self-sustaining, complex, interacting groups of bull trout distributed throughout the species' native range so that the species can be delisted.** To achieve this goal, the following objectives have been identified for the Willamette Recovery Unit:

- ▶ Maintain current distribution of bull trout within the Willamette Recovery Unit and reestablish bull trout in previously occupied habitats.
- ▶ Maintain stable or increasing trends in abundance of bull trout in the Willamette Recovery Unit.
- ▶ Restore and maintain suitable habitat conditions for all bull trout life history stages and strategies.
- ▶ Conserve genetically diverse populations of bull trout populations within the Willamette Recovery Unit.

Rieman and McIntyre (1993) and Rieman and Allendorf (2001) evaluated the bull trout population numbers and habitat thresholds necessary for long-term viability of the species. They identified four elements, and the characteristics of those elements, to consider when evaluating the viability of bull trout populations. These four elements are (1) number of local populations; (2) adult abundance (defined as the number of spawning fish present in a core area in a given year); (3) productivity, or the reproductive rate of the population (as measured by population trend and variability); and (4) connectivity (as represented by the migratory life history form and functional habitat). For each element, the Willamette Recovery Unit Team classified bull trout into relative risk categories based on the best available data and the professional judgment of the team.

The Willamette Recovery Unit Team also evaluated each element under a potential recovered condition to produce recovery criteria. Evaluation of these elements under a recovered condition assumed that actions identified within this chapter had been implemented. Recovery criteria for the Willamette Recovery Unit reflect 1) the stated objectives for the recovery unit, 2) evaluation of each population element in both current and recovered conditions, and 3) consideration of current and recovered habitat characteristics within the recovery unit. Recovery criteria will probably be revised in the future as more detailed information on bull trout population dynamics becomes available. Given the limited information on bull trout, both the level of adult abundance and the number of local populations needed to lessen the risk of extinction should be viewed as a best estimate.

This approach to developing recovery criteria acknowledges that the status of populations in some core areas may remain short of ideals described by conservation biology theory. Some core areas may be limited by natural attributes or by patch size and may always remain at a relatively high risk of extinction. Because of limited data within the Willamette Recovery Unit, the recovery unit team relied heavily on the professional judgment of its members.

Local Populations. Metapopulation theory is important to consider in bull trout recovery. A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1994) (see Chapter 1). Multiple local populations distributed and interconnected throughout a watershed provide a mechanism for spreading risk from stochastic events. In part, distribution of local populations in such a manner is an indicator of a functioning core area. Based in part on guidance from Rieman and McIntyre (1993), bull trout core areas with fewer than 5 local populations are at increased risk, core areas with between 5 and 10 local populations are at intermediate risk, and core areas with more than 10 interconnected local populations are at diminished risk. For the upper Willamette River core area, there are currently 3 known local populations. Based on the above guidance, bull trout in the Upper Willamette River core area is at an increasing risk category.

Adult Abundance. The recovered abundance levels in the Willamette Recovery Unit were determined by considering theoretical estimates of effective population size, historical census information, and the professional judgment of recovery team members. In general, effective population size is a theoretical concept that allows us to predict potential future losses of genetic variation within a population due to small population sizes and genetic drift (see Chapter 1). For the purpose of recovery planning, effective population size is the number of adult bull trout that successfully spawn annually. Based on standardized theoretical equations (Crow and Kimura 1970), guidelines have been established for maintaining minimum effective population sizes for conservation purposes. Effective population sizes of greater than 50 adults are necessary to prevent inbreeding depression and a potential decrease in viability or reproductive fitness of a population (Franklin 1980). To minimize the loss of genetic variation due to genetic drift and to maintain constant genetic variance within a population, an effective population size of at least 500 is recommended (Franklin 1980; Soule 1980; Lande 1988). Effective population sizes required to maintain long-term genetic variation that can serve as a reservoir for future adaptations in response to natural selection and changing environmental conditions are discussed in Chapter 1 of the recovery plan.

For bull trout, Rieman and Allendorf (2001) estimated that a minimum number of 50 to 100 spawners per year is needed to minimize potential inbreeding effects within local populations. In addition, a population size of between 500 and 1,000 adults in a core area is needed to minimize the deleterious effects of genetic variation from drift.

For the purposes of bull trout recovery planning, abundance levels were conservatively evaluated at the local population and core area levels. Local populations containing fewer than 100 spawning adults per year were classified as at risk from inbreeding depression. Bull trout core areas containing fewer than 1,000 spawning adults per year were classified as at risk from genetic drift.

Adult abundance in the upper Willamette River core area was estimated at 300 adult spawners per year in the three known local populations. Based on

the aforementioned abundance guidance, bull trout in the upper Willamette River core area were considered at increasing risk of inbreeding depression.

Productivity. A stable or increasing population is a key criterion for recovery under the requirements of the Endangered Species Act. Measures of the trend of a population (the tendency to increase, decrease, or remain stable) include population growth rate or productivity. Estimates of population growth rate (*i.e.*, productivity over the entire life cycle) that indicate a population is consistently failing to replace itself also indicate an increased risk of extinction. Therefore, the reproductive rate should indicate that the population is replacing itself, or growing.

Since estimates of the total population size are rarely available, the productivity or population growth rate is usually estimated from temporal trends in indices of abundance at a particular life stage. For example, redd counts are often used as an index of a spawning adult population. The direction and magnitude of a trend in the index can be used as a surrogate for the growth rate of the entire population. For instance, a downward trend in an abundance indicator may signal the need for increased protection, regardless of the actual size of the population. A population that is below recovered abundance levels, but that is moving toward recovery, would be expected to exhibit an increasing trend in the indicator.

The population growth rate is an indicator of probability of extinction. This probability cannot be measured directly, but it can be estimated as the consequence of the population growth rate and the variability in that rate. For a population to be considered viable, its natural productivity should be sufficient for the population to replace itself from generation to generation. Evaluations of population status will also have to take into account uncertainty in estimates of population growth rate or productivity. For a population to contribute to recovery, its growth rate must indicate that the population is stable or increasing for a period of time.

Based on the depressed and probably declining population trend and the loss of range within the Willamette River basin, bull trout in the Upper Willamette River core area are considered to be at intermediate risk due to an apparent population trend that is not declining and that has low to moderate annual variability (based on five years of data).

Connectivity. The presence of the migratory life history form within the Willamette Recovery Unit was used as an indicator of the functional connectivity of the recovery unit. If the migratory life form was absent, or if the migratory form was present but local populations lacked connectivity, the core area was considered to be at increased risk. If the migratory life form persisted in at least some local populations, with partial ability to connect with other local populations, the core area was judged to be at intermediate risk. Or, if the migratory life form was present in all, or nearly all, local populations and had the ability to connect with other local populations, the core area was considered to be at diminished risk.

Migratory bull trout may persist in some local populations in the Upper Willamette River core area and are, therefore, considered to be at an intermediate risk.

Recovery Criteria

Recovery criteria for bull trout in the Willamette Recovery Unit are the following:

1. **Distribution criteria will be met when bull trout are distributed among five or more local populations in the recovery unit: four in the Upper Willamette River core area and one in the Clackamas River core habitat area.** In a recovered condition, the Upper Willamette River core area would include local populations in the mainstem McKenzie River (connectivity with Trail Bridge population would be reestablished), South Fork McKenzie River, upper Middle Fork Willamette River, and the Salt Creek/Salmon Creek/North Fork

Middle Fork Willamette River complex. The Clackamas River core habitat area would also contain one or more local populations as yet to be identified. Feasibility analyses are needed to assess the potential for reintroducing bull trout into historic habitat in the Middle Fork Willamette River subbasin (Salt Creek, Salmon Creek, and North Fork Middle Fork Willamette River watersheds) and into the Clackamas River core habitat area. Additional population studies and a better understanding of bull trout fidelity to natal streams are needed to further define local populations in the recovery unit.

2. **Abundance criteria will be met when the Willamette Recovery Unit supports an estimated 900 to 1,500 adult bull trout, distributed in each core area or core habitat as follows: 600 to 1,000 in the Upper Willamette River core area and 300 to 500 in the Clackamas River core habitat.** The recovered abundance range was derived from the professional judgment of the recovery unit team in estimating the productive capacity of identified local populations and potential habitat. These abundance goals may be refined as more information becomes available through monitoring and research.

Increased population abundance in the Upper Willamette River core area is expected to occur through expanding of seasonal distribution in the Upper Willamette River core area and through expanding of populations to additional basins, for example, the Clackamas and Santiam River basins.

Opportunities to protect spawning and rearing habitat on private lands through purchase, conservation easement, land exchange, or other means should be pursued. Habitat restoration efforts to improve anadromous salmonid production in the recovery unit can be expected to benefit existing and potential migration corridors and overwintering habitat for bull trout, as well as improve the prey base for bull trout.

3. **Trend criteria will be met when adult bull trout exhibit stable or increasing trends in abundance in the recovery unit.** Achievement of this recovery criterion will be based on a minimum of 10 years of monitoring data.

4. **Connectivity criteria will be met when migratory forms are present in all local populations and when intact migratory corridors among all local populations in the Willamette Recovery Unit provide an opportunity for genetic exchange and diversity.** Addressing passage barriers within the Willamette Recovery Unit would ensure opportunities for connectivity among local populations within each core area. In the Upper Willamette River core area, addressing fish passage at Cougar, Trail Bridge, Dexter, Lookout Point, and Hills Creek Dams would ensure opportunities for exchange of genetic material among bull trout populations in the core area. In the future, addressing fish passage at dams in the Clackamas and Santiam River basins may be necessary, but there is insufficient information at this time to make that determination.

Connectivity between core areas via the Willamette River may become a factor in achieving recovery. However, additional monitoring and research is needed to assess this connectivity.

Identifying barriers does not imply that other actions associated with passage and habitat degradation are not crucial for recovery to occur. To achieve recovery in the Willamette Recovery Unit, all four recovery criteria (distribution of local populations, abundance, population trends, and connectivity) must be achieved. Meeting all four recovery criteria will probably not be accomplished by only removing barriers.

Recovery criteria for the Willamette Recovery Unit were established to assess whether recovery actions are resulting in the recovery of bull trout. The Willamette Recovery Unit Team expects that the recovery process will be dynamic and will be refined as more information becomes available. While

removal of bull trout as a listed species under the Endangered Species Act (*i.e.*, delisting) can only occur for the entity that was listed (Columbia River distinct population segment), the criteria listed above will be used to determine when the Willamette Recovery Unit is fully contributing to recovery of the population segment.

Research Needs

Using the best scientific information available, the Willamette Recovery Unit Team has identified recovery criteria and actions necessary for recovery of bull trout. However, the Willamette Recovery Unit Team recognizes that many uncertainties exist regarding bull trout population abundance and distribution and about actions needed to recover bull trout in the Willamette Recovery Unit. The Willamette Recovery Unit Team believes that if effective management and recovery are to occur, the recovery plan for the Willamette Recovery Unit should be viewed as a “living” document, to be updated as new information becomes available. As part of this adaptive management approach, the Willamette Recovery Unit Team has identified essential research needs within the recovery unit.

Primary research needs throughout the recovery unit include evaluating food web interactions, especially where introduced nonnative fish are present; evaluating the response of different bull trout life stages and population productivity to environmental variables such as stream temperature, introduced fine sediments, and changing habitat conditions; documenting and describing habitat use, especially of the reservoir environments, by different bull trout life stages and rearing use of the mainstem McKenzie River; evaluating predator–prey relationships, and potential disease and pathogen relationships, between bull trout and other fish species present in the recovery unit; and attempting to document or quantify the relative response or effectiveness of the full range of management, recovery, and conservation actions within the recovery unit.

Santiam River Basin. The North Santiam River has the most potential in the Santiam River basin for supporting the reintroduction of bull trout. Historically, bull trout were probably present throughout the North Santiam and Breitenbush River systems. Spawning and early rearing probably took place primarily in the upper parts of the Breitenbush and North Santiam Rivers, including suitable tributaries such as the North and South Forks of the Breitenbush River and the larger, colder tributaries of the upper North Santiam River that flow in from the Mount Jefferson Wilderness Area. The Little North Santiam River probably did not support a population of bull trout because Salmon Falls would have been impassable and would not have allowed access to potential spawning habitat upstream. Salmon Falls has since been laddered, and bull trout could potentially make it almost up to Opal Creek (Somes, pers. comm., 1999). An assessment of the potential of the Santiam River subbasin to support bull trout is needed.

ACTIONS NEEDED

Recovery Measures Narrative

In this chapter and all other chapters of the bull trout recovery plan, the recovery measures narrative consists of a hierarchical listing of actions that follows a standard template. The first-tier entries are identical in all chapters and represent general recovery tasks under which specific (*e.g.*, third-tier) tasks appear when appropriate. Second-tier entries also represent general recovery tasks under which specific tasks appear. Second-tier tasks that do not include specific third-tier actions are either programmatic activities that are applicable across the species' range and appear in *italic type*. These tasks may or may not have third-tier tasks associated with them; see Chapter 1 for more explanation. Some second-tier tasks may not be sufficiently developed to apply to the recovery unit at this time and appear in *a shaded italic type (as seen here)*. These tasks are included to preserve consistency in numbering tasks among recovery unit chapters and are intended to assist in generating information during the comment period for the draft recovery plan, a period during which additional tasks may be developed. Third-tier entries are tasks specific to the Willamette Recovery Unit. They appear in the Implementation Schedule that follows this section and are identified by three numerals separated by periods.

The Willamette Recovery Unit chapter should be updated or revised when recovery tasks are accomplished, environmental conditions change, or monitoring results or other new information becomes available. Revisions to the Willamette Recovery Unit chapter will probably focus on priority streams or stream segments within core areas where restoration activities occurred and where habitat or bull trout populations have shown a positive response. The Willamette Recovery Unit Team should meet annually to review annual monitoring reports and summaries and to make recommendations to the U.S. Fish and Wildlife Service.

- 1 Protect, restore, and maintain suitable habitat conditions for bull trout.

- 1.1 Maintain or improve water quality in bull trout core areas or potential core habitat.
 - 1.1.1 Complete an access and travel management plan for Federal lands in the upper Middle Fork Willamette River. U.S. Forest Service roads that have been identified in current watershed analyses as needing decommissioning include 2100392, 2100390, 2100391, 2100401, 21004023, and 2100273 along the upper Middle Fork Willamette River.
 - 1.1.2 Assess turbidity from operation of Blue River project for impacts on bull trout. Take corrective action if turbidity is a problem.
 - 1.1.3 Identify and eliminate industrial, agricultural, residential and sewage effluent runoff (nutrients and chemicals) that impact bull trout habitat in the mainstem Middle Fork Willamette River and the lower mainstem McKenzie River.
 - 1.1.4 Investigate the effects on bull trout of thermal effluent discharged into the McKenzie River.
- 1.2 Identify barriers or sites of entrainment for bull trout and implement tasks to provide passage and eliminate entrainment.
 - 1.2.1 Assess feasibility of restoring fish passage at dams to reconnect fragmented bull trout populations in the Upper Willamette River core area. Dams include Cougar, Trail Bridge, Hills Creek, Lookout Point, and Dexter Dams. Analysis should include cost/benefits, potential quality and quantity, and relative importance of habitat that could be newly accessed.

- 1.2.2 Prioritize and then implement fish passage at dams to reconnect fragmented bull trout populations in the Upper Willamette River core area. Base prioritization on analyses of feasibility and potential benefit.
 - 1.2.3 Document, enumerate, and evaluate entrainment at Cougar Dam as a factor influencing bull trout status in the South Fork McKenzie River.
 - 1.2.4 Provide fish protection at water diversions and associated structures. Examples include the Walterville Canal powerhouse, Leaburg Dam roll gates, and Bigelow powerhouse.
 - 1.2.5 Correct manmade barriers that impede bull trout access to suitable habitat. Examples include road culverts on Echo Creek Road 325, Swift Creek Road 2300422, and Road 2300 and barriers in the upper Middle Fork Willamette River at Coal Creek Road 2133 and Road 2133228.
 - 1.2.6 Identify and evaluate opportunities for improving passage through dams to increase survival rates. Dams include Trail Bridge, Leaburg-Walterville, and U.S. Army Corps of Engineers Projects at turbine intakes, regulating outlets, and spillways.
 - 1.2.7 Improve survival below the regulating outlet at Hills Creek Dam by addressing inadequate plunge pool at low or moderate flows.
- 1.3 *Identify impaired stream channel and riparian areas and implement tasks to restore their appropriate functions.*

- 1.4 Operate dams to minimize negative effects on bull trout in reservoirs and downstream.
 - 1.4.1 Review and evaluate reservoir operations and provide recommendations through Federal Energy Regulatory Commission relicensing process and/or Federal consultation. Reservoir operations include water level manipulation, flows downstream from reservoirs, and others.
- 1.5 Identify upland conditions that negatively affect bull trout habitats and implement tasks to restore appropriate functions.
 - 1.5.1 Identify existing road systems that have a high risk of adversely affecting bull trout streams. Negative changes include sediment delivery and natural drainage networks, interception of groundwater, and interruption of delivery of woody material. Road management plans should be developed to modify, reduce, or eliminate such roads.
 - 1.5.2 Update the watershed analysis for the upper Middle Fork Willamette River. This task is necessary to determine appropriate U.S. Forest Service management activities and to help establish short- and long-term goals and actions compatible with bull trout recovery.
- 2 Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout.
 - 2.1 *Develop, implement, and enforce public and private fish-stocking policies to reduce stocking of nonnative fishes that affect bull trout.*

- 2.2 *Evaluate enforcement of policies for preventing illegal transport and introduction of nonnative fishes.*
 - 2.3 *Provide information to the public about ecosystem concerns of illegal introductions of nonnative fishes.*
 - 2.4 *Evaluate biological, economic, and social effects of control of nonnative fishes.*
 - 2.5 *Implement control of nonnative fishes where feasible and appropriate.*
 - 2.6 *Develop tasks to reduce negative effects of nonnative taxa on bull trout.*
- 3 Establish fisheries management goals and objectives that are compatible with bull trout recovery and implement practices to achieve goals.
- 3.1 Develop and implement State and Tribal native fish management plans integrating adaptive research.
 - 3.1.1 Continue reestablishment of bull trout into the upper Middle Fork Willamette River. Identify conflicts with the reestablishment program such as road management, cumulative impacts from timber harvest, and impacts of and access to recreation sites.
 - 3.1.2 Incorporate bull trout recovery actions into the Oregon Department of Fish and Wildlife's Willamette River basin fish management plans.
 - 3.1.3 Coordinate bull trout recovery with management plans and with recovery and other efforts for other species, such as chinook salmon and steelhead trout.

- 3.1.4 Coordinate bull trout recovery monitoring in the Willamette River basin with the monitoring program for the Oregon Plan for Salmon and Watersheds.
- 3.1.5 Restore historic prey base by reestablishing spring chinook salmon into habitats occupied by bull trout. Priority areas remaining in the Willamette River basin include Salt Creek and Salmon Creek.
- 3.2 Evaluate and prevent overharvest and incidental angling mortality of bull trout.
 - 3.2.1 Conduct a creel census at Trail Bridge Reservoir to document angling pressure and mortality.
- 3.3 *Evaluate potential effects of introduced fishes and associated sport fisheries on bull trout recovery and implement tasks to minimize negative effects on bull trout.*
- 3.4 *Evaluate effects of existing and proposed sport fishing regulations on bull trout.*
- 4 Characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout.
 - 4.1 *Incorporate conservation of genetic and phenotypic attributes of bull trout into recovery and management plans.*
 - 4.2 *Maintain existing opportunities for gene flow among bull trout populations.*
 - 4.3 *Develop genetic management plans and guidelines for appropriate use of transplantation and artificial propagation.*

- 5 Conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks.
 - 5.1 *Design and implement a standardized monitoring program to assess the effectiveness of recovery efforts affecting bull trout and their habitats.*
 - 5.2 Conduct research evaluating relationships among bull trout distribution and abundance, bull trout habitat, and recovery tasks.
 - 5.2.1 Assess habitat conditions and capacity in tributaries with historic or potential habitat in the Upper Willamette River core area. For example, assess conditions in Salmon Creek, Salt Creek, and the North Fork Middle Fork Willamette River.
 - 5.2.2 Assess capacity of habitat in the Santiam and Clackamas River basins to support self-sustaining populations of bull trout.
 - 5.3 *Conduct evaluations of the adequacy and effectiveness of current and past best management practices in maintaining or achieving habitat conditions conducive to bull trout recovery.*
 - 5.4 *Evaluate effects of diseases and parasites on bull trout and develop and implement strategies to minimize negative effects.*
 - 5.5 Develop and conduct research and monitoring studies to improve information concerning the distribution and status of bull trout.
 - 5.5.1 Assess feasibility of reestablishing bull trout in the Clackamas and Santiam River basins. Include task numbers 5.2.2 and 5.5.2 as part of the analysis.

- 5.5.2 Conduct additional field sampling to determine presence/absence of bull trout in the Clackamas and Santiam River basins.
- 5.5.3 Conduct physical and biological surveys in the Upper Willamette River core area to determine current abundance of populations and factors preventing or limiting productivity. Eugene Water and Electric Board is proposing in the draft biological assessment to assess population status of bull trout and brook trout in Trail Bridge Reservoir.
- 5.6 *Identify actions needed to improve understanding of relationships among genetic characteristics, phenotypic traits, and local populations of bull trout.*
- 6 Use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats.
 - 6.1 Use partnerships and collaborative processes to protect, maintain, and restore functioning core areas for bull trout.
 - 6.1.1 Participate in efforts by local and regional (basinwide) watershed groups and others to accomplish site-specific protection and restoration activities. Examples of groups and others include watershed councils (McKenzie Trust) and the Willamette Restoration Initiative.
 - 6.1.2 Coordinate with other agencies, research scientists, and conservation organizations. Efforts include 1) identifying and facilitating activities necessary to accomplish tasks at basin and subbasin levels, 2) implementing prioritization and scheduling of projects (such as surveys, habitat restoration, reintroductions), and 3) soliciting

participation of organizations. Coordinate recovery actions with recommendations for watershed improvements developed by the McKenzie Watershed Council.

- 6.2 Use existing Federal authorities to conserve and restore bull trout.
 - 6.2.1 Identify opportunities to incorporate bull trout recovery actions into the relicensing process for hydroelectric projects in the Willamette Recovery Unit. Examples of projects include the Carmen-Smith Project in the McKenzie River basin and Portland General Electric projects in the Clackamas River basin.
 - 6.2.2 Identify and develop opportunities for collaboration between total maximum daily load planning (Clean Water Act) and bull trout recovery unit planning and implementation in the Willamette Recovery Unit.
- 6.3 *Evaluate enforcement of existing Federal, State, and Tribal habitat protection standards and regulations and evaluate their effectiveness for bull trout conservation.*
- 7 Assess the implementation of bull trout recovery by recovery units and revise recovery unit plans based on evaluations.
 - 7.1 *Convene annual meetings of each recovery unit team to review progress on recovery plan implementation.*
 - 7.2 *Assess effectiveness of recovery efforts.*
 - 7.3 *Revise scope of recovery as suggested by new information.*

IMPLEMENTATION SCHEDULE

The Implementation Schedule that follows lists recovery task priorities; task numbers; task descriptions; duration of tasks; potential or participating responsible parties; total cost estimate and estimates for the next four or five years, if available; and comments. These tasks, when accomplished, will lead to recovery of bull trout in the coterminous United States as discussed in Chapter 1 of this recovery plan.

Parties with authority, responsibility, or expressed interest to implement a specific recovery task are identified in the Implementation Schedule. Listing a responsible party does not imply that prior approval has been given or require that party to participate or expend any funds. However, willing participants will benefit by demonstrating that their budget submission or funding request is for a recovery task identified in an approved recovery plan and, therefore, part of a coordinated effort to recover bull trout. In addition, section 7 (a)(1) of the Endangered Species Act directs all Federal agencies to use their authorities to further the purposes of the Act by implementing programs for the conservation of threatened or endangered species.

The following are definitions to column headings used in the Implementation Schedule:

Priority Number: All priority 1 tasks are listed first, followed by priority 2 and priority 3 tasks.

Priority 1: All actions that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 2: All actions that must be taken to prevent a significant decline in species population or habitat quality or to prevent some other significant negative impact short of extinction.

Priority 3: All other actions necessary to provide for full recovery (or reclassification) of the species.

Task Number and Task Description: Recovery tasks as numbered in the recovery outline. Refer to the action narrative for task descriptions.

Task Duration: Expected number of years to complete the corresponding task. Study designs can incorporate multiple tasks, which, when combined, can reduce the time needed for task completion.

Responsible or Participating Party: The following organizations are those with responsibility or capability to fund, authorize, or carry out the corresponding recovery task.

Federal Agencies:

BLM	Bureau of Land Management
FERC	Federal Energy Regulatory Commission
NMFS	National Marine Fisheries Service
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service

State Agencies:

ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OSP	Oregon State Police
OWRD	Oregon Water Resources Department

Others:

EWEB	Eugene Water and Electric Board
PGE	Portland General Electric Company
RUT	Recovery Unit Team
WC	Watershed Councils
WeyCo	Weyerhaeuser Corporation, Inc.
WRI	Willamette Restoration Initiative

Bolded type indicates the agency or agencies that have the lead role for task implementation and coordination, though not necessarily sole responsibility.

Cost Estimates: Cost estimates are rough approximations and are provided only for general guidance. Total costs are estimated for the duration of the task and also itemized annually for the next five years. Total costs include estimates of expenditures by local, Tribal, State, and Federal governments and by private business and individuals. These costs are attributed to bull trout conservation but other aquatic species will also benefit. Cost estimates are not provided for tasks which are normal agency responsibilities under existing authorities.

An asterisk (*) in the total cost column indicates ongoing tasks that are currently being implemented as part of normal agency responsibilities under existing authorities. Because these tasks are not being done specifically or solely for bull trout conservation, they are not included in the cost estimates. Some of these efforts may be occurring at reduced funding levels and/or in only a small portion of the watershed.

Double asterisk (**) in the total cost column indicates that estimated costs for these tasks are not determinable at this time. Input is requested to help develop reasonable cost estimates for these tasks.

Triple asterisk (***) indicates costs are combined with or embedded within other related tasks.

Implementation Schedule for the bull trout recovery plan: Willamette River Recovery Unit										
Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimates (in \$1,000 units)					Comments
					Total Costs	Year 1	Year 2	Year 3	Year 4	
1	1.2.1	Assess feasibility of restoring fish passage at dams to reconnect fragmented bull trout populations Upper Willamette River core area	5	EWEB, USACE, USFWS, ODFW, NMFS	50		20	20	10	Proposed biological assessment/ biological opinion study of passage feasibility for Carmen-Smith
1	1.2.2	Prioritize and then implement fish passage at dams to reconnect fragmented bull trout populations in the Upper Willamette River core area	10	EWEB, USACE, USFWS, ODFW, NMFS	1,000 to 5,000					Cost depends on details of proposal; any major structural work probably done as part of post-2008 project relicensing
1	1.2.3	Document, enumerate, and evaluate entrainment at Cougar Dam as a factor influencing bull trout status in the South Fork McKenzie River	3	USACE, USFWS, ODFW	90	30	30	30		
1	1.2.4	Provide fish protection at water diversions and associated structures	3-4	EWEB, FERC, ODFW, Private individual	17,000		13 M	4 M		Fish screen, tailrace barriers, ladders

Implementation Schedule for the bull trout recovery plan: Willamette River Recovery Unit										
Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimates (in \$1,000 units)					Comments
					Total Costs	Year 1	Year 2	Year 3	Year 4	
1	1.2.5	Correct manmade barriers that impede bull trout access to suitable habitat	3	USFS, ODOT	725	5	180	360	180	
1	1.2.6	Identify and evaluate opportunities for improving passage through dams to increase survival rates	2-5	EWEB, USACE	50		20	20	10	EWEB proposed study of entrainment/mortality for Trail Bridge
1	1.4.1	Review and evaluate reservoir operations and provide recommendations through Federal Energy Regulatory Commission relicensing process and/or Federal consultation	8	EWEB, USACE, ODFW, FERC, NMFS, USFWS, USFS	400	50	50	50	50	Figures are for Carmen-Smith relicensing; EWEB proposed study; relicensing process to 2008
1	3.1.1	Continue reestablishment of bull trout into the Upper Middle Fork Willamette River	10	ODFW, USFS, EWEB, USFWS	400	40	40	40	40	Fry reintroductions limited to 5–6 years; some sites begun later
1	5.5.1	Assess feasibility of reestablishing bull trout in the Clackamas and Santiam River basins	3	ODFW, USFWS, USFS, PGE	150	50	50	50		

Implementation Schedule for the bull trout recovery plan: Willamette River Recovery Unit										
Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimates (in \$1,000 units)					Comments
					Total Costs	Year 1	Year 2	Year 3	Year 4	
1	5.5.3	Conduct physical and biological surveys in the Upper Willamette River core area to determine current abundance of populations and factors preventing or limiting productivity	5	ODFW, USFS, EWEB, USACE	500	100	100	100	100	Proposed biological assessment/ biological opinion study of habitat and other possible limiting factors (e.g., brook trout) above dams as part of passage study, task 1.2.1
2	1.2.7	Improve survival below the regulating outlet at Hills Creek Dam by addressing inadequate plunge pool at low or moderate flows		USACE	**					The cost will depend on whether operational or structural solution is implemented
2	3.1.2	Incorporate bull trout recovery actions into the ODFW's Willamette River basin fish management plans	Ongoing	ODFW, USFWS	*					May require action by Fish and Wildlife Commission

Implementation Schedule for the bull trout recovery plan: Willamette River Recovery Unit										
Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimates (in \$1,000 units)					Comments
					Total Costs	Year 1	Year 2	Year 3	Year 4	
2	3.1.3	Coordinate bull trout recovery with management plans and with recovery and other efforts for other species, such as chinook salmon and steelhead trout	3	ODFW, USFS, USFWS, NMFS	60	20	20	20		
2	3.1.5	Restore historic prey base by reestablishing spring chinook salmon into habitats occupied by bull trout	Ongoing	ODFW, USFS	*					Covered under existing programs
2	3.2.1	Conduct a creel census at Trail Bridge Reservoir to document angling pressure and mortality	1	ODFW, EWEB	15		15			Proposal submitted to USFWS for section 6 funding
2	5.2.1	Assess habitat conditions and capacity in tributaries with historic or potential habitat in the Upper Willamette core area	4	ODFW, USFS, USFWS	40	10	10	10	10	
2	5.2.2	Assess capacity of habitat in the Santiam and Clackamas River basins to support self-sustaining populations of bull trout	4	ODFW, USFS, USFWS	40	10	10	10	10	
2	5.5.2	Conduct additional field sampling to determine presence/absence of bull trout in the Clackamas and Santiam River basins	3	USFS, ODFW, USFWS	150	50	50	50		

Implementation Schedule for the bull trout recovery plan: Willamette River Recovery Unit										
Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimates (in \$1,000 units)					Comments
					Total Costs	Year 1	Year 2	Year 3	Year 4	
2	6.2.1	Identify opportunities to incorporate bull trout recovery actions into the relicensing process for hydroelectric projects in the Willamette Recovery Unit	8	USFWS, FERC, USACE, EWEB, USFS, ODFW, PGE	***					Carmen-Smith; see also task 1.4.1
3	1.1.1	Complete access and travel management plan for Federal lands in the upper Middle Fork Willamette River	3	USFS	75	35	20	20		Through Access and Travel Management Planning
3	1.1.2	Assess turbidity from operation of Blue River project for impacts on bull trout	3	USACE	150	50	50	50		
3	1.1.3	Identify and eliminate industrial, agricultural, residential, and sewage effluent runoff (nutrients and chemicals) that impact bull trout in the mainstem Middle Fork Willamette River and the lower mainstem McKenzie River	Ongoing	ODEQ	***					Much of this task will be covered in the total maximum daily load (TMDL) process
3	1.1.4	Investigate effects on bull trout of thermal effluent discharged into the McKenzie River	3	WeyCo	300	100	100	100		

Implementation Schedule for the bull trout recovery plan: Willamette River Recovery Unit										
Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimates (in \$1,000 units)					Comments
					Total Costs	Year 1	Year 2	Year 3	Year 4	
3	1.5.1	Identify existing road systems that have a high risk of adversely affecting bull trout streams	Ongoing	USFS	120	30	30	30	30	
3	1.5.2	Update the watershed analysis for the Upper Middle Fork Willamette River	1	USFS	***					Upper Middle Fork Willamette River watershed analysis revision; cost covered under task 1.3.1
3	3.1.4	Coordinate bull trout recovery monitoring in the Willamette River basin with the monitoring program for the Oregon Plan for Salmon and Watersheds	4 Ongoing	USFS, BLM, ODFW, USFWS, NMFS, WRI	50	5	15	15	15	
3	6.1.1	Participate in efforts by local and regional (basinwide) watershed groups and others to accomplish site-specific protection and restoration activities	25	All agencies, WC	475	15	15	15	15	McKenzie River watershed council has set of recommendations
3	6.1.2	Coordinate with other agencies, research scientists, and conservation organizations	Ongoing	RUT, WC	*					

Implementation Schedule for the bull trout recovery plan: Willamette River Recovery Unit										
Task Priority	Task Number	Task Description	Task Duration (years)	Responsible Parties	Cost Estimates (in \$1,000 units)					Comments
					Total Costs	Year 1	Year 2	Year 3	Year 4	
3	6.2.2	Identify and develop opportunities for collaboration between total maximum daily load planning (Clean Water Act) and bull trout recovery unit planning and implementation	8	ODEQ, USFS, USACE	***					Part of total maximum daily load (TMDL) planning process

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APPENDIX A: Fish Species

The following table shows fish species found in the McKenzie, Middle Fork Willamette, Santiam, and Clackamas River subbasins. Nonnative species are indicated by an asterisk (*) before the name or in the subbasin column. Compiled from basin plans and surveys of the Oregon Department of Fish and Wildlife and from documents from the U.S. Forest Service.

Common Name	Scientific Name	Subbasin			
		McKenzie River	Middle Fork Willamette River	Santiam River	Clackamas River
Lampreys	Family Petromysontidae				
Western brook lamprey	<i>Lampetra richardsoni</i>	Y			Y
Pacific lamprey	<i>Lampetra tridentata</i>	Y	Y		Y
Sturgeons	Family Acipenseridae				
White sturgeon	<i>Acipenser transmontanus</i>	Y			Y
Minnows	Family Cyprinidae				Y
Chiselmouth	<i>Acrocheilus alutaceus</i>	Y			Y
Peamouth	<i>Mylocheilus caurinus</i>	Y			Y
Northern Pikeminnow	<i>Ptychocheilus oregonensis</i>	Y	Y		Y
*Goldfish	<i>Carassius auratus</i>				Y

Common Name	Scientific Name	Subbasin			
		McKenzie River	Middle Fork Willamette River	Santiam River	Clackamas River
*Common carp	<i>Cyprinus carpio</i>	Y			Y
Oregon chub	<i>Oregonichthys crameri</i>		Y	Y	
Longnose dace	<i>Rhinichthys cataracta</i>	Y			Y
Speckled dace	<i>Rhinichthys osculus</i>	Y	Y		
Leopard dace	<i>Rhinichthys falcatus</i>	Y			
Redside shiner	<i>Richardsonius balteatus</i>	Y	Y		Y
Suckers	Family Castosomidae				
Largescale sucker	<i>Catostomus macrocheilus</i>	Y	Y		Y
Mountain sucker	<i>Catostomus platyrhynchus</i>	Y			Y
Bullhead catfishes	Family Ictaluridae				
*Yellow bullhead	<i>Ameiurus natalis</i>	Y	Y?	Y	Y
*Brown bullhead	<i>Ameiurus nebulosus</i>	Y	Y?	Y	Y
*Channel catfish	<i>Ictalurus punctatus</i>			Y	Y
Trouts	Family Salmonidae				

Common Name	Scientific Name	Subbasin			
		McKenzie River	Middle Fork Willamette River	Santiam River	Clackamas River
Cutthroat trout	<i>Oncorhynchus clarki</i>	Y	Y	Y	Y (wild and hatchery)
Rainbow trout/steelhead	<i>Oncorhynchus mykiss</i>	Y	Y (wild and hatchery)	Y (wild and hatchery)	Y (wild and hatchery)
Coho salmon	<i>Oncorhynchus kisutch</i>	Y*		Y*	Y (wild and hatchery)
Sockeye salmon (Kokanee)	<i>Oncorhynchus nerka</i>			Y*	Y*
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	Y	Y (wild? and hatchery)	Y (wild and hatchery)	Y (wild and hatchery)
Mountain whitefish	<i>Prosopium williamsoni</i>	Y	Y	Y	Y
*Brown trout	<i>Salmo trutta</i>				Y
Bull trout	<i>Salvelinus confluentus</i>	Y	Y	H	H
*Brook trout	<i>Salvelinus fontinalis</i>	Y	Y	Y	Y
Trout Perch	Family Percopsidae				
Sand Roller	<i>Percopsis transmontana</i>	Y			Y
Killifishes	Family Cyprinodontidae				

Common Name	Scientific Name	Subbasin			
		McKenzie River	Middle Fork Willamette River	Santiam River	Clackamas River
*Banded killifish	<i>Fundulus diaphanus</i>				Y
Livebearers	Family Poeciliidae				
*Western mosquitofish	<i>Gambusia affinis</i>	Y			
Stickleback	Family Gasterosteidae				
Three-spine stickleback	<i>Gasterosteus aculeatus</i>	Y			Y
Sculpins	Family Cottidae				
Prickly sculpin	<i>Cottus asper</i>		Y (not identified to species)		Y
Paiute sculpin	<i>Cottus beldingi</i>	Y			
Shorthead sculpin	<i>Cottus confusus</i>	Y			
Reticulate sculpin	<i>Cottus perplexus</i>	Y			Y
Torrent sculpin	<i>Cottus rhotheus</i>	Y			
Sunfishes	Family Centrarchidae				
*Pumpkinseed	<i>Lepomis gibbosus</i>			Y	Y
*Warmouth	<i>Lepomis gulosus</i>			Y	Y
*Bluegill	<i>Lepomis macrochirus</i>	Y	Y	Y	Y

Common Name	Scientific Name	Subbasin			
		McKenzie River	Middle Fork Willamette River	Santiam River	Clackamas River
*Smallmouth bass	<i>Micropterus dolomieu</i>			Y	Y
*Largemouth bass	<i>Micropterus salmoides</i>	Y	Y	Y	Y
*White crappie	<i>Pomoxis annularis</i>		Y?	Y	Y
*Black crappie	<i>Pomoxis nigromaculatus</i>		Y?	Y	Y
*American shad	<i>Alosa sapidissima</i>				Y
Perches	Family Percidae				
*Yellow perch	<i>Perca flavescens</i>				Y
*Walleye	<i>Stizostedion vitreum</i>		Y		Y
Righteye flounders	Family Pleuronectidae				
Starry flounder	<i>Platichthys stellatus</i>				Y

APPENDIX B: List of Chapters

Chapter 1	Introductory
Chapter 2	Klamath River Recovery Unit, Oregon
Chapter 3	Clark Fork River Recovery Unit, Montana and Idaho
Chapter 4	Kootenai River Recovery Unit, Montana and Idaho
Chapter 5	Willamette River Recovery Unit, Oregon
Chapter 6	Hood River Recovery Unit, Oregon
Chapter 7	Deschutes River Recovery Unit, Oregon
Chapter 8	Odell Lake Recovery Unit, Oregon
Chapter 9	John Day River Recovery Unit, Oregon
Chapter 10	Umatilla–Walla Walla Rivers Recovery Unit, Oregon and Washington
Chapter 11	Grande Ronde River Recovery Unit, Oregon
Chapter 12	Imnaha–Snake Rivers Recovery Unit, Oregon
Chapter 13	Hells Canyon Complex Recovery Unit, Oregon and Idaho
Chapter 14	Malheur River Recovery Unit, Oregon
Chapter 15	Coeur d’Alene Lake Basin Recovery Unit, Idaho
Chapter 16	Clearwater River Recovery Unit, Idaho
Chapter 17	Salmon River Recovery Unit, Idaho
Chapter 18	Southwest Idaho Recovery Unit, Idaho
Chapter 19	Little Lost River Recovery Unit, Idaho
Chapter 20	Lower Columbia River Recovery Unit, Washington
Chapter 21	Middle Columbia River Recovery Unit, Washington
Chapter 22	Upper Columbia River Recovery Unit, Washington
Chapter 23	Northeast Washington Recovery Unit, Washington
Chapter 24	Snake River Washington Recovery Unit, Washington