UPPER DESCHUTES RIVER SUBBASIN FISH MANAGEMENT PLAN

UPPER DESCHUTES FISH DISTRICT

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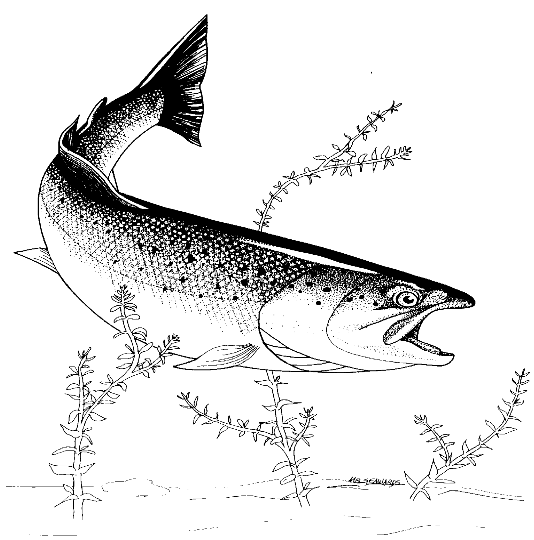

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FOREWORD

The Oregon Department of Fish and Wildlife (ODFW) develops management plans for each basin or management unit in the state following the requirements of Oregon Administrative Rule 635-07-515, which states: Resources of the state shall be managed according to plans which set forth goals, objectives and operating principles for management of species, waters, or areas. Such plans are a primary means of implementing Department policies regarding fish management.

The Upper Deschutes River Subbasin Fish Management Plan was developed to direct management of fish resources of the upper 132 miles of the Deschutes River, its tributaries, lakes, reservoirs, and the Cascade Mountain high lakes within the upper Deschutes River subbasin.

ODFW is committed to the planning process as an integral part of all current and future management by the agency. The Upper Deschutes River Subbasin Fish Management Plan is one element in the Department's planning efforts. Species plans for chinook and coho salmon, steelhead, trout, and warmwater game fish have been adopted. These statewide plans guide the development of more localized plans for individual river basins and subbasins.

These plans serve several needed functions. They present a logical, systematic approach to conserving our aquatic resources. They establish management priorities and direct attention to the most critical problems affecting our fisheries so that the Department's funds and personnel can be used accordingly. They inform the public and other agencies about the Department's management programs and provide them with the opportunity to help formulate those programs.

Plan Scope

Fish management in the waters of the upper Deschutes River subbasin, which flows into Lake Billy Chinook, is addressed by this plan. Companion documents, the Crooked River and Metolius River Subbasin Fish Management Plans have been adopted. The Upper Deschutes River Subbasin Fish Management Plan will be presented to the Oregon Fish and Wildlife Commission in August of 1996 with adoption expected in September of 1996.

Plan Development Process and Participants

This plan was developed by the Oregon Department of Fish and Wildlife (ODFW) and the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS) with the help of two committees. The Public Advisory Committee, representing non-treaty user groups and other interested members of the public, helped identify a range of objectives and actions for managing the fishery resources in the upper Deschutes

River basin. The Technical Advisory Committee, composed of representatives of state and federal fishery agencies, tribes, land and water management agencies, and utilities, developed specific fishery and other technical information and described and assessed potential actions for managing the fisheries.

Members of the Public Advisory Committee and their affiliations are:

PAT SCHATZ	Crane Prairie Resort
BYRON BEACH	Metolius River Lodges
JOHN JUDY	Metolius flyfisherman and guide
LEN MATHISEN	Deschutes River Mitigation and Enhancement Committee
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CRAIG LACY	Oregon Trout
PHIL HORTON	Warmwater fishing groups
GARY WARD	Crook County Parks and Recreation
CHARLIE BROWN	Des. Basin Resource Committee and Swalley Water
DAVE NOLTE	Trout Unlimited, Bring Back the Natives, Fish
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BOB GRIFFIN	Central Oregon Flyfishers
JOHN HOFFERD	East Lake Resort and Paulina Lake Resort
JIM MYRON	Oregon Trout

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Purpose of Plan

This plan is intended to set fish management direction for the next five to ten years within the specified water bodies of the subbasin. The policies and objectives within each section provide the core of the management program and describe the fundamental direction that will be pursued. These are implemented through specific actions, which may include (but are not limited to) acquiring habitat, developing angling regulations, and stocking fish. Because of funding uncertainties, a wide variety of actions are described, but not all may be implemented.

Organization of Plan

This plan is divided into 11 major sections which address the fish management in individual waters or groups of waters in the upper Deschutes River subbasin.

Each of these sections is, in turn, divided into sub-sections that address habitat, the major fish species or groups of species, and angling access, within major water bodies of the river subbasin. Each of these sub-sections contains:

1. Background and status: historical and current information which helps explain the context of the policies, objectives, and actions.

2. Policies: constraints or principles developed specifically for management activities in the subbasin related to that species or topic.

3. Objectives: what is intended to be accomplished.

4. Assumptions and Rationale: support and justification for objectives.

5. Actions: individual tasks and activities needed to be carried out to progress toward attainment of objectives.

For each significant water body or group of water bodies, a management direction or two or more management alternatives were written during the initial scoping of this document. This version of the plan contains only the management direction adopted by the Oregon Fish and Wildlife Commission.

All of the management options, including specific actions, are governed by Oregon Administrative Rules (OARs) currently in place which relate to fish management. A partial list of those OARs can be found in Appendix G.

Procedures developed by ODFW are incorporated in the Manual for Fish Management (1977) and A Department Guide for Introductions and Transfers of Finfish into Oregon Waters (1982), and Habitat Protection Policies and Standards (1991).

Oregon Fish and Wildlife Commission Action

The entire plan is presented to the Oregon Fish and Wildlife Commission (OFWC), which reviews the management direction and management alternatives described within the plan. After considering staff recommendations and public comments, the Commission chooses management directions for each significant water body. After a period of 60 days, in which further public review may take place, the entire plan will be finalized to reflect the Commission decisions. Oregon Administrative Rules are developed from the policies and objectives of the approved plan, and will be submitted to the Attorney General for finalization within the same time frame.

GENERAL CONSTRAINTS

Legal Considerations

Besides the statewide species plans, the Upper Deschutes River Subbasin Fish Management Plan must also conform to other established constraints, such as federal acts (e.g., Wilderness, Endangered Species), state statutes, administrative rules, memoranda of understanding, and other policies.

ODFW interacts with other agencies primarily in dealing with fish habitat issues. Although the U.S. Forest Service is the major public land manager in the planning areas, several federal and state entities have jurisdiction over activities that affect fish habitat. These include the U.S. Fish and Wildlife Service (USFWS), the U.S. Department of the Interior's Bureau of Land Management (BLM), Oregon State Police (OSP), U.S. Soil Conservation Service (SCS), U.S. Army Corps of Engineers (COE), Oregon Division of State Lands (DSL), the Department of Environmental Quality (DEQ), the Water Resources Department (WRD), and the Department of Geology and Mineral Industries (DOGAMI).

State regulatory actions that affect habitat

The Oregon Water Resources Commission regulates water use throughout the state. The Oregon Department of Environmental Quality (DEQ) has developed state water quality standards that are in compliance with federal water quality standards. DEQ administrative rules (Chapter 340, Division 41) address water quality standards for individual basins.

The Oregon Forest Practices Act (ORS 527.610 to 527.730) was adopted in 1972. Commercial timber operations on state and private lands are regulated by the act, which is administered by the Oregon Department of Forestry. Forest management activities on U.S. Forest Service and Bureau of Land Management lands are designed to comply with Forest Practices Act rules and state water quality standards.

The Division of State Lands oversees the Oregon Removal-Fill Law. A permit is required for the removal or filling of 50 cubic yards or more of material in natural waterways.

ODFW goals and policies for commercial and sport fishing regulations, fish management, hatchery operation, and the Natural Production and Wild Fish Management policies are adopted as Oregon Administrative Rules (OARs). ODFW's Natural Production and Wild Fish Management policies (OAR 635-07-521 through 635-07-529) provide guidance on the development of fisheries management options for water bodies throughout the state.

The Oregon Riparian Tax Incentive Program of 1981 provides a tax exemption to land owners for riparian lands included in a management plan developed by the land owner and ODFW personnel. The Governor's Watershed Enhancement Board gives both private individuals and organizations an opportunity to become involved in watershed rehabilitation projects.

Wild and Scenic Waterway Issues

Sections of the Upper Deschutes River are designated a "scenic waterway" under the Oregon Scenic Waterways Program. The scenic waterway includes the river and its shoreline and all tributaries within a quarter of a mile of its banks. The program protects the free-flowing character of designated rivers for fish, wildlife, and recreation. Dams, reservoirs, impoundments, and placer mining are not allowed on scenic waterways. The program is designed to protect and enhance scenic, aesthetic, natural, recreation, scientific, and fish and wildlife qualities along scenic waterways. New development or changes in existing uses proposed within a scenic waterway are reviewed before they may take place. In 1988, 147.3 miles of stream within the subbasin were added to the Federal Wild and Scenic Rivers system. Stream portions added were Squaw Creek, Big Marsh Creek, Crescent Creek, the Deschutes River, and Little Deschutes River. Wild and scenic river designation strengthens protection given under the state scenic waterways program. Timber harvest, road building, mining, and grazing can be regulated to reduce adverse impacts on the designated rivers. Designation of these rivers within the wild and scenic system provides access to increased federal funding for management of the rivers.

Tribal Authority to Co-Manage Fish and Wildlife in the Subbasin

The Confederated Tribes of the Warm Springs Reservation of Oregon is the modern-day political successor to the seven bands of Wasco- and Sahaptin-speaking Indians of the mid-Columbia area whose representatives were signatories to the Treaty with the Tribes of Middle Oregon of June 25, 1855, 12 Stats. 963. Article I of the treaty describes the 10 million acre area of eastern Oregon ceded by the tribes to the United States and sets out the boundaries of the Warm Springs Indian Reservation. Article I also contains the express reservation by the tribes to "the exclusive right of taking fish in the streams running through and bordering said reservation...and at all other usual and accustomed stations, in common with citizens of the United States."

Streams running through and bordering the reservation to which the tribes have exclusive fishing rights pursuant to Article I of the treaty include the Deschutes, Metolius, and Warm Springs River systems. Streams within the ceded area where the tribes have primary off-reservation rights at usual and accustomed fishing stations include the John Day River, Fifteenmile Creek, and Hood River. Additionally, the tribes claim off-reservation rights at usual and accustomed stations on streams outside of the ceded area, which may be primary, secondary, or co-equal with the treaty rights of other tribes.

The Warm Springs Tribes' role as a management entity for purposes of subbasin planning in the upper Columbia River Basin is based on the tribes' exclusive fishing rights in the Deschutes, Warm Springs, and Metolius river systems; primary fishing rights in the John Day River, Fifteenmile Creek, and Hood River; and on the provisions of the recently executed Columbia River Fish Management Plan.

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FISH MANAGEMENT PLAN

Introduction

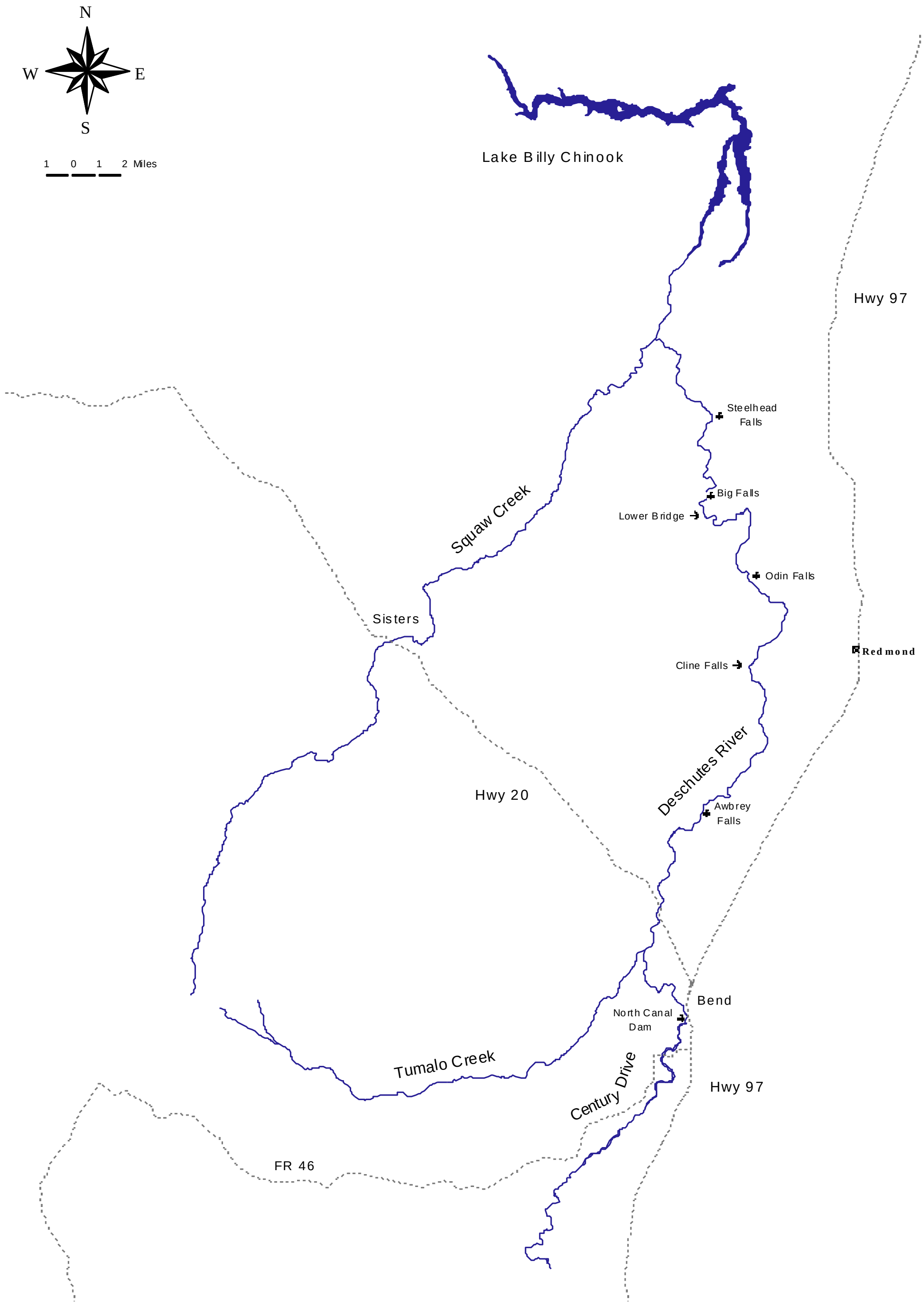
This basin plan covers the Upper Deschutes River and its tributaries from Lake Billy Chinook (RM 120) to the headwaters at Little Lava Lake (RM 252), natural lakes, high lakes, and impoundments within the basin. The plan consists of 12 sections. These include: this introduction and the following 11 individual sections:

1. The Deschutes River from North Canal Dam downstream to Lake Billy Chinook and the tributaries, Tumalo and Squaw Creeks.
2. The Deschutes River from Wickiup Dam downstream to North Canal Dam (Bend) and the tributaries, Fall and Spring Rivers.
3. Wickiup Reservoir and the Deschutes River up to Crane Prairie Dam.
4. Crane Prairie Reservoir and the Deschutes River up to Little Lava Lake.
5. Natural lakes connected to the Deschutes River: Lava, Little Lava, Cultus, Little Cultus.
6. Lakes not connected to the Deschutes River (Century Drive Lakes): Sparks, Elk, Hosmer, South Twin, North Twin, Devils
7. The Little Deschutes River and its tributaries, Crescent and Summit lakes.
8. East and Paulina lakes, and Paulina Creek
9. Odell and Davis lakes, and Odell Creek
10. Cascade Mountain Lakes
11. Miscellaneous Waters: Three Creeks and Little Three Creeks lakes, Shevlin Pond, Fireman's Pond, Sprague Pit Pond, Century Gravel Pond.

Each water body management section is broken into subsections which include location and ownership, habitat and habitat limitations, fish stocking history, angling regulations, fish management, and management issues. Following this background is a brief description of management direction specific to that water body or a group of similarly managed water bodies. The specific policies, objectives, assumptions and rationale and actions are listed after the brief description.

Overview

The Upper Deschutes River encompasses the upper 132 river miles of the Deschutes River. Situated in Central Oregon, the majority of the basin is located in Deschutes County with smaller portions in Jefferson and Klamath counties. The basin is bounded on the west by the Cascade Mountains, high desert plateau and Paulina Mountains to the east, high elevation pine forest to the south, and deep basalt canyons to



NORTHERN PORTION OF THE UPPER DESCHUTES RIVER SUBBASIN the north. The total drainage area is approximately 2,200 square miles. The average annual discharge of the Deschutes River at Benham Falls (RM 181) is 1,024,700 acre-feet. The highest point in the basin is South Sister Mountain (elevation 10,358 ft) located in the central Cascade Mountains. Elevation drops to 1,900 ft at Lake Billy Chinook where the Deschutes River enters.

The Deschutes River flows north to south from its headwaters at Little Lava Lake to Crane Prairie Reservoir (RM 239), south and east through Wickiup Reservoir (RM 226), and then north again to its confluence with Lake Billy Chinook (RM 120). The major tributaries above Crane Prairie Dam are Snow Creek, Cultus River, Cultus Creek, Quinn River, and Deer Creek. The principal tributaries between Wickiup Dam and Bend are the Little Deschutes River, Fall River, and Spring River. Squaw and Tumalo Creeks are the principal tributaries to the Deschutes River from Bend to Lake Billy Chinook.

The principal natural lakes in the basin are: Odell, Crescent, Davis, Cultus, Little Cultus, Lava, Little Lava, South Twin, North Twin, Hosmer, Elk, Sparks, East, and Paulina. There are also over 400 high elevation lakes in the Cascades, of which, the Department actively stocks fish in 90.

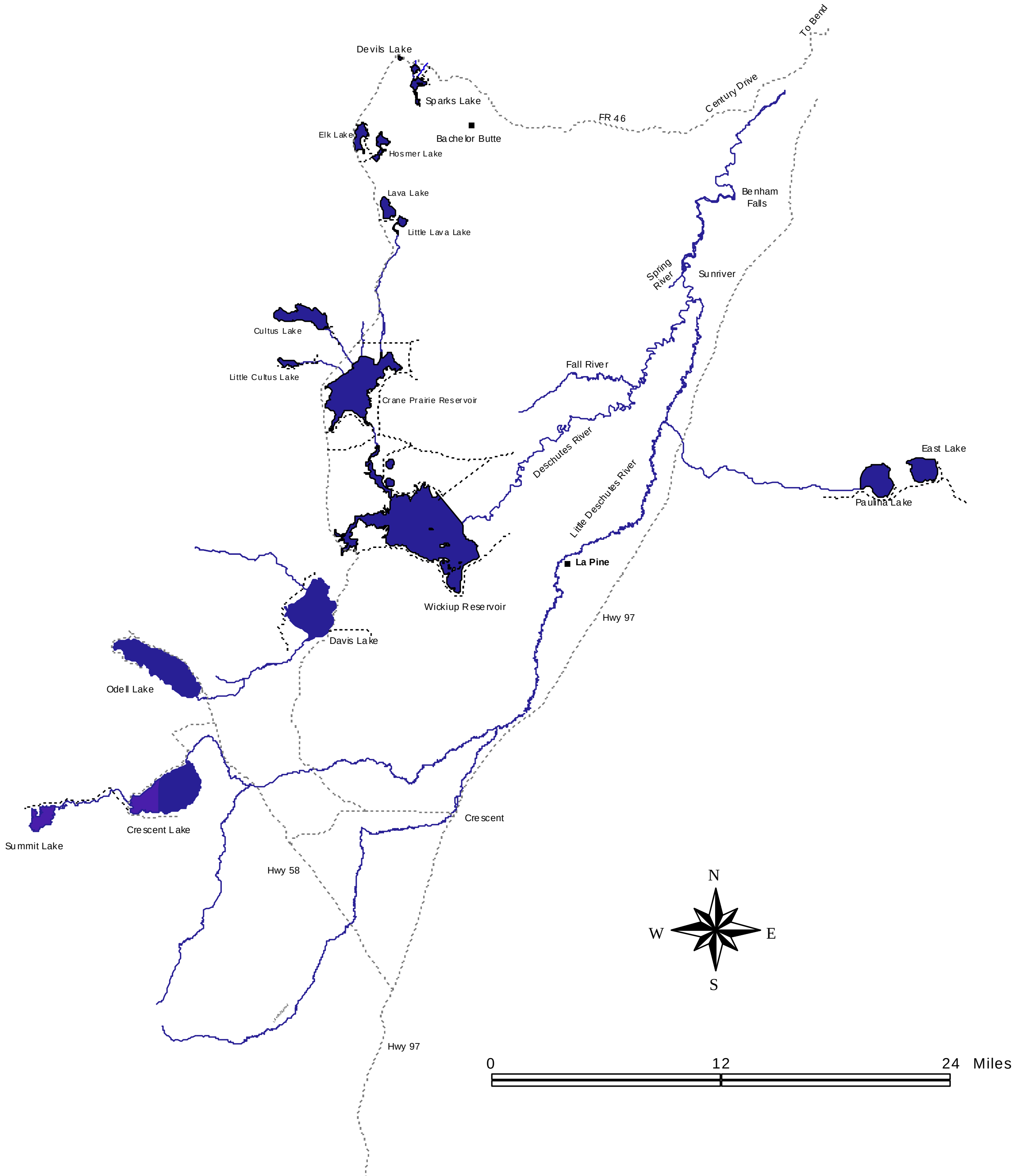
Miscellaneous waters included in the plan are Three Creeks and Little Three Creeks lakes, Fireman's Pond, Shevlin Pond, Sprague Pond and Century Pond.

The climate in the basin is continental, moderating affects of the Pacific Ocean are not entirely shut off by the Cascade Mountains. Average annual precipitation is as high as 100 inches in some areas in the Cascade Range, but drops to between 9 and 14 inches in the Deschutes valley and on the eastern plateaus. Most precipitation falls in the form of snow during winter.

Temperatures are characterized by moderate days and cool nights. Bend averages about 10 days per year with temperatures above 90^{o}F. Lows in the winter average between 20 and 30^{o}F. Extreme temperatures can range from 100^{o}F to minus 30^{o}F.

Mountain hemlock, alpine, and subalpine plant communities occur in the high elevation and high precipitation zones of the basin. Mixed conifer and ponderosa pine communities are common to the middle elevation and precipitation zones. Sagebrush, juniper, and sparse ponderosa pine communities occur on the semiarid, lower elevations along the eastern edge of the basin. Lodgepole pine occurs over a wide range of site conditions and elevations. Riparian vegetation is dominated by willow, alder and sedges.

Soils in the Upper Deschutes River basin are formed partially to entirely from materials deposited by volcanic eruptions. These materials include pumice, ash, and cinders. These deposits fell upon previously developed soils that became buried. Most of the buried soils were formed from hard basalts, and andesites, tuffs, breccias, glacial till



SOUTHERN PORTION OF THE UPPER DESCHUTES RIVER SUBBASIN and outwash gravels. Practically all bedrock materials are extrusive volcanic rocks (USDA 1990). These volcanic soils are characterized by being very porous.

Historic game fish populations included anadromous spring chinook and summer steelhead, resident populations of redband rainbow trout and mountain whitefish throughout the basin, bull trout throughout the mainstem of the Deschutes River, Little Deschutes drainage, Odell Lake, Odell Creek, Davis Lake, and Pacific lamprey in the Deschutes River. Anadromous fish runs have been lost due to the construction of dams on the mainstem of the Deschutes River. Bull trout were also extirpated from most of the basin above Steelhead Falls due to migration barriers (dams), water withdrawal from irrigation development, and excessive harvest. The current distribution of bull trout in the Upper Deschutes River subbasin is the Deschutes River from Lake Billy Chinook upstream to Steelhead Falls, lower Squaw Creek, and Odell Lake. However, bull trout will likely be found occasionally in Odell Creek and Davis Lake since there are no restrictions to their movement out of Odell Lake.

Indigenous and introduced fish species currently present in the Upper Deschutes River subbasin include a diversity of game and non-game species. Game fishes include redband and hatchery rainbow trout, bull, brown, brook, cutthroat, and lake trout, kokanee (resident sockeye salmon), mountain whitefish, coho and Atlantic salmon, largemouth bass, bluegill, brown bullhead catfish, black and white crappie, crayfish, and bullfrog (Table 1). Non-game fish species include tui and blue chub, bridgelip and largescale sucker, northern squawfish, chiselmouth, sculpin, three-spine stickleback, and dace.

Table 1. Historical and current fish species in the waters of the Upper Deschutes River Basin.

Common Name	Scientific Name	Origin	Status	Abundance
Pacific lamprey	*Entosphenus tridentatus*	indigenous	extinct	-
Summer steelhead	*Oncorhynchus mykiss*	indigenous	extinct	-
Chinook salmon	*Oncorhynchus tshawytscha*	indigenous	extinct	-
Coho salmon	*Oncorhynchus kisutch*	introduced	present	locally abundant
Kokanee	*Oncorhynchus nerka*	introduced	present	abundant
Atlantic salmon	*Salmo salar*	introduced	present	rare
Redband trout	*Oncorhynchus mykiss*	indigenous	present	moderate
Bull trout	*Salvelinus confluentis*	indigenous	present	very rare
Mountain whitefish	*Prosopium williamsoni*	indigenous	present	very abundant
Rainbow trout	*Oncorhynchus mykiss*	introduced	present	abundant
Brown trout	*Salmo trutta*	introduced	present	abundant
Brook trout	*Salvelinus fontinalis*	introduced	present	abundant
Cutthroat trout	*Oncorhynchus clarki lewisi*	introduced	present	moderate
Lake trout	*Salvelinus namaycush*	introduced	present	low
Largemouth bass	*Micropterus salmoides*	introduced	present	moderate
Smallmouth bass	*Micropterus dolomieui*	introduced	present	low
White crappie	*Pomoxis annularis*	introduced	present	low
Black crappie	*Pomoxis nigromaculatus*	introduced	present	low
Table 1. Continued.				
Brown bullhead catfish	*Ictalurus nebulosus*	introduced	present	locally abundant
Bluegill	*Lepomis macrochirus*	introduced	present	moderate

Shorthead sculpin	*Cottus confusus*	indigenous	present	locally abundant
Reticulate sculpin	*Cottus perplexus*	indigenous	present	unknown
Longnose dace	*Rhinichthys cataractae*	indigenous	present	low
Chiselmouth	*Acrocheilus alutaceus*	indigenous	present	moderate
Largescale sucker	*Catostomus macrocheilus*	indigenous	present	locally abundant
Bridgelip sucker	*Catostomus columbianus*	indigenous	present	moderate
Northern squawfish	*Ptychocheilus oregonensis*	indigenous	present	moderate
Three-spine stickleback	*Gasterosteus aculeatus*	introduced	present	very abundant
Tui chub	*Gila* (Siphateles) *bicolor*	introduced	present	very abundant
Blue chub	*Gila* (Gila) *coerulea*	introduced	present	locally abundant
Crayfish	*Pacifastacus leniusculus*	indigenous	present	abundant
Bullfrog	*Rana catesbeiana*	introduced	present	unknown

Location and Ownership

The Upper Deschutes River subbasin is located along the southern edge of the Columbia Basin Plateau extending south into high elevation lodgepole and ponderosa plateaus. The Basin is bordered on the west by the Cascade Mountain Range and on the east by the high desert and Paulina Mountains.

Land ownership is predominantly public: United States Forest Service- Deschutes National Forest, and Bureau of Land Management- Prineville District. Other public lands include city, county, and Oregon State Parks.

Primary land uses in the basin are agriculture, wood products manufacturing, recreation and tourism. Agriculture in the basin is primarily animal production (horses, llamas, cattle, emus, hogs and sheep). Secondary in importance is the production of animal feed, primarily alfalfa hay. The wood products industry has been the leader in manufacturing jobs, however, many high-tech and cottage industries have appeared in recent years as the timber jobs declined. In 1987, the tourism and recreation industry was the second largest source of income in Central Oregon (USDA 1990). This trend has continued.

Demographics

The City of Bend is the principal community in the basin. The next largest is Redmond, followed by Sisters, LaPine, Gilchrist and Crescent.

The population of Deschutes County has grown at a faster rate than any other area of Oregon during the decade of the 1990's. The growth of Deschutes County during this decade is expected to be 42.3% followed by Jefferson County (33.7%), and Crook County (22.3%). The 1995 population projection for Deschutes County was 92,245 and reaching 128,868 by the year 2010. Jefferson County is expected to grow to 22,618 and Klamath County to 69,058 by 2010. Statewide, Oregon is projected to increase by 931,357 people during the 1990-2010 period, the greatest growth during any 20-year period in its history (PSU 1993).

Access

The Upper Deschutes River subbasin's natural resources, including forests, lakes, streams, and wildlife contribute substantially to recreation and tourism in the region. The Deschutes National Forest is the largest landowner in the basin. In 1986, it ranked third among the 19 National Forests in the Pacific Northwest Region and 25th among 125 Forests nationally in total recreation use. During 1987, 2.6 million recreation visitor days were recorded (this measure represents a 12 hour visit on the Forest). Of this total, camping and picnicking represented 33.4% and hunting and fishing represented 9.6 % (USDA 1990).

Most major streams, rivers, reservoirs, and natural lakes are on public land. Private ownership is most prevalent along streams, primarily the Little Deschutes River and tributaries, the Deschutes River between Bend and Lake Billy Chinook, Squaw Creek, and Fall River. These streams are where public access is most needed in the basin.

The Three Sisters Wilderness (Deschutes National Forest) area encompasses 283,402 acres, the largest wilderness area within the basin. In 1984, the Oregon Wilderness Act created the 157,000 acre Oregon Cascade Recreation Area. It is located on four National Forests including 42,656 acres of the Deschutes in the south end of the basin.

In 1988, 147.3 miles of stream within the basin were added to the Federal Wild and Scenic Rivers systems. Stream portions added were Squaw Creek, Big Marsh Creek, Crescent Creek, the Deschutes River, and Little Deschutes River.

In 1991, 50 miles of the Upper Deschutes River was added to the Oregon State Scenic Waterways.

The Department has an on-going effort to gain public access to streams through the purchase of property, easements, and development of boat access. These are cooperative efforts with developers, landowners, Deschutes County, and land managers such as Forest Service, State Parks, and Bureau of Land Management.

Fish Resources

<u>Anadromous Fish (Historical)</u>

Prior to construction of dams on the Deschutes River, the Deschutes River (up to Big Falls) and Squaw Creek supported runs of summer steelhead and spring chinook salmon. Round Butte Dam, completed in 1964, incorporated fish passage facilities, but they were not effective and anadromous fish passage was terminated in 1968, eliminating spring chinook and summer steelhead from the Upper Deschutes River subbasin.

Squaw Creek was a major producer of summer steelhead. In the 1950's, the number of steelhead counted in Squaw Creek ranged from 62 to a high of 619 in 1953; counts dwindled to zero in the late 1960's (Nehlsen 1995). Prior to the 1950's, information on summer steelhead runs in Squaw Creek is lacking. On the Deschutes River, Big Falls is considered to have been the upstream limit of anadromous fish migration (Nehlsen 1995).

Steelhead could negotiate Steelhead Falls in high winter or early spring flows, and after the fishway was constructed in 1922, could move upstream through the fish ladder for a period of years. It was determined that a minimum flow of about 300 cfs in the Deschutes River at Bend was required to assure adequate efficiency of the fishway. After 1930, such flows were available only in November through April, so summer and fall migrating fish may have been hampered in their attempts to move above Steelhead Falls.

Although fishways were constructed at Big Falls and Cline Falls in the 1920's, no steelhead were ever observed attempting to pass either falls (Mathisen 1985a; Nehlsen 1995). Summer steelhead were trapped in the Steelhead Falls fishway in 1953, 1954 and 1955. Eighteen fish were recovered at the falls during those years (Nehlsen 1995).

Spring chinook salmon spawning ground counts were conducted in Squaw Creek through 1960 and they were observed in the Deschutes River in the Steelhead Falls fish ladder trap in 1953. Records of spawning salmon and redds in Squaw Creek from 1951-1960 showed a high count of 30 in 1951 and 0 by 1960 (Nehlsen 1995). As with summer steelhead, accounts of spring chinook abundance prior to 1950 are lacking.

Pacific lamprey probably occurred in the Deschutes River above the Round Butte-Pelton project, however, very little is known about their life history or abundance in the subbasin.

Redband Trout

The redband trout (inland rainbow trout) is indigenous to the Upper Deschutes subbasin. Redband trout are a subspecies of rainbow trout and steelhead, and are adapted to the arid conditions east of the Cascades. Historically, they were found throughout the Upper Deschutes subbasin in waters connected to the Deschutes River.

Today, their distribution in the subbasin is fragmented due to dams without fish passage, natural barriers, severe stream flow alterations from irrigation development, chemical treatment projects, and introduction of non-indigenous trout stocks. Presently, they are found in the mainstem Deschutes River from Lake Billy Chinook upstream to the headwaters, the Little Deschutes River, Crescent Creek, Squaw Creek, Tumalo Creek, and Odell Creek. Samples of redbands from these drainages have been collected for genetic analyses to determine if they have been influenced by hatchery stocks or remain pure redbands and results are pending. Generally, redband trout populations are thought to be in a depressed status and are listed as a state sensitive species and as a federal Category 2 sensitive species.

Redband trout spawn in rivers and streams during the spring (March, April and May). Cool, clean, well-oxygenated water is necessary for the eggs to survive. Redband trout fry emerge from the gravel in June and July. For the most part, they live near where they were spawned. Age at maturity is 3 years with size varying depending on productivity of individual waters. Few redband trout exceed 10 inches in length.

Bull Trout

Bull trout are indigenous to the Upper Deschutes River subbasin and historically were found in the mainstem Deschutes River to the headwaters, Odell Lake, Odell Creek, Davis Lake, and Crescent Lake. It is likely they were also present in other waters connected to the Deschutes River, but no documentation could be found. Bull trout were extirpated from the Deschutes River mainstem in the 1950's due primarily to flow manipulations and dams with no upstream fish passage. Today, they are found in Odell Lake, occasionally in Odell Creek and Davis Lake, Squaw Creek below Alder Springs, and in the Deschutes River from Lake Billy Chinook upstream to Steelhead Falls. Harvest of bull trout is allowed only in the Deschutes River upstream to Steelhead Falls.

Bull trout spawn in cold tributary streams in the early fall (September - October). They deposit eggs in a redd and juvenile bull trout typically rear in the parent stream for two years and then migrate in the spring to larger waters for rearing to adulthood. At age 5, they migrate back to their natal tributary to spawn. Bull trout are very piscivorous allowing them to reach up to 20 lbs in size depending on food availability.

Kokanee

Kokanee are landlocked sockeye salmon. They are an introduced fish species to the Upper Deschutes River subbasin. They were stocked in many waters of the basin and are found today in Odell, Crescent, Elk, Paulina and East lakes, Wickiup and Crane Prairie reservoirs. They appear rarely in Davis Lake as emigrants from Odell Lake. The Department stocks fingerling kokanee in Crescent, East, and Paulina lakes, and Crane Prairie reservoir. The remaining kokanee populations are naturally reproducing in sufficient numbers to maintain fisheries without annual stocking.

Paulina Lake grows larger-than-average-size kokanee and holds the current state record. The Paulina Lake kokanee provide the annual supply of eggs for Oregon and in some years, Idaho and Washington.

Kokanee spawn in the fall (September - October), generally preferring cold spring-fed tributaries. They spawn at age 3-4 and like all Pacific salmon, die after spawning. They build redds for egg deposition and the fry emerge from the gravel in mid-winter when they immediately migrate to larger waters for rearing to adults.

Mountain Whitefish

Mountain whitefish are members of the Salmonidae family and are closely related to salmon and trout. They are indigenous to the Upper Deschutes River subbasin. For the most part, they are still found in their original distribution pattern with the exception of waters which were chemically treated and recolonization did not occur. Today, they are found in Little Lava Lake, the Deschutes River mainstem from the headwaters to Lake Billy Chinook, Crane Prairie and Wickiup Reservoirs, the Little Deschutes River system, Crescent and Odell Lakes, Odell

Creek, Davis Lake, Fall River, Spring River, lower Squaw Creek, lower Tumalo Creek, and the Cultus Lake basin.

Whitefish broadcast spawn over gravel areas of streams in the late fall or early winter. No nest (redd) is prepared and they prefer cold spring-fed streams for spawning. Juvenile whitefish hatch in the spring (March-April). Their growth rates are similar to those for rainbow trout and they sexually mature at age 3-4. Mountain whitefish prefer large lakes or large rivers where they are generally found in deep pools and they form schools of up to several hundred fish. Mountain whitefish are primarily bottom feeders consuming aquatic insects and can be direct competitors with trout. They are considered to be a barometer of good water quality and have adapted well to the barrage of habitat alterations in the subbasin.

The largest whitefish (20" or greater) are found in the larger lakes and reservoirs. The current state record whitefish was caught in Crane Prairie Reservoir.

Chinook Salmon

Spring chinook salmon are indigenous to the subbasin and historically were present in the Deschutes River up to Steelhead Falls and Squaw Creek. A remnant population is believed to exist in Lake Billy Chinook and in the last 15 years, reports have been received of anglers catching chinook near Steelhead Falls. No spawning adults have been found recently in either the Deschutes River above Lake Billy Chinook or Squaw Creek.

Spring chinook adult fish spawn in gravel areas of streams or rivers during August and September. Eggs remain in the gravel until hatching in late winter. Juvenile chinook salmon remain in the streams for approximately 3 months until they begin their seaward migration, or in this case, their migration down to Lake Billy Chinook. Spring chinook salmon reside in the ocean for 2-4 years before returning to their natal stream. Upstream migration usually commences in April and May, with adults remaining in large, deep pools until they spawn in early fall.

Brown Trout

Brown trout are an introduced fish species to the subbasin and first made their appearance in the early 1900's. Today they are found in the Deschutes River mainstem from Crane Prairie Dam downstream to Lake Billy Chinook, Wickiup Reservoir, East, Paulina, and Crescent lakes, Spring River, Fall River, Little Deschutes basin, Squaw and Tumalo Creeks.

The largest brown trout in Oregon are produced in this subbasin with the current state record of 27 lbs 12 oz from Paulina Lake. East and Paulina lakes, and Wickiup Reservoir have produced brown trout in excess of 20 lbs. Brown trout up to 15 lbs have been taken in the Deschutes River.

Brown trout spawn in rivers and streams during the fall (October-November) and prefer cold spring-fed streams. Eggs are deposited in a redd and fry usually emerge in March. They generally sexually mature at 3 years of age with an average length of 15 inches. Brown trout are very piscivorous, and long-lived which accounts for them reaching large sizes. They are highly regarded by anglers as a trophy trout.

Brown trout eggs are collected annually from Brown's Creek (Wickiup Reservoir) for statewide needs. No brown trout brood fish are maintained in hatcheries. They are not stocked in any basin streams, but are maintained by natural reproduction.

Brook Trout

Brook trout are an introduced fish species and were first stocked in the early 1900's. They are widely distributed in the subbasin from high mountain lakes to headwater tributaries. They are found in all stream systems and most major lakes. They are the most prevalent fish in both wilderness and non-wilderness high lakes.

Brook trout spawn in October and early November and redds are typically built in headwater streams and springs with spring-fed cold streams preferred. Eggs hatch in early winter and juveniles emerge from the gravel in the spring. Sexual maturity is reached at age 3 with size varying depending on productivity of the individual water.

This basin has a history of producing large brook trout and the current state record brook trout of 9 lbs 6 oz came from the Deschutes River below Little Lava Lake.

Lake Trout

Lake trout are an introduced species to the basin with the first introductions in 1917 into Odell and Crescent lakes. Hatchery reared lake trout were stocked into Odell, Crescent, Summit, and Cultus lakes from 1951-1965. Today, they are still found in these four basin waters. They have maintained fishable populations through natural reproduction. Lake trout are very piscivorous eating primarily whitefish, kokanee, tui chubs, other trout, and crayfish. They are very long-lived (>20 years) and can reach very large size. The current state record is a 36 lb 8 oz specimen from Odell Lake.

Lake trout spawn in the fall (October) when they move to gravel/cobble shoals. They do not build nests (redds), but rather broadcast spawn with the fertilized eggs settling in the crevices between the rocks. Eggs do not hatch until spring. Sexual maturity is generally reached at age 6 or 7.

Cutthroat Trout

Cutthroat trout are an introduced species to the Upper Deschutes subbasin. They are presently only being stocked in a few high lakes.

Two strains of cutthroat trout, Long Tom River (Willamette Basin), and Twin Lakes (Lake Chelan, State of Washington) have been used in the basin. The Long Tom cutthroat is a low elevation strain which did not perform well in basin high lakes. The Twin Lakes stock is a high elevation strain of West Slope cutthroat which has done very well in the high lakes. The

Department receives surplus cutthroat eggs from the state of Washington, but the supply of eggs is not dependable from year to year. It would be desirable to develop a brood stock here in Oregon to assure a consistent annual program with the potential to expand the use of these cutthroat in other waters. This Twin Lakes stock is very popular with anglers because they are relatively easy to catch all summer, highly attractive, and good table fare.

Twin Lakes cutthroat trout spawn from early May to early June. They build nests (redds) in gravel of cold lake inlet streams. The young typically spend from 2-3 years in the stream before migrating to the lake at a size of 7 to 9 inches. After 1-3 years in the lake, sexual maturation occurs typically at age 4 or 5 and at a size of 14-16 inches in more productive waters. Typical maximum age is 7 and typical maximum size is 18-20 inches (Behnke 1979) in productive waters. In the high lakes within the basin, cutthroat trout sexually mature at about 12 inches in length and reach a maximum size of 16 inches.

Atlantic Salmon

Atlantic salmon are an introduced species to the Upper Deschutes River subbasin. They are currently present in East and Hosmer lakes. They were initially stocked at Hosmer Lake in 1958. The original shipment of sea-run Atlantic salmon eggs was received from Gaspe Bay, Quebec, Canada in 1951. Atlantic salmon were stocked in many basin lakes, however, they failed to survive or generate fisheries in all but Hosmer and East lakes. In 1984, the Gaspe Bay Atlantic salmon stock was replaced with a land-locked stock from Maine, called Grand Lakes. Since 1984, this is the stock used at Hosmer Lake and at East Lake since 1990.

Atlantic salmon are anadromous, spawn during the fall in streams and build nests (redds) in suitable gravel. In contrast to Pacific salmon, Atlantic salmon do not die after spawning. Many spent fish survive the winter in freshwater and resume feeding. They can repeat spawn two or three times and reach ages of up to 7 years. The young salmon typically spend 1-3 years in their natal stream before going to sea. In Hosmer and East Lakes, Atlantic salmon do not reproduce naturally and the fisheries are maintained by annual stocking.

Largemouth Bass

Illegally introduced largemouth bass are present in Crane Prairie and Wickiup reservoirs, and Davis Lake. The Department has stocked largemouth bass in Fireman's Pond in Redmond. In addition to public waters, largemouth bass are found in many private ponds.

Largemouth bass spawn on sand and mud beaches when the water temperature approaches 62^{o}F. Most spawning is associated with shallow littoral areas (<10 feet) which have aquatic vegetation. Juvenile largemouth bass remain near the nest for 5-7 days with the male guarding the young and the nest. Adult largemouth bass generally inhabit water less than 20 feet deep. They tend to reside in the protection of structure such as aquatic and shoreline vegetation, woody material, or rocky areas. Juvenile largemouth bass eat plankton, immature aquatic insects, and crayfish. Adult bass eat mostly fish and crayfish.

Smallmouth Bass

Introduced smallmouth bass are present in Deschutes River upstream of Lake Billy Chinook. They spawn on gravel and sandy beaches when the water temperature approaches 65^{o}F. Smallmouth bass have been observed on spawning nests in June. Most spawning appears to be associated with shallow littoral areas (<10 feet) which have pea size gravel. Juvenile smallmouth bass remain near the nest for 5-7 days with the male guarding the young and the nest. After spawning, adult smallmouth bass retreat to deeper water. Juvenile smallmouth bass remain in the protection afforded by boulders, cobble, and talus slopes. Juvenile smallmouth bass eat plankton, immature aquatic insects and crayfish. Adults eat mostly crayfish and fish.

Brown Bullhead Catfish

Introduced brown bullhead catfish are present in low numbers in Gilchrist Mill Pond (Little Deschutes River), Little Deschutes River downstream of Gilchrist, and occasionally in the Deschutes River (mainstem) downstream to Lake Billy Chinook. They have been illegally introduced into North Twin Lake and Wickiup Reservoir. They are flourishing in North Twin Lake, but are rarely found in Wickiup Reservoir. In addition to these public waters, they are found in many private ponds.

Brown bullhead catfish spawn in the spring when the water temperature reaches 70^{o}F. They spawn in mud or sand in depths from 6 inches to several feet. The eggs are cared for by one or both parents and hatch in 6-9 days. Growth is slow; they may only reach 10 inches at age 5. Sexual maturity is reached at age 3. Brown bullhead catfish feed on or near the bottom, mainly at night. Adult catfish are omnivorous eating offal, waste, mollusks, immature insects, leeches, crustaceans, worms, plants, algae, fish and fish eggs. Juveniles feed primarily on chironomid larvae, cladocerans, ostracods, amphipods, bugs, and mayflies. Juvenile catfish are eaten by many fish species.

Bluegill

Bluegill are rare in public waters of the basin, but abundant in private ponds. Because they are rare in abundance, they will not be discussed in detail in this section.

Crappie (Black, White)

Crappie are rare in public waters of the basin, found only in Fireman's Pond (Redmond). However, they are fairly abundant in some private ponds. They will not be discussed in detail in this section.

Nongame Fish

Several indigenous and introduced nongame fish species are present in the basin. Indigenous species include; sculpins, suckers, squawfish, and dace. Introduced species are tui and blue chubs, and three-spine stickleback. Other introduced species which appeared rarely in the basin were carp and goldfish. Following chemical treatment projects, these two species are not presently found in the basin.

Sculpin Species

Sculpins are found in the Deschutes River mainstem and tributaries downstream of Wickiup Reservoir. They are not widely distributed. Sculpins spawn in spring. They prefer streams having a boulder, cobble, and flat rock bottom. Sculpins grow to a maximum length of only 6-7 inches. They feed primarily on aquatic insect larvae. They are often eaten by other piscivorous fish species.

Dace Species

Dace are indigenous to the Upper Deschutes River subbasin, however their total distribution is unknown. They are known to be present in lower Squaw Creek and the Deschutes River downstream of Steelhead Falls. They are small fish with some specimens reaching a length of 6 inches, usually about 4 inches. Dace are bottom dwellers; its wedge-shaped head and reduced air-bladder adapt them well to holding position on the bottom, even in a swift stream. They are solitary rather than schooling fish. Their diet is primarily insect larvae varying in size as dace grow larger. Spawning occurs in spring in shallow gravelly streams. No nest is constructed, but the males guard a territory over which they entice the females to spawn. They are not abundant where found, so their value as forage for larger piscivorous fish is minimal.

Bridgelip Sucker

Bridgelip sucker are present in the Deschutes River from Steelhead Falls downstream to Lake Billy Chinook, Squaw Creek, and Indian Ford Creek. They spawn in the spring and broadcast their eggs. Sexual maturity is reached when individuals reach about 5 inches in length. They can reach a maximum length of about 17 inches. They prefer colder water of small, swift rivers with gravel to rocky bottoms, but it is also found in rivers where current is more moderate and the bottom comprised of sand and mud. Populations in many central Oregon lakes and reservoirs suggest that it adapts well to lake environments. The sharp edged bottom lip indicates its food is algae which is obtained by scraping rocks. It may not be a competitor with trout for food, but rather spatial habitat.

Largescale Sucker

Largescale sucker distribution in the basin is limited to the Deschutes River from Steelhead Falls to Lake Billy Chinook. Largescale suckers may play a more important role in trout management because of competition for food and their greater biomass.

Largescale suckers generally mature at 8-12 inches in length. They spawn in the spring, usually in deeper sandy areas of streams, but at times on gravel or sand shoals in lakes. Spawning takes place from late April to late June depending on stream temperatures. A female may deposit as many as 20,000 eggs, which are adhesive. Eggs hatch in about 2 weeks and the fry remain in the gravel or on the surface of the sand for the first few weeks. The young are pelagic until they reach about 3/4 inch. As they grow, they move toward the bottom and into deeper water. Growth is slow and a 12-inch largescale sucker may be 8 or more years old. Maximum size is about 24 inches and 7 pounds. Adults are usually found at depths of only a few feet, but have been taken as deep as 80 feet.

Food composition varies with size of individual, time and habitat, but adults feed almost exclusively on bottom invertebrates such as ostracods, amphipods, Trichoptera, Chironomidae, and mollusks. However, they will eat fish eggs, diatoms, algae, and detritus when available. They compete directly with trout species, and probably also prey upon their eggs.

Chiselmouth

Chiselmouth distribution in the basin is limited to the mainstem Deschutes River from Big Falls downstream to Lake Billy Chinook and the lower reaches of Squaw Creek. Chiselmouth spawn in streams when water temperatures exceed 62^{o}F. They feed on diatoms, surface insects and vegetation. They reach a maximum length of about 12 inches and are not considered a serious competitor with trout. They may serve as a food source for large piscivorous fish such as brown and bull trout.

Northern Squawfish

Squawfish distribution in the basin is limited to the mainstem of the Deschutes River from Steelhead Falls downstream to Lake Billy Chinook and lower Squaw Creek.

Although very restricted in its distribution within the basin, the northern squawfish is abundant where found, is piscivorous and considered a threat to trout populations.

Spawning takes place in gravel shallows, in streams or lake shores. Spawning fish tend to gather in large numbers, but no nests are built. The fish broadcast spawn and the adhesive eggs settle in the gravel where they hatch in about 1 week. Sexual maturity is attained in about 6 years at a length of about 12 inches. Squawfish can reach over 20 lbs in weight and 25 inches in length.

The northern squawfish is typically a lake species. The young inhabit inshore waters in summer months, moving offshore to deeper water in the fall. Larger fish tend to remain offshore. Squawfish typically feed on shiners, sticklebacks, terrestrial insects, plankton, aquatic insects, and crustaceans while onshore. During fall and winter, squawfish feed primarily on fish in deeper water. Young squawfish, 1-4 inches, feed heavily on insects, but rely more on fish as they grow older. Large squawfish feed almost exclusively on fish and crayfish.

Tui Chub

The most abundant fish species in the basin is the introduced tui chub. They are found in most large lakes, reservoirs, and streams; Deschutes and Little Deschutes Rivers, Odell, Crescent, Davis, East, Paulina, Lava, Little Lava, and Cultus lakes; and Crane Prairie and Wickiup reservoirs.

The tui chub was indigenous to the Klamath and Sacramento River systems and also in a number of isolated interior basins of California, Oregon and Nevada. It is likely they were introduced to this basin from the Klamath basin, probably by anglers using them as live bait for large trout.

Tui chub gather in large schools to broadcast spawn in or near heavily vegetated lake shorelines in June and July. The fecundity of mature female tui chub can reach nearly 50,000 eggs. The eggs hatch in about 1 week. The young remain in the vegetated shallows until reaching sexual maturity at age 2-3. They have a life span of up to 9 years and reach maximum lengths of about 11 inches. Tui chubs feed on amphipods, Diptera larva, gastropods and cladocerans. For the most part, their food preferences mirror those of trout, especially rainbow. Tui chubs are prey for piscivorous rainbow and brown trout, and largemouth bass. They are also utilized by fish-eating birds, mink and otter.

Blue Chub

Blue chub are an introduced fish species found only in Paulina Lake and occasionally in Paulina Creek as emigrants from the lake. The blue chub was indigenous to the Klamath River system of California and Oregon and like the tui chub, was most likely introduced to Paulina Lake by anglers using them as live bait for large trout.

Blue chubs gather in large schools to broadcast spawn from July through mid-August. They spawn directly adjacent to the shoreline in areas of clean gravel or large rock in 3 feet of water or less. The adhesive eggs hatch in 7-9 days and the young remain in the shallow areas until age 3 when they reach sexual maturity. They can attain ages of 10 years and lengths near 9 inches. Fecundity of an adult female blue chub can be as high as 25-30,000 eggs. The blue chub diet consists mainly of Diptera larvae, cladocerans, gastropods, and amphipods. Their diet overlaps that of rainbow trout, thus they are direct competitors for food. Blue chubs are prey for piscivorous brown and rainbow trout in Paulina Lake. They are also utilized by fish-eating birds and mammals such as osprey and mink.

Three-Spine Stickleback

Three-spine stickleback are an illegally introduced species in the basin presently found in the Deschutes River from Crane Prairie Reservoir downstream to Lake Billy Chinook. They are also present in the lower Little Deschutes and Spring Rivers. They were first discovered in Spring River in the 1980's and have spread upstream and downstream in the Deschutes River. They are a popular fish for aquariums and may have been introduced to the Deschutes River by someone in the Sunriver area. Three-spine stickleback are indigenous to Oregon coastal streams and estuaries and are anadromous in those areas.

They are small fish with adults reaching 3 inches in length in freshwater. Their food consists largely of small plankton organisms such as water-fleas and copepods, and also aquatic insect larvae, small crustaceans, and other animal forms usually found on the bottom. A considerable amount of plant material (algae) is also taken. Breeding takes place throughout the summer months, the male constructing a saucer-shaped nest on the bottom in shallow water. Several females contribute eggs (as many as 600) to one nest. Sticklebacks are prey items for trout and largemouth bass. They are also extensively eaten by the American merganser and other fish-eating birds.

Crayfish

Crayfish are indigenous to the basin and widely distributed in streams, reservoirs and lakes. They inhabit benthic environments down to 60+ feet. Mating occurs in the summer or fall. Females may spawn twice or more during their life. Females extrude 100-300 eggs shortly after mating. Eggs are carried through the winter and hatch in late spring. Young remain with the female for several weeks, molting twice. Sexual maturity occurs at 18-30 months and at a nose-to-tail length of 2.5 inches. Some crayfish with good growth rates may mate during their first fall. Juveniles favor shallow weedy areas whey they can find protection from predators, and the adults favor deeper water. They are well-utilized food item for piscivorous fish and a variety of birds and mammals. They have been harvested commercially in Paulina Lake, but their primary contribution is for use as bait or food by sport anglers.

Fish Stocking History

Historic hatchery stocking programs in the Upper Deschutes River subbasin were very extensive beginning in the early 1900's. Some of the earliest stocking occurred in the high mountain lakes where brook and rainbow trout were packed in by ODFW and Forest Service horse and mule pack strings. Most major waters in the basin had been stocked by 1930.

All current hatchery programs are being reviewed for compliance with the Trout and Warmwater Fish Plans, adopted by the Oregon Fish and Wildlife Commission in 1987 (ODFW a, b), and the Wild Fish Policy, (ODFW 1990). Programs are being critically reviewed for potential genetic and disease impacts on indigenous trout stocks. The Metolius River stocking of rainbow trout was discontinued beginning in 1996 due to wild fish genetic concerns.

Current hatchery stocking programs in the basin are primarily in standing waters. Stocking of streams is limited to Fall River and the Deschutes River between Wickiup Reservoir and Sunriver. The majority of stocking is with fingerling-size rainbow, brook and cutthroat trout, kokanee, and coho salmon. Stocking of legal-size (yearling age) trout and Atlantic salmon is done on several waters to generate put-and-take fisheries or specialized fisheries such as Hosmer Lake Atlantic salmon and trophy brown trout at East and Paulina lakes, and Wickiup Reservoir.

Three stocks of rainbow trout are stocked; Oak Springs domestic (Lot 53), Klamath wild rainbow (Lot 28), and Cape Cod (Lot 72). The Oak Springs stock is the most widely used rainbow stock in Eastern Oregon. The Cape Cod (Lot 72) stock is used for the legal rainbow trout programs, and the Klamath wild (Lot 28) rainbow trout is used in Davis and Lava Lakes experimentally to evaluate their success in utilizing tui chubs. Currently, approximately 100,000 legal-size and 733,000 fingerling-size trout and salmon are stocked annually in the basin.

In addition, 90 high mountain lakes are stocked every two years with approximately 67,000 small fingerling trout (brook, rainbow, cutthroat). All trout stocked in this basin are produced at Central Region hatcheries (Wizard Falls, Fall River, Oak Springs, Klamath). Table 2 summarizes fish stocking in the basin by water body.

The only warmwater fish stocking has been in Fireman's pond where largemouth bass and redear sunfish were released.

Table 2. Waters in the Upper Deschutes River subbasin that are stocked annually with hatchery fish. Fingerling fish are 2-4 inches long and legal-size fish are 8-12 inches long. High lakes are not included.

WATER BODY	SPECIES	SIZE	NUMBER
Deschutes River	rainbow	legal	25,000
Fall River	rainbow	legal	7,500
	brook	legal	7,500
Three Creeks Lake	rainbow	legal	4,000
Devils Lake	rainbow	legal	5,000
Little Cultus Lake	brook	fingerling	8,000
Cultus Lake	rainbow	legal	6,000
Sprague Pond	rainbow	legal	1,000
Century Gravel Pond	rainbow	legal	1,000
Fireman's Pond	rainbow	legal	500
Shevlin Pond	rainbow	legal	1,000
North Twin Lake	rainbow	legal	6,000
	rainbow	fingerling	15,000
South Twin Lake	rainbow	legal	6,000
	rainbow	fingerling	20,000
East Lake	brown	legal	10,000
	rainbow	legal	30,000
	Atlantic salmon	legal	6,000
Paulina Lake	brown	legal	10,000
	kokanee	fingerling	20,000
	rainbow	fingerling	75,000
Crane Prairie Reservoir	rainbow	fingerling	200,000
	kokanee	fingerling	20,000
Wickiup Reservoir	brown	legal	6,000
	coho	fingerling	100,000
Lava Lake	rainbow	fingerling	100,000
	brook	fingerling	25,000
Little Lava Lake	rainbow or brook	fingerling	10,000
Hosmer Lake	Atlantic salmon	legal	2,000
	brook	fingerling	5,000*
Elk Lake	brook	fingerling	20,000
Sparks Lake	brook	fingerling	30,000
Davis Lake	rainbow	fingerling	35,000

* Brook trout stocked every few years to maintain a small population of large size fish.

Numerous private ponds are stocked with a mixture of coldwater and warmwater species, some on an annual basis, some sporadically as requested by the landowner. Transporting fish from public waters or private hatcheries to private ponds requires a Department approved fish transport permit. Each permit is reviewed and approved, conditioned, or denied depending on species involved, extent and nature of receiving water, and access of fish to escape into public waters.

Angling Regulations

Angling regulations for waters in the Upper Deschutes River subbasin are designed to accomplish a number of objectives:

1. Protect spawning fish for natural production and to provide for egg collections.
2. Provide both consumptive and non-consumptive fisheries.
3. Provide a diversity of angling opportunities.
4. Conserve wild trout populations.
5. Provide bonus bag limits for abundant species.
6. Meet a growing angling demand while maintaining quality of fish.

Regulations in the basin have always been rather complex due to the variety of water types, fisheries, access conditions, fish species present, and management direction. Generally, standing waters are regulated with general statewide trout rules with the more restrictive 5 fish per day bag limit. Streams tend to have more restrictive regulations.

There are more fly angling only waters in this basin than anywhere else in Oregon. Presently, Hosmer Lake, Sparks Lake, Davis Lake, and Fall River are so designated. Hosmer Lake is the most regulated standing water with fly angling only, barbless hooks, catch and release for Atlantic salmon, 2 fish bag limit for brook trout, April through October season and no angling while motor in operation.

Currently, there are no standing waters in the basin open to angling the entire year. The only water open the entire year is the Deschutes River from Bend downstream to Lake Billy Chinook and this is also the only stream portion restricted to flies and lures only. In this reach of the Deschutes River, bull trout harvest is restricted to one fish per day, consistent with regulations in Lake Billy Chinook.

Bonus bag limits for kokanee are in effect for Suttle Lake, Elk Lake, and Wickiup Reservoir. In Crane Prairie Reservoir and Paulina Lake, kokanee are not as abundant and are regulated under the standard trout limit.

Closures to protect spawning fish are present on tributaries to Crane Prairie Reservoir, the Deschutes River between Wickiup Reservoir and Crane Prairie Dam, Browns Creek, Odell Creek, the Deschutes River below Wickiup Dam, Fall River below the Falls, and Spring River.

Fish Management

The first comprehensive physical and biological surveys of standing waters in the basin were conducted in 1940 by Oregon State Game Commission biologists. Prior to that time, fish stocking was the primary fish management activity. Following World War II, limited fish management on a few major lakes occurred until 1950 when the Central Region Office of the Oregon State Game Commission was established in Bend. Since 1950, waters of the basin have been managed by biologists in Bend and Klamath Falls.

Early fish management activities concentrated on control of "undesirable" fish populations, angler harvest and catch studies, monitoring of anadromous fish runs, stocking of waters, and biological and physical surveys. Most work centered on standing waters because they were most in abundance, generated the most fishing activity, and contained the populations of "undesirable" fish species.

Chemical control of "undesirable" fish populations has been a major component of fish management in the basin since the 1940's. Total chemical treatments were done on Big Lava Lake in 1941, 1946, 1949, 1963, and 1980. South Twin Lake was totally treated in 1941, 1957, 1965, 1972, and 1987. Davis Lake and its tributaries were chemically treated in 1961. Little Cultus Lake was treated once in 1949. Hosmer Lake was totally treated once in 1957. In addition to the total treatments, spot treatments of chub concentrations were conducted on Lava, Davis, East and Paulina lakes from the 1940's through the 1980's. The only stream treatment was Fall River in 1973 when all fish were chemically removed to eliminate the spread of two diseases, bacterial kidney disease, and infectious pancreatic necrosis virus.

Basic management strategies of trout and salmon in standing waters has changed little over the years. Most of the major waters are stocked with hatchery trout or salmon fingerlings or legal-size fish to either provide the entire fishery where natural production is absent or augment naturally producing populations. Fish populations are monitored annually, stocking allocations developed, and angler use and catch monitored. Fingerling trout are used in waters capable of growing a legal-size fish after one growing season. Legal-size trout are used in non-productive waters to provide "instant" fisheries, in small ponds close to urban areas to provide juvenile angling opportunities, or in intensively fished waters as augmentation of fingerling programs.

Management of high lakes in the basin began prior to 1920 with stocking of brook and rainbow trout. Almost all high lakes in the basin were historically fishless. Physical and biological high lake surveys began as early as 1932 and have continued to the present. Information gathered from surveys and angler reports was used to determine which lakes would support fish populations year after year without winter kills and appropriate stocking rates by species. Aerial stocking of the high lakes began in the 1950's using fixed-wing aircraft. In 1980, helicopters replaced fixed-wing aircraft increasing stocking accuracy and fish survival. There are over 400 high lakes in the basin, however, only 90 are stocked every two years. It would be desirable to stock each year to maintain a variety of fish size-classes, but that is precluded by a shortage of funding. Brook, rainbow, and cutthroat trout are used in the high lake management program to provide basic yield fisheries for wilderness and non-wilderness lakes.

Specialized or featured species fisheries have been in place in the basin since the 1950's. These fisheries are provided using unique species such as Atlantic salmon and lake trout, or using the piscivorous brown trout to generate fisheries for trophy-size fish. Kokanee in Paulina Lake are managed to provide larger-than-average size fish for the anglers as well as provide for annual egg collections.

Following the completion of Wickiup Dam and reservoir in 1947, studies began of fish populations and habitat impacts in the Deschutes River from Wickiup to Bend. Those studies continued through the 1970's. In the 1980's, emphasis shifted to habitat improvement, habitat restoration, and habitat protection.

Stream management has changed significantly in the last 20 years with implementation of the Wild Fish Management Policy. Most stocking has been eliminated because of wild trout concerns, lack of public access, habitat alterations, and poor return of these fish to the angler. Regulations have become more restrictive on streams to protect wild trout, protect spawning fish, accommodate increasing numbers of anglers, and protect fish during low water conditions.

In the 1990's, emphasis has been placed on learning more about wild inland rainbow "redband" trout distribution (primarily in streams), abundance, and genetic characteristics to meet compliance and implement the Wild Fish Policy (Table 3).

Table 3. Redband trout populations identified in the Upper Deschutes River subbasin and their compliance with Wild Fish Management Policy.

Location/Population	<10% Hatchery Spawners	>300 Spawners
Deschutes River above Lake Billy Chinook		
Squaw Creek	yes	yes
Tumalo Creek	yes	yes
Deschutes River to Steelhead Falls	yes	yes
Deschutes River to Big Falls	yes	yes
Deschutes River to Odin Falls	yes	no
Deschutes River to Cline Falls	yes	no
Deschutes River to Awbrey Falls	yes	no
Deschutes River to North Canal Dam	yes	yes
Deschutes River- North Canal Dam to Bend Hydro	yes	yes
Deschutes River- Bend Hydro to Colorado St. dam	yes	unknown
Deschutes River- Colorado St. Dam to Wickiup	yes	yes
Little Deschutes River	yes	unknown
Upper Little Deschutes River	yes	unknown
Crescent Creek	yes	unknown
Fall River	no	no
Deschutes River above Wickiup Reservoir	yes	no
Deschutes River above Crane Prairie Reservoir	no	yes
Little Cultus Lake	yes	unknown
Cultus Lake	unknown	unknown
Davis and Odell lakes Basin		
Odell Creek	unknown	no

Since the 1970's, fisheries management has changed rather dramatically from emphasizing direct fish population and angler management to emphasizing habitat protection and resource concerns arising out of a growing population, changes in social climate, heightened environmental awareness, and specialized interest groups.

Habitat and Habitat Limitations

Historical Habitat Conditions

The Upper Deschutes River subbasin has been a home to humans as well as diverse plant and animal life since prehistoric times. Evidence from nearby Newberry Crater indicates that humans inhabited the region at least 10,000 years ago as did mastodons, camels and other now extinct species. The myriad of volcanoes, cinder cones, and lava flows document the sometimes violent natural events the earliest people experienced. The geologic evolution of the region has been constant and rapid. Periods of mountain building and river moving volcanic activity have been interspersed with periods of erosion and sedimentation associated with glaciation and stream runoff. The combination of volcanic and glacial activity and the sedimentary deposits from both has created the largely spring fed drainage of the Upper Deschutes River subbasin.

The most significant natural determinant of the hydrological characteristics of the Upper Deschutes subbasin is groundwater inflow. The subsurface flows travel in large quantities and at relatively rapid rates. As a result, the Upper Deschutes River has relatively few tributaries. The headwaters of the Deschutes, Fall, and Spring rivers all originate from large springs. These large springs offer clear, cold, high quality waters which moderate winter temperatures in the Deschutes River and offer important spawning areas for brown trout.

Because the Upper Deschutes subbasin drainage is largely spring fed, it has a very stable natural hydrologic regime. In a 1914 U.S. Reclamation Service report describing the water resources of the Deschutes River, the authors reported: "The flow of the Deschutes River is one of the most uniform of all streams in the United States, not only from month to month, but also from year to year. The normal minimum flow during the irrigation season is between 1,500 and 1,600 cubic feet per second (cfs) at Bend. The extreme minimum is usually in midwinter when it occasionally drops, for a few days only, from 1,100 to 1,200 cfs."

The combination of hydrologic and geologic conditions established a diverse riverine habitat. Cold, clean water with limited fluctuation promoted a riparian habitat of rich streamside vegetation, providing food and shelter for insects, fish, and small mammals and birds. Larger mammals and birds also relied on the abundant food supply found in the river environment. (DNF 1995).

The historically stable flow regime, excellent water quality and lush riparian zone of the Upper Deschutes River supported extremely abundant trout populations. The following excerpts from the Deschutes County and City of Bend River Study (1986) describe the nature of the trout population and fishery which existed prior to extensive basin development.

In 1916, Warden W.O. Hadley, commenting on the quality of the Deschutes River fishery in an Oregon Sportsman article headed, "The Best Trout Stream in Oregon", stated that: "The Deschutes River, I think, is the best trout stream in Oregon. I will go further in my claims for this wonderful stream and its tributaries and say that if it is not already, it soon will be the best trout stream in the United States."

At the turn of the century, conditions were ideal for the redband trout, bull trout and whitefish. Until construction of Pelton Dam in the late 1950's, summer steelhead and spring chinook salmon migrated upstream into Squaw Creek and over Steelhead Falls. Big Falls, 4 miles further upstream, may have been a blockade to upstream movement. Early day settlers of Central Oregon took advantage of the excellent populations of redband trout and bull trout and spread widely the reputation of Deschutes River fishing. Frances Day Stearns, pioneer rancher recollecting her experience along the Deschutes River in Bend in 1887, recalled in 1939, " The Deschutes River was literally full of fish of all sizes. We could stand on the log and throw fish into the frying pan."

In a 1903 article entitled "The Lake Trout", Bend Bulletin editor Don P. Rea wrote, " At Pringle Falls, 30 miles south of Bend, is a natural fish trap. In July and August each year, the lake trout are in such a hurry to get up to their spawning grounds that they get into the trap at the falls, which many years ago the hand of man converted into an artificial one, in the night time, and the next morning they are dispatched with spears or clubs. These lake trout, or Dolly Varden, are very heavy, weighing from 5 to 20 pounds, and vary in length from 24 to 37 inches. At this time, the trap is surrounded by campers who make the most of their time by salting down barrel after barrel of the fish, the flesh of which is as highly esteemed as that of the steelhead salmon."

Fish fries or barbecues were popular activities for many years in Bend, Redmond, Laidlaw (Tumalo), Madras and Prineville. The fish fry was an integral and attractive part of early-day July 4th celebrations in Bend. One of the first, if not the first fish fry took place in Bend on July 4, 1906, when celebrants fed on about 3,400 trout caught on hook and line. N.P. Smith reported in 1953, " he remembered a Fourth of July [1906] celebration fish fry for which he and three other anglers took 3,125 trout from the Deschutes River in four days fishing."

The first major development affecting fish populations in the Upper Deschutes River basin was irrigation which started in Deschutes County along Squaw Creek near Sisters about 1869. Homesteading began in 1898 and irrigation was begun on a large scale in about 1900. Several irrigation companies were formed about this time, but most were short-lived and merged into larger companies which were taken over by landowners who formed irrigation districts (Deschutes County/City of Bend River Study 1986).

Three large storage reservoirs were constructed in the Upper Deschutes River subbasin by the Bureau of Reclamation beginning with Crane Prairie Reservoir and Crescent Lake in 1922, followed by Wickiup Reservoir in 1947. The purpose of the reservoirs was to store water during the non-irrigation season (winter) to supplement natural river flows during the summer.

A summary of storage and diversion facilities in the Upper Deschutes Basin is shown in Table 4.

Table 4. Storage and Diversion Facilities in the Upper Deschutes River subbasin

Name	River mile	Maximum storage/diversion	Irrigation district
Crane Prairie Reservoir	239.0	55,000 acre feet of storage	Lone Pine, Arnold, and Central Oregon Irrigation Districts
Wickiup Reservoir	227.0	200,000 acre feet of storage	North Unit Irrigation District
Crescent Lake	*	86,050 acre feet of storage	Tumalo Irrigation District
Arnold Canal	174.6	135 cfs	Arnold Irrigation District
Central Oregon Canal	171.0	650 cfs	Central Oregon Irrigation District
Crown Pacific	168.0	3 cfs consumptive, 15 cfs nonconsumptive	
PP&L Hydroelectric (Bend)	166.2	1,325 cfs	
Bend Feed Canal	165.8	150 cfs	Tumalo Irrigation District
North Unit Main Canal	164.8	1,100 cfs	North Unit Irrigation District
North Canal	164.8	600 cfs	COID and Lone Pine Irrigation Districts
Swalley Canal	164.8	120 cfs,	Swalley Irrigation District
PP&L Hydroelectric (Cline Falls)	145.0	90 cfs	
Tumalo Creek (City of Bend)	n/a	6 cfs winter, 21 cfs summer	
Tumalo Creek (Columbia Southern Canal)	n/a	164 cfs,	Tumalo Irrigation District
Tumalo Creek (Tumalo Feed Canal)	n/a	85 cfs	Tumalo Irrigation District
Squaw Creek Canal	n/a	135 cfs	Squaw Creek Irrigation District

Table 4. Continued.

* Located at head of Crescent Creek

Present Habitat Conditions and Causative Factors

Streams and Rivers

Streams and rivers of the Upper Deschutes River subbasin are generally either spring-fed with stable annual flow patterns or glacier and snowmelt systems with high spring runoff and low summer flow patterns. Some are a combination of both systems. Most of these streams once supported abundant aquatic life and indigenous fish populations. However, land and water management practices over the past 100 years have resulted in an overall decline in water quality and quantity, riparian condition, river channel morphology, and subsequent declines or extirpation of indigenous fish populations.

Of all the waters in the Upper Deschutes River subbasin, streams and rivers have suffered the most degradation from man's influence. Streams and rivers which have been the most degraded are the Deschutes River from Crane Prairie Dam to Lake Billy Chinook, the Little Deschutes River from the mouth of Crescent Creek to its confluence with the Deschutes River, Paulina Creek, Crescent Creek, Spring River, Tumalo Creek, and Squaw Creek. The degradation of these streams and rivers has limited fish management options and presented a challenge to create productive fisheries in altered habitats while conserving populations of indigenous fish species.

Good riparian habitat conditions result in cool water, and directly influence instream habitat by maintaining stable streambanks, good water quality, and late summer flows. Effects on fish habitat from loss of riparian vegetation include increased stream temperature, loss of cover, increased bank erosion, widening and shallowing of the stream channel, and reduction or loss of perennial flow. Degraded riparian zones are present on the Little Deschutes River, Lower Crescent Creek, Deschutes River from Wickiup Dam downstream to Benham Falls, Paulina Creek, Spring River, Tumalo Creek, and Squaw Creek.

Of the factors limiting fish production, the seasonally low water, or no water conditions in streams and rivers are probably the most significant factor in the Upper Deschutes River subbasin. Water quantity and quality problems, primarily flow reduction or loss, elevated water temperatures, sedimentation, and turbidity limit fish distribution and production. The amount of stream flow affects all fish life stages including spawning, incubation, rearing, and migration. Fish abundance is directly related to volume of water available in streams and rivers. Sedimentation and turbidity reduces spawning habitat, egg survival, and food production of insects and plankton. Sedimentation affects quality of fish habitat by increasing the amount of fine sediments which cause embeddedness of gravel and substrate. Embeddedness degrades spawning habitat by making gravel difficult to move, prevents adequate oxygenation of incubating eggs, and reduces cover for fry. Turbidity affects fish production by reducing production of aquatic insects and plankton, and foraging efficiency of fish. Streams and rivers in the basin affected by reduced flows are the Deschutes River from Wickiup Dam to Lake Billy Chinook, the Little Deschutes River below the mouth of Crescent Creek, Crescent Creek, Paulina Creek, Tumalo Creek and Squaw Creek.

High water temperatures caused by reduced stream flows results in stress or direct fish mortality of cold water species and aquatic invertebrates and increases competition from more temperature-tolerant nongame species such as suckers, chiselmouth, and squawfish. Optimal growing temperatures for most trout species are in the range of 55-65^{o}F. Temperatures during the irrigation season in the Deschutes River between the North Canal Dam at Bend and Lower Bridge near Terrebonne have been recorded as high as 80^{o}F, exceeding state water quality standards for the Deschutes Basin. Other basin streams which experience excessively high water temperatures are Tumalo Creek, Paulina Creek, Crescent Creek, and Squaw Creek.

The abundance and quality of large woody debris also affects aquatic food production, trout cover, migration, and streambank protection. Large woody material helps to form pools which provide trout rearing habitat, traps spawning gravel, provides a refuge for fish during high flows, provides cover from predators, stabilizes streambanks, and provides structure for aquatic insect production.

Large woody material has been removed from basin streams by a variety of man's activities including; log transport, artificial flow manipulation, logging of riparian timber (recruitment source), fires, and removal by private streamside landowners. Large woody material is severely lacking in the Deschutes River especially in the reach from Wickiup Dam downstream to Benham Falls. Other streams lacking large woody material are the Deschutes River above Crane Prairie Reservoir, the Little Deschutes River below Gilchrist, lower Crescent Creek, Fall River, Spring River, Tumalo Creek, and Squaw Creek below the town of Sisters.

For the most part, the best stream habitat remaining is in headwater portions of basin streams on Forest Service land where man's influence is most limited.

Land and Water Management Practices Affecting Streams and Rivers

The majority of water quantity and quality problems, including flow alteration, temperature and sedimentation, lack of cover, and physical alteration of stream channels result from nonpoint source pollution activities associated with land use practices. In the Upper Deschutes River subbasin, the land use practices most commonly responsible for degrading stream and river habitats were irrigation development, livestock grazing, timber harvest, private land development, and recreation.

In the basin, the single most degrading land use activity has been irrigation development which began almost 100 years ago. Irrigation diversions and irrigation storage reservoirs contribute to instream aquatic problems primarily by disrupting natural flow patterns.

In some basin streams such as Tumalo Creek and Squaw Creek, water rights for natural stream flow were over-appropriated resulting in dry stream reaches during the irrigation season. Crane Prairie, Wickiup and Crescent Lake dams forever changed the natural flow patterns of the Deschutes River, Little Deschutes River, and Crescent Creek. The winter flows of the Deschutes River from Crane Prairie Dam to Bend are unnaturally low because water is being stored and abnormally high from Bend to Lake Billy Chinook because no water is being diverted. During the irrigation season, the flow pattern is reversed with abnormally high flows above Bend and abnormally low flows below Bend. The same pattern is present on the Little Deschutes River and Crescent Creek.

During early development of irrigation in the basin, no provisions were included to protect minimum flows in streams or rivers for aquatic life. Prior to 1983, the only legally established minimum stream flow was 20 cfs in the Deschutes River below Wickiup Dam. In 1983, three instream water rights were certified by the Water Resources Department for Deschutes River from Wickiup Dam to Bend; 300 cfs from Wickiup Dam to the Little Deschutes River, 400 cfs from the Little Deschutes River to Spring River, and 660 cfs from Spring River to North Canal Dam at Bend.

Unscreened diversions can divert fish into irrigation systems where they become stranded and die. On the Upper Deschutes River, there are four main irrigation diversions diverting a total of 1,005 cfs without screens or equipped with ineffective louvers. There are two hydroelectric diversions (Bend Hydroelectric and Cline Falls) totaling 1,415 cfs without screening. There are no screens on Squaw or Tumalo creeks, or Little Deschutes River diversions. Crane Prairie Reservoir and Crescent Lake dam outlets are screened, but Wickiup Dam outlet is not.

Historically, livestock grazing in the riparian zones of basin streams was more widespread than today. As ranch properties along streams were sold and subdivided for residential development, livestock numbers declined. There are still portions of the Deschutes River, Little Deschutes River, Crescent Creek, and Squaw Creek which have not recovered from livestock grazing over 100 years ago. Excessive grazing removed riparian vegetation resulting in accelerated bank erosion, channel cutting, sedimentation, turbidity, and loss of cover.

Upstream fish passage was not provided on many man-made structures within the basin, thus limiting access to spawning areas by indigenous fish species and was largely responsible for extirpation of the bull trout. Facilities without upstream fish passage facilities are Crane Prairie and Wickiup reservoir dams, Crescent Lake dam, Colorado Street Bridge, Bend hydroelectric dam, and North Canal dam.

Fishways do exist on the Gilchrist Mill Pond dam (Little Deschutes River), Bend Feed Canal and (Tumalo Irrigation District). Natural falls are abundant on the mainstem Deschutes River and they were both passable and impassable. Fish ladders were built at Steelhead Falls, Big Falls, and Cline Falls, however they are not functional at the present time. Other natural falls passable at certain flows were Awbrey, Odin, Lava Island, Dillon, Benham, and Pringle falls. These barriers have isolated existing redband trout populations, creating small separate gene pools of fish.

Most of the forested lands in the basin have sustained some level of harvest and roading in the past 70 years. The overall impact on streams and rivers from timber harvest has been minimal with the exception of the early practice of transporting logs down the upper Deschutes River. Woody material, naturally recruited to the river or not, was routinely removed to facilitate log transportation. There was also harvest of timber along streams. Removal of streamside timber reduced future recruitment of new woody material, and coupled with fluctuating stream flows, allowed bank erosion to accelerate. The major impact from roading was at stream and river crossing where impassable culverts were often placed thus delaying or preventing upstream fish movement.

One of the most recent land use activities affecting stream and river habitats has been the subdividing and construction of homes, golf courses and resorts on private lands, primarily on the Deschutes, Little Deschutes, Spring and Fall rivers. This land use began to expand tremendously in the late 1970's and continues to the present. There are 1,242 private parcels on the Little Deschutes River, Deschutes River, and Spring River, of which, approximately half have been developed (James Lewis. Deschutes County Community Development. personal communication. 1995). Impacts from this type of land use on streams and rivers are: loss of riparian vegetation through land clearing, loss of streambank habitat, instream structure, and water surface area from construction of retaining walls and boat docks, and degradation of water quality from fertilizers, pesticides, and failed septic systems.

Impoundments

Reservoirs constructed to provide irrigation water in the basin have created artificial habitats for indigenous and introduced fish species. Habitat limitations for reservoir fisheries include seasonal water drawdown, elevated water temperatures, low minimum pool levels, loss of vegetation in drawdown zones, loss of fish holding structure, and inundation of stream spawning habitat.

Irrigation reservoirs such as Crane Prairie and Wickiup are drawn down during the irrigation season (April-October) and store water during the non-irrigation season. Drawdown limits natural production of warmwater species by dewatering nests and causing mortality of eggs and young. In extreme drawdown years, low pool levels limit survival of both cold and warmwater fish species by extreme water temperatures, low oxygen levels, reduced food supply, increased vulnerability to predation, angler harvest or limited access to spawning areas. Drawdown also limits the establishment of shoreline and riparian vegetation.

Impoundments have allowed illegally introduced nongame species such as tui chub and three-spine stickleback to expand their range and population size to compete effectively with preferred game fish species. On the positive side, construction of Crane Prairie, Wickiup and Crescent Lake reservoirs has provided large water areas and expanded fisheries to increase recreational opportunities in the basin. Species such as kokanee and coho salmon, brown trout and lake trout have proven to be successes in these reservoirs.

The only impoundment created by a hydroelectric facility in the basin is Mirror Pond on the Deschutes River within the City of Bend. Mirror Pond has become one of the primary attractions of Bend as a park for a variety of recreation and local events. However, this impoundment has created a settling basin for sediment being carried in the river and has been dredged on one occasion at a high cost both in dollars and environment disruption of the stream channel. A smaller impoundment created by the North Canal dam downstream of Mirror Pond has also created a settling basin for sediment and loss of the natural stream channel, but has not been dredged.

Natural Lakes

The basin is blessed with many natural lakes in public ownership. These natural lakes are in generally good condition in terms of fish habitat. The major impact has been recreational development such as campgrounds, resorts, and boat facilities. Some of the high mountain lakes, wilderness and non-wilderness, have suffered shoreline damage from overuse by livestock, campers, and vehicles.

Water levels in natural lakes within the basin generally fluctuate with annual precipitation patterns, but are more stable than impoundments. Some natural lakes such as Davis and Sparks lose tremendous amounts of water through shoreline basalt fissures and can be severely impacted during years of drought. One habitat deficiency common to natural Cascade lakes is lack of trout cover, primarily large woody material. The shallow, clear water lakes such as Sparks and Hosmer could support additional fish rearing with additional cover.

Water quality is generally very good in basin natural lakes, many of which are fed in part by springs. Natural lakes vary in productivity from oligotrophic to eutrophic. In 1994, elevated levels of mercury were discovered in East Lake trout. The mercury was coming from natural sources in the lake, presumably the hot springs. Mercury levels were high enough that the Oregon Health Department issued human consumption advisories for all fish in the lake. Brown trout, because of their piscivorous nature and longevity, were the highest risk in terms of consumption. Because of the mercury situation, the Department is exploring management options to maintain fishing opportunities at East Lake with limited fish consumption.

Habitat Protection

One aspect of habitat enhancement and restoration is to change or modify the land water management practices that have degraded riparian and fish habitat and protect remaining habitat for indigenous fish species. The Department has worked with public agencies and private landowners to improve existing practices through planning processes, and direct habitat improvement projects. Comments are made on federal land use issues through the National Environmental Policy Act process with the USFS, BLM, and Bureau of Reclamation; and on fish, water, riparian, and wetland issues with state agencies such as WRD, DEQ, DOF, DSL, and State Parks; and county and city land use issues with the Deschutes and Klamath County planning departments, city of Bend Planning Department, and Soil and Water Conservation Districts.

In addition, the Department coordinates with five Central Oregon Irrigation Districts on water withdrawal issues and management of irrigation reservoirs including Crescent Lake, Crane Prairie and Wickiup reservoirs. Occasionally, the Department is involved with violations of state regulations and provides inputs where losses or mitigation of fish populations or their habitat is concerned.

An active program is underway to adequately screen irrigation diversions to prevent fish loss in canal systems. Most mainstem Deschutes River diversions are large in size (120-1,325 cfs), so the cost of screening is very high and technically challenging. Several of the larger diversions were fitted with louver arrays in the 1960's, but have proven to be ineffective in diverting sufficient numbers of fish back to the river.

A major screen was installed in 1995 on the Central Oregon Irrigation District Canal and its efficiency is currently being evaluated. In addition, negotiations with Tumalo Irrigation District have been completed to screen all of their diversions in the Deschutes River and Tumalo Creek. A screen was installed on Indian Ford Creek (Squaw Creek tributary) in 1996, cost shared by the Department with a private landowner.

State legislation passed in 1987 mandated the development of instream water rights to provide for aquatic life, habitat and recreation, for present and future generations. Instream water rights applications were filed with the ODWR in 1990 and 1993 for 27 reaches on 22 streams within the basin (Table 5). These flow recommendations were developed using the Oregon Method from flow data collected in the late 1960's and early 1970's. Instream water rights could only be applied for where there was existing flow data on record from a recognized methodology. Recent legislation in 1995 dictated that WRD resolve all pending applications for water rights including ODFW instream water right applications by October 1996.

Table 5. Streams and rivers in the Upper Deschutes River subbasin (exclusive of the Metolius River Basin) with Instream Water Right applications on file with the Oregon Department of Water Resources.

Stream or river	Tributary of	Application date
Basin Creek	Hemlock Creek	04/05/93
Big Marsh Creek	Crescent Creek	10/11/90
Browns Creek	Deschutes River	04/05/93
Crescent Creek	L. Deschutes River	10/11/90
Cultus Creek	Deschutes River	04/05/93
Cultus River	Deschutes River	04/05/93
Deschutes River(3)	Columbia River	09/24/90, 10/11/90
Fall Creek	Sparks Lake	04/05/93
Fall River	Deschutes River	10/11/90
Goose Creek	Sparks Lake	04/05/93
Hemlock Creek	L. Deschutes River	04/05/93
Indian Ford Creek	Squaw Creek	10/11/90
L. Deschutes R.(3)	Deschutes River	10/11/90
Odell Creek	Davis Lake	09/24/90
Quinn Creek	Hosmer Lake	04/05/93
Snow Creek	Deschutes River	10/11/90
Soda Creek	Sparks Lake	04/05/93
Spring River	Deschutes River	04/05/93
Spruce Creek	Hemlock Creek	04/05/93
Squaw Creek (2)	Deschutes River	10/11/90
Three Creeks Creek	Snow Creek	04/05/93
Tumalo Creek	Deschutes River	10/11/90

Habitat Restoration

A second aspect of habitat restoration and enhancement has been to develop partnerships with other agencies, organizations, and private landowners to enhance fish habitat. In recent years, the primary vehicle to accomplish fish habitat restoration in the basin has been the Central Oregon Irrigation District Mitigation and Enhancement Program.

In 1987, the Central Oregon Irrigation District (COID) constructed a hydroelectric facility on the Deschutes River near river mile 171, upstream from Bend. The facility (known as the Central Oregon Siphon Power Project) was developed in conjunction with COID's existing siphon and canal diversion system. The project was licensed by the Federal Energy Regulatory Commission and further authorized by a Deschutes County Conditional Use Permit.

A condition of both the FERC license and conditional use permit is that COID will provide the Department (ODFW) with funds to develop and implement a fish and wildlife habitat mitigation and enhancement program for the Upper Deschutes River Basin. COID and the Department entered into an agreement which pays the Department from $45,000-$95,000 per year for 32 years plus initial start-up funding of $225,000.

Since the first project in 1989, the Department has used the COID funds in match with other contributors to complete 18 major fish habitat improvement projects in the basin costing $964,079. Contributors have included ODFW Restoration and Enhancement Program, Deschutes National Forest, Bend Metro Parks and Recreation, Fish America, Federation of Fly Fishers, Trout Unlimited, Oregon State Parks, Central Oregon Flyfishers, Sunriver Anglers, STEP, and Coors Pure Water 2000.

Projects have involved improvements such as; adding spawning gravel, placement of whole trees and root wads for trout cover in streams and reservoirs, placing boulders to create pools and anchor wood, and planting of willows in reservoir drawdown zones. In addition to the projects; stream surveys have been completed on 128 miles of streams and rivers in the basin, 10 different stream sites are being monitored for water temperatures, and all projects are being monitored for structural integrity and biological benefits.

Individual sections of the plan present management issues and concerns for a water or group of waters. Each section of the plan also includes habitat restoration and enhancement objectives that are management actions common to all alternatives presented.

DESCHUTES RIVER

Bend (North Canal Dam) to Lake Billy Chinook including the tributaries Tumalo and Squaw creeks

Overview

This portion of the Basin Plan includes the Deschutes River from the North Canal Dam (RM 164.8) near Bend to its confluence with Lake Billy Chinook (RM 120.0) and the two tributaries, Tumalo and Squaw creeks. The mainstem Deschutes and each tributary will be discussed separately under each heading.

In October 1988, 20 miles of the Deschutes River, from Odin Falls (RM 140) to the gauging station (RM 120) near Lake Billy Chinook was designated by the U.S. Congress as a National Wild and Scenic River and classified as a scenic river area. The Bureau of Land Management is responsible for administration of the classification and completed a management plan in December 1992.

In addition to the Federal Wild and Scenic designation, the Deschutes River from Sawyer Park (RM 164) in Bend to Tumalo State Park (RM 158) and Deschutes Market Road (RM 157) to Lake Billy Chinook (RM 120) was designated as a component of the Oregon State Scenic Waterway System in 1988. Oregon State Parks is responsible for administration of State Scenic Waterways and their management plan is included as an amendment to the BLM plan.

A portion of Squaw Creek, from the headwaters at Bend Glacier (RM 39.4) to the Three Sisters Wilderness boundary (RM 38.2), is designated as "Wild" under the Federal Wild and Scenic waterway designation. This "Wild" designation is the most restrictive classification in terms of access.

Location and Ownership

<u>Deschutes River</u>

Streambank ownership for the Deschutes River from North Canal Dam to Lake Billy Chinook is approximately 61% private, 34% federal, 3% state and 2% county. Public ownership is primarily a combination of BLM, USFS lands, and three state parks. Most of the public land is included in the Deschutes River Recreation Area within the Crooked River National Grasslands, administered by the Ochoco National Forest.

Public access is very limited in this section of the Deschutes River. The Department would like to coordinate with respective agencies and landowners to develop additional access. Deschutes County has been actively pursuing additional public access. However, the priority would be to maintain the remote, hike-in atmosphere that exists in certain sections from Cline Falls to Lake Billy Chinook. Public access is currently limited to sites such as state parks and county bridges and poorly identified conservation easements. Concerns are primarily for bank access because low summer flows, natural falls, absence of access points and the rough character of the stream channel itself severely restricts boating opportunities. However, with additional summer flow, this section could provide excellent technical whitewater boating opportunities. It is highly unlikely anglers would use boats in this section.

North Canal Dam is the upstream boundary of this river section. The dam creates the diversion for three canals operated by Swalley, Central Oregon and North Unit Irrigation districts.

Downstream of North Canal Dam, the river flows into a well-defined narrow canyon to Tumalo State Park. Ownership in the section is private except for Sawyer and Tumalo State Parks. Sawyer Park, a 40-acre day use area is used for picnicking, sightseeing and walking. Tumalo State Park, a 320-acre park, provides about 1 and 1/2 miles of river frontage and attracts visitors for hiking, nature study, fishing, wading, camping and picnicking. There are a few conservation easements in this section, but they are not well marked.

Below Tumalo State Park, the river canyon widens for approximately three miles and becomes more of a valley. Located in this area is the unincorporated town of Tumalo.

The next river section is mostly canyon and extends from Tumalo downstream to Lake Billy Chinook. Varying amounts of residential development occur in this section of the Deschutes River. The largest developments include Deschutes River Ranch, Eagle Crest, Lower Bridge and Crooked River Ranch.

The land from Deschutes Market Road near Tumalo (RM 157) to Cline Falls (RM 145) is privately owned with the exception a parcel of BLM land near Awbrey Falls (covering about two miles of riverfront). The Eagle Crest (RM 144) residential development overlooks the canyon rim on the west side of the river. The canyon widens out again at Cline Falls State Park (RM 145) where Highway 126 crosses the river. Cline Falls State Park is a 9-acre day use area used for picnicking and fishing. Peak use months at Cline Falls State Park are June through August with use in spring months primarily related to angling.

From Cline Falls to Lower Bridge (RM 135), there is little development within the canyon. About 70% of the river frontage is in private ownership. Public lands are limited to about three miles of riverfront. Trout fishing is the most popular recreational activity along with hunting and hiking (ODOT 1987).

The largest private land developments in this river section are located between Lower Bridge (RM 134) and Lake Billy Chinook (RM 120). At Lower Bridge, a historical open pit diatomaceous earth mine extends for 1/2 mile along the west bank of the river. This was a very active mine during the 1930's and 40's, but is not in operation today. Crooked River Ranch is an unincorporated residential development located on east bank rimrock plateaus between RM 130 and RM 122.

Tributaries

Tumalo Creek

Tumalo Creek originates on the northeast side of Tumalo Mountain and the east side of Broken Top mountain, approximately 20 miles west of Bend. It enters the Deschutes River at RM 160.2 just north of the City of Bend. Forest Road 4601 provides the primary public access with secondary access from FR 4603 and 4606. The mainstem of Tumalo Creek is approximately 16 miles long and four tributaries; North Fork, South Fork, Middle Fork and Bridge Creek contribute approximately 20 additional stream miles to the basin. Land ownership in the basin is approximately 67% federal (Forest Service), 24% private, 8% city (Bend), 1% county (Deschutes) and >1% state (Parks). Primary land uses in the basin are recreation, timber, farming, residential, mining, and water withdrawal.

Bridge Creek, a major tributary to Tumalo Creek, is a principal source of water for the City of Bend which maintains a diversion facility near RM 15 (Tumalo Creek). Approximately 2.6 miles of Tumalo Creek flows through Shevlin Park, owned and operated by Bend Metro Park and Recreation District. Tumalo Irrigation District diverts water from Tumalo Creek at the Tumalo Feed Canal (RM 2.5) and Columbia Southern Canal near RM 11.

Squaw Creek

Squaw Creek headwaters in the Bend Glacier of Broken Top mountain, then flows 39 miles in a northeasterly direction, through the City of Sisters and enters the Deschutes River at RM 123.1, approximately five miles downstream of Steelhead Falls. Park Creek, Soap Creek, Snow Creek, North Fork Squaw Creek and South Fork Squaw Creek are headwater tributaries to Squaw Creek originating from the Three Sisters Wilderness area. Elevations in the basin range from about 2,100 feet at the mouth to more than 9,000 feet on the three glacier covered peaks in the Three Sisters Wilderness.

The Squaw Creek basin encompasses approximately 150,000 acres. Land ownership is approximately 82% federal (Forest Service, BLM, Crooked River National Grassland), 17% private, and <1% state.

Squaw Creek is federally designated under the Omnibus Oregon Wild and Scenic Rivers Act of 1988. It is designated as Wild from its source, including tributaries, downstream to the boundary of the Three Sisters Wilderness, 27 stream miles. It is designated as Scenic from the Three Sisters Wilderness boundary downstream to the USGS gauging station, 800 feet upstream from the McAllister Ditch, 8.8 stream miles. The US Forest Service is responsible for management, but has not yet completed a Wild and Scenic Management Plan.

The downstream section of Squaw Creek remains quite natural except for limited livestock grazing. The lower seven miles are located within the BLM Steelhead Falls Wilderness study area.

Road access to the Squaw Creek basin upstream from Sisters is provided by the primary FR 16 and a number of secondary forest roads. Road access downstream of Sisters is restricted to a few private roads and FR 6360. Much of the stream from near Henkle Butte to the mouth flows in a canyon mostly inaccessible by road.

Habitat and Habitat Limitations

Deschutes River

Below Bend, the Deschutes River corridor changes dramatically in two ways: (1) spring and summer river flow is a small fraction of that found upstream of Bend due to water withdrawals for irrigation, and (2) the habitat type changes from forest to desert canyon reflecting a more arid, high desert climate.

The Deschutes at RM 160 near its junction with Tumalo Creek consists of a transition zone between the upper forested watershed and desert canyon, with juniper habitat and pine trees dominating the landscape. In this section, the river flows through a narrow canyon.

At RM 156 the river canyon narrows again as the river flows between basalt rimrock. This area is undeveloped except for stock trails.

From Lower Bridge (RM 134) to Lake Billy Chinook (RM 120), the river courses through a deep rimrock canyon until it reaches the slack water of Lake Billy Chinook. In many places the canyon wall's vertical distance from rim to water level exceeds 700 feet. Major features in this section include the river canyon and the Crooked River National Grasslands. Canyon width varies from a few hundred yards to a half-mile.

ODFW, through its Restoration and Enhancement Program, surveyed the river section from Steelhead Falls upstream to Bend in 1993. The survey was completed during the summer low flow period. Surveyors broke the river into 5 sections:

1. Steelhead Falls to Long Butte, 25 river miles.
2. Long Butte upstream 1.3 RM.
3. Section 2 upstream 1.3 RM to Tumalo.
4. Tumalo to upstream end of Tumalo State Park, 3.5 river miles.
5. Tumalo State Park to North Canal Dam, 5.8 river miles.

Section 1 was constrained by steep (80%) and moderate v-shaped hill slopes (15%). Average width of the active channel was 109 ft with a wetted width of 62 ft. The width to depth ratio averaged 67.4 through the section. Gradient through the section averaged 0.6%. Streambank stability is excellent and protected by non-erodible substrate and vegetation. Instream wood material is lacking to absent. Habitat area was 29% pool, 37% riffle, and 19% glide. Pools through the section averaged 8.6 feet in depth. Streambed substrate was classified as 28% cobble, 23% boulder, 18% bedrock, and gravel 16%. Sand and silt substrate made up the balance. Special cases through the section include Awbrey, Cline (24.6 ft), Steelhead (21.3 ft), and Big Falls (21 ft). An additional 24 step or falls were identified through the section.

Section 2 was broken out by increased valley width. The active channel in the section averaged 96 ft. with a wetted width averaging 47 ft. The width to depth ratio was 55.6. Gradient through the section averaged 0.5%. Streambank stability was excellent and provided almost solely by streambank vegetation. Wood material is lacking. Habitat distribution was classified as 61% riffle and 38% glide. No pool area was identified. Substrate was classified as 48% cobble, 24% gravel, 13% sand, and 11% boulder with silt and bedrock comprising the balance.

Section 3 is constrained by steep v-shaped hill slopes. No actively eroding areas were identified through the section with non-erodible streambank and vegetation providing the stability. The active channel width averaged 87 feet with a wetted surface width of 47 feet. Gradient through the section was 0.4%. Habitat distribution was 70% pool, 17% riffle, and 11% rapids. Substrate included 34% boulder, 28% cobble, 13% sand and 11% for each gravel and bedrock. Wood material contribution was insignificant through the section.

In section 4 the valley width increases with the river being constrained by terraces. The streambank along the entire section length was stabilized by vegetation. Average width of the active channel was 125 feet with an average wetted width and depth of 54 and 0.49 feet. The width to depth ratio was 69.7. Gradient for the section was 0.3%. Glide habitat comprised 49% of the total area with riffles 38% and pools 12%. Substrate was classified as 40% cobble, 28% gravel, 14% boulder, and 10% silt. Sand and bedrock made up the remaining substrate.

Section 5 was constrained primarily by steep v-shaped hill slopes. The active channel averaged 85 feet with an average wetted width of 47 feet. Depth averaged 3 feet. The width to depth ratio for the section was 47.5. Section gradient was 1.2. Streambanks through the section are stabilized by non-erodible substrate and vegetation. No eroding streambanks were identified. Habitat distribution included 32% pool, 22% glide, 25% riffle, with the balance composed of cascades, step/falls, and rapids. Substrate through the section was 34% boulder, 25% cobble, 15% bedrock, 14% gravel, 9% sand, and 4% silt.

Good spawning habitat in this section of the Deschutes is not abundant, however there is good spawning habitat in the Foley Waters area just upstream of Steelhead Falls. We do not have detailed observations on spawning fish. Spawning is most likely confined to small pockets of gravel in the mainstem, in the lower two miles of Squaw Creek and in Tumalo Creek. The potential for gravel addition and rearing habitat improvement is good particularly if summer flows can be increased. Carefully selected gravel placement throughout the mainstem should greatly increase available brown and rainbow spawning habitat. Improved summer flows would still be necessary to realize any benefit.

The Department has three principal biological concerns that affect fish management in this section of the Deschutes River. They include: (1) changes in flow regime (particularly low flows below Bend in the summer and corresponding warm water temperatures, (2) fish barriers, (3) unscreened diversions and resulting loss of fish.

Flow diversions and impoundments upstream of and in this section (Table 6) of river result in extreme low water conditions during the summer (Figure 1). Low flows occur from North Canal Dam near Bend to Lower Bridge during summer months and impact the river in a variety of ways including changes in insect and trout production and river temperatures. Flow extremes through this section of the river have been as high as 2,820 cfs (1964) to as little as 1 cfs (1930). The low reading was probably a result of a maintenance shutdown at one of the dams (Kyle Gorman. Oregon Department of Water Resources. personal communication. 1993). Flow recorded immediately downstream from Bend ranged from 22 cfs during irrigation season (April to October) to 804 cfs during non-irrigation season (November to March) during water year 1989 (USGS 1990). Irrigators release approximately 30 cfs below Bend during the irrigation season, but there is no legally established minimum flow for instream use in the Deschutes River below North Canal Dam. Low summer flows are supplemented by springs and Squaw Creek approximately 36 river miles downstream of Bend. Average summer flows in the Deschutes River are increased from 30 cfs to 550 cfs by supplementation (Figure 2) (Clark 1992).

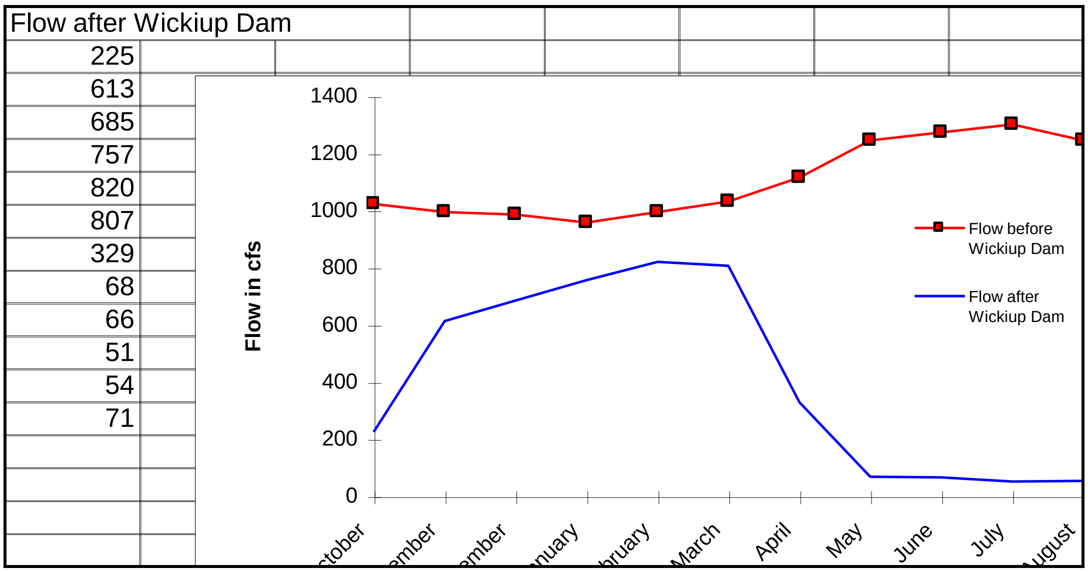


Figure 1. Average monthly flow in the Deschutes River below Bend (North Canal Dam) before (1925-1941) and after (1957-1987) construction of Wickiup Dam.

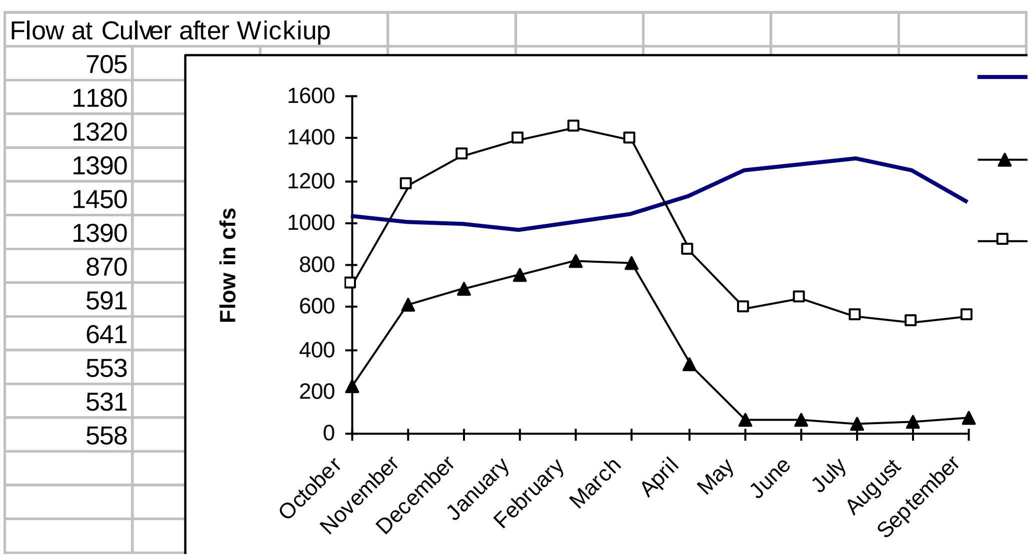


Figure 2. Comparison of average monthly flow in the Deschutes River below North Canal Dam in Bend and above Lake Billy Chinook (Culver) before and after construction of Wickiup Dam. Pre-Wickiup Dam data is not available for the Lake Billy Chinook site.

Table 6. Diversion facilities from river mile 166 to Lake Billy Chinook

Diversion	River mile	Maximum diversion (cfs)
Pacific Power - Bend Hydroelectric*	166.2	1,325
Bend Feed Canal (Tumalo ID)	165.8	150
North Unit Main Canal (North Unit ID)	164.8	1,100
North Canal (Central OR & Lone Pine ID)	164.8	600
Swalley Canal	164.8	120
Pacific Power - Hydroelectric (Cline Falls)*	145.0	90
Total		3,385

*Flow returned to the river

Flows as low as 30 cfs in hot summer months in the section from Bend (although flows to 1 cfs have been recorded) to Lower Bridge (RM 134) results in extremely high (highest recorded in 1994 was 81^{o}F) stream temperatures making the habitat less suitable for trout.

The Department has applied to the Oregon Water Resources Department for a minimum instream flow of 250 cfs year-round for fish and wildlife habitat. In addition, the Department applied to the Water Resources Department in 1992 for 200 cfs of Reserved Water for Instream Use under the authority of the 1921 Order by the State Water Board. This reserved water right has a 1913 priority date. To date, neither of the requested instream flow rights have been acted upon by the Water Resources Commission.

Fish barriers in this section of the Deschutes includes North Canal Dam, Awbrey Falls, Cline Falls, Odin Falls, Big Falls, and Steelhead Falls. A fish ladder at Steelhead Falls was purposely blocked in the late 1960's to keep nongame fish from migrating upstream. Cline Falls contains an old fish ladder that is likely not passable for upstream migrating trout. These barriers prevent resident fish upstream migration to spawning areas and genetic interchange of trout populations between barriers.

Currently, the North Unit Irrigation District's Main Canal is the one diversion screened for fish in this river section. The North Unit screen is equipped with a rotary drum system. Other main diversions have ineffective louvers or contain no screens at all, with resultant loss of fish from the Deschutes River into canals.

Unscreened or inadequately screened diversions include Cline Falls hydroelectric plant, Pacific Power hydroelectric (Bend), North Canal (COID and Lone Pine Irrigation District), and Swalley Canal.

Aquatic macroinvertebrate samples collected downstream of Bend at Tumalo State Park indicated moderate organic enrichment (by nutrients, sediment, dissolved oxygen, or thermal impacts). Sediment is the main factor as temperatures and dissolved oxygen are satisfactory in this area.

Macroinvertebrate abundance summaries showed that species feeding on fine organic particulate materials represented 95.1% of the total individuals sampled with midge larva representing 71%. Those species sensitive to changes in riparian condition were only represented by 1.6% of the total abundance. Pollution intolerant mayflies, stoneflies, and caddisflies represented 4.6% of the total abundance with no representation by pollution intolerant caddisflies. Only one group of macroinvertebrates that exhibited a life cycle of greater than 1 year (semivoltine) were identified and represented 2.3% of the abundance. This life history is more dependent on stable habitat conditions.

Tumalo Creek

The Tumalo Creek watershed encompasses approximately 47.3 square miles, (USFS 1989).

Historical discharge data was collected at a gauging station located at RM 3, just below Shevlin Park. That gauge is no longer used. Maximum discharge normally occurs during May and minimum discharge occurs during the winter. The mean flow of Tumalo Creek for the years 1936-86 was 102 cfs. The maximum flow recorded was 1,140 cfs on November 9, 1968 and the lowest recorded flow was 25 cfs on January 3, 1924.

Three water diversions exist on Tumalo Creek. Tumalo Feed Canal is located near RM 2.5 and diverts on average 60 cfs during the April to October irrigation season. Columbia Southern Canal is located at approximately RM 11.0 and diverts on average 40 cfs during the April to October irrigation season. Both of these diversions are operated by Tumalo Irrigation District which has water permits for up to 252 cfs (Figure 3). The Bend Aqueduct (water supply for the City of Bend) is located at approximately RM 15 and diverts an average 17 cfs year round. The City of Bend has permits for 6 cfs in the winter and up to 21 cfs in the summer. Return flow from the Bend Aqueduct averages 5 cfs from November to April and 3 cfs from May to October. Return flow re-enters Tumalo Creek near the upstream boundary of Shevlin Park.

Man-made barriers to upstream migrating trout exist on Tumalo Creek at Tumalo Feed Canal and Columbia Southern Canal diversion dams. Both of these diversions are unscreened, and it is unknown how many trout are lost annually. Tumalo Falls (RM 15.4) and an unnamed waterfall just downstream are complete natural barriers to upstream migrating trout.

Tumalo Creek becomes dry two and one-half miles upstream from its mouth during the irrigation season. The Department is currently working with Tumalo Irrigation District and the Oregon Department of Water Resources to obtain a minimum of 2 cfs in this stream and to screen all of Tumalo Irrigation District's diversions. In 1992, Tumalo Creek was allowed to run to the Deschutes for the first time in years when a 1.5 cfs water right was leased from Bend Parks and Metro District during a Deschutes County Drought Declaration. The Department paid for the lease. Local irrigation districts contributed another 1.0 cfs for a combined 2.5 cfs flow. This leased and donated flow is maintained today.

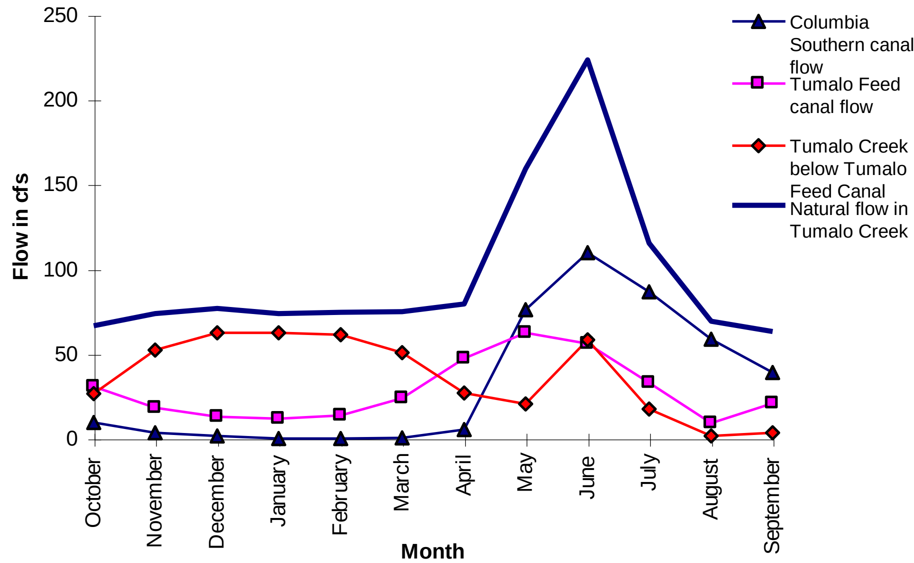


Figure 3. Average monthly flow in Columbia Southern Canal, Tumalo Feed Canal, Tumalo Creek below the Feed Canal, and the natural flow in Tumalo Creek, 1966-1987.

A habitat survey was done in 1992 on Tumalo Creek by Department personnel. The stream was surveyed from its confluence with the Deschutes River upstream to RM 13.7 at Skyliner Bridge. The total wetted surface area in the section surveyed was 49.3 acres. A total of 362 habitat units were surveyed. Habitat units averaged 200 feet in length with an average width of 26 feet. Riffles were the predominant habitat type (77.6%). Other habitat unit types include 10.0% cascades, 6.7% primary channel pools, 4.4% glides, 1.2% side channels and a few backwater pools. Substrate is 50% cobble, 13% gravel, 10% small boulder, 7% sand, 5% large boulder and 5% bedrock. The number of pools averaged 0.68 per mile and 1.9 feet deep. Large (>12 inches and 35 feet long) pieces of wood averaged 32 per mile and total wood pieces averaged 120 per mile. Surveyors noted a lack of wood between the two diversions. Effective trout cover in survey sections ranged from 6.9 to 27.9% of wetted area with substrate being dominant. Woody material was subdominant along with undercut banks and overhanging vegetation. The dominant riparian vegetation species were grasses, forbs, Douglas fir, dogwood, and alder. Subdominant riparian species were subalpine fir, alder, and dogwood. Other species noted were large ponderosa pine and aspen.

The remainder of Tumalo Creek (from FR 4601 to just below Tumalo Falls) was surveyed by Deschutes National Forest personnel in 1989.

The overall gradient for this section of Tumalo Creek was 2%. Riffle habitat accounted for 56% of the total habitat, followed in order by pools (16%), side channels (16%), and glides (10%). There were 6.0 pools per mile and they were generally 2.5 to 3.9 feet in depth. Glides were 16.5 to 30 inches deep, and riffles 14 to 30 inches deep. Depth in glides and riffles was often attributed to lateral bank scour and scour pools from woody material. Stream width averaged 22.9 feet. Tufted hairgrass was most abundant along with blue wild rye grass and Kentucky bluegrass. Alder was abundant along the stream banks. Ponderosa pine has been planted in the floodplain and lodgepole pine has naturally regenerated. Near the bridge at

Skyliner Lodge, Englemann spruce seedlings were planted on the stream banks. Manzanita, aspen and snowbrush were also present in the floodplain.

The dominant substrate type was cobble followed by gravel. Above the confluence of the South Fork, small boulders became an abundant substrate type. Embeddedness was scarce. Spawning gravel was good overall. The substrate had abundant algae which increased toward the upstream end of the survey section.

Trout cover was fair overall. Woody material was most prevalent followed by overhanging vegetation (alder). There were 5.0 pieces of large (>12 inches and 35 feet long) average per mile and 105 total pieces of wood per mile. Riffles and glides generally had poor cover, provided by woody material, overhanging vegetation and substrate. Cover in the pools was good, provided by woody material, turbulence, and overhanging vegetation. Side channels were very abundant and provide good rearing habitat. The channel becomes very braided in areas, partially due to large log jams which diverts the flow from the main channel. Several small springs entering the creek provided fair rearing habitat. Beaver ponds provided excellent rearing habitat and were being utilized by brook trout of all ages.

Macroinvertebrate samples collected at three sites along Tumalo Creek indicate slight to moderate enrichment. Dominant family groups found were the midges and small minnow mayflies (Baetidae). Species that fed on fine organic particulate material comprised 77.1% of the total abundance. Species that fed on periphyton represented 5.4% of the total abundance (much higher than the mainstem Deschutes River). These species decrease in relative abundance as sedimentation increases. Species of mayflies, stoneflies, and caddisflies that are intolerant to pollution represented 36% of the total abundance. Several species very intolerant to fine sediment were identified. Five groups of invertebrates were identified that had life histories greater than one year and represented 3.7% of the total abundance indicating fair to good system stability.

The water quality of Tumalo Creek is excellent and generally cold depending on flows and season. The USFS survey was done September 29, 1989 and recorded water temperatures of 42 to 48^{o}F in the upper stream section. The Department recorded water temperatures continually using Hobo recorders from April 5 to October 1, 1995. Temperatures were recorded at the mouth and the USGS gauge at Shevlin Park. The Tumalo Feed Canal diverts water between the two sites. Results and the effect on temperatures from the flow reduction are shown in Table 7.

Table 7. Minimum, maximum and mean water temperatures (^{o}F) recorded on Tumalo Creek at the mouth and Shevlin Park, April 5 to October 1, 1995.

Location	Minimum	Maximum	Mean
At mouth	32.2	73.0	51.1
Shevlin Park	33.4	64.2	47.3

In 1979, a fire burned a large section of the land upstream of the Skyliner Lodge area (RM 12 to the river’s headwaters) destroying three miles of the creek's riparian vegetation. Large, woody material was also removed from the stream during salvage logging. As a result, this three mile section was largely riffle with very few pools.

Habitat improvement to restore woody structure, reestablish pool habitat and stabilize stream channel was done in 1990. Phase I placed 85 trees within the burn area which created 101 structures. In 1992 Phase II was completed with an additional 100 structures built with trees brought in from outside the burn area. A helicopter was used to place the trees on Phase II to prevent damage to wetlands surrounding the project area. Funding and personnel were provided as a cooperative effort between state, federal and private organizations.

Squaw Creek

The first irrigation diversion in the Deschutes basin was established in Squaw Creek in 1871. In 1895, the Squaw Creek Irrigation Company (later the Squaw Creek Irrigation District) built a canal that dewatered Squaw Creek in the area near Sisters (Robert Main. Oregon Department of Water Resources. personal communication. 1991; Nehlsen 1995). By 1912, summer flow in the area of Squaw Creek near Sisters was entirely diverted for irrigation (Nehlsen 1995). Nielson (1950) (Nehlsen 1995) noted 10 dams and diversions on Squaw Creek above Sisters. During the summer the diversions took the entire stream flow, leaving a 3-mile section near Sisters completely dry. The dams all were barriers during low water, and none of the diversions were screened. Haas and Warren (1961); (Nehlsen 1995) identified four diversions above Sisters, each of which comprised a "serious barrier" and one "partial barrier" After 1961, water use permits totaled far more than the flows recorded at the time; new permits had been issued even though the creek had been dry through Sisters for many years, and new permits allowed additional major sections of the creek to become dewatered during the irrigation season (Mathisen 1985a; Nehlsen 1995). The average monthly flow in Squaw Creek is shown in Figure 4. The gauge site is upstream of all irrigation diversions.

The primary diversion is the Squaw Creek canal operated by the Squaw Creek Irrigation District. Its flow is monitored by a USGS gauge located within one quarter mile of the USGS gauge on Squaw Creek at RM 26.8. The average water withdrawn is approximately 135 cfs during the month of June. This average is not consistent every year. The average diverted flow of 135 cfs was only reached once since 1986 during the months of June and July and once in August since 1961 (Curtis 1994).

Studies indicate that canal seepage water loss in the upper Deschutes Basin canals range from 35-60% water loss. A conservative estimate for Squaw Creek canal would be 40% potential water loss (Curtis 1994).

Downstream of Sisters, the creek is augmented by springs and irrigation return flow. The creek continually picks up groundwater downstream from Sisters to Alder Springs (Robert Main. Oregon Department of Water Resources. personal communication. 1991).

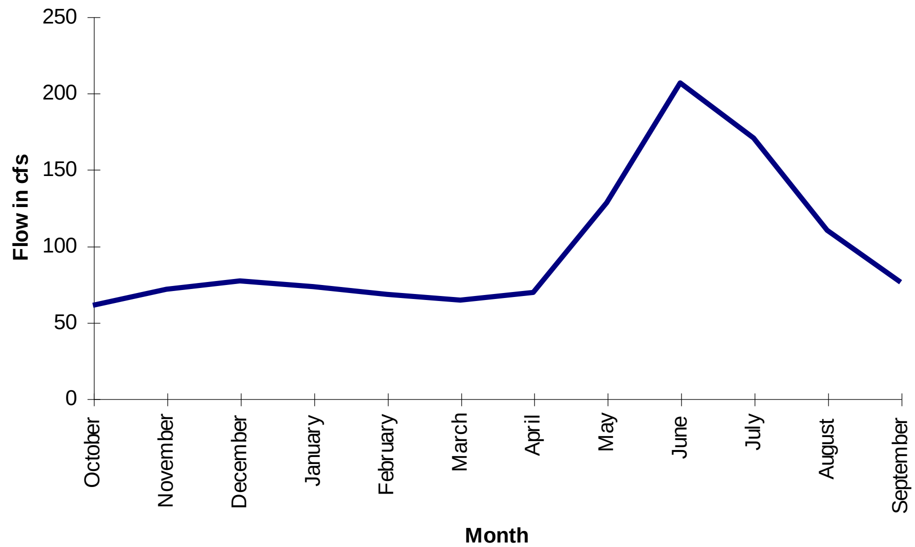


Figure 4. Average monthly flow in Squaw Creek, 1966-1994. This graph shows natural flow, the gauge station is upstream of all water diversions.

The State of Oregon Water Resources Department surveyed Squaw Creek water quantity from Sisters to the mouth during the 1993 low flow period. Their data indicated there is no water in the stream at Sisters. The water quantity increases to 6.61 cfs at Camp Polk road crossing. Squaw Creek maintains that amount of water varying between 7.46 cfs and 6.61 cfs until it reaches Alder Springs where it gained 74.5 cfs from that area to the mouth (1.5 miles) where it delivers 101 cfs into the Deschutes River (Curtis 1994).

The Sisters Ranger District conducted a stream survey of the upper 22.4 miles in August, 1991. Lower Squaw Creek was surveyed by Department personnel in 1995, but a summary of their findings is not yet available. Sisters Ranger District personnel prepared a Preliminary Fish and Watershed Assessment in 1995. Most of the following habitat information is taken from the above described Forest Service documents.

Flows are recorded at a USGS gauge 4 miles south of Sisters at RM 26.8. Squaw Creek flows have averaged 105 cfs for a 77-year period (1907-18, 1920, 1926-89). In 1989 Squaw Creek had a maximum flow of 369 cfs in June and a minimum of 22 cfs in February, measured upstream from Sisters. The highest flow recorded, since 1909, on Squaw Creek was 2,000 cfs on December 25, 1980. The fall is the time when rain-on-snow events may be more likely, with frozen or dry ground which may reduce infiltration. The flow of Squaw Creek also fluctuates diurnally as the snow and glacial melt changes with air temperature and sunlight exposure.

Since 1986, drought has affected the flow of Squaw Creek. The lowest daily average flow was 18 cfs on February, 17, 1993. The previous seven-day minimum flow was 21 cfs from January 7, 1937.

Carver Lake

In the last 50 years, at least three Cascade lakes have breached their moraine dams and flooded down White Branch, Soda and Squaw creeks drainages. During the flood in the Squaw Creek drainage in 1970, flows in excess of 10,000 cfs were released in upper North Fork Squaw Creek. By the time the flood reached the gauge 4 miles south of Sisters, the flood was reduced to 1,200 cfs and increased the stage by 2.5 feet (Laenen et al. 1992). Carver Lake has a similar risk of breaching the moraine, but has 5.7 times the volume of water. This lake is the water source of an unnamed tributary on the South Fork of Squaw Creek.

Carver Lake has a volume of 740 acre-feet and is located at the base of South Sister mountain. The moraine at risk was formed from the glacial retreat some time from 1925 through 1935. These high risk moraines are comprised of loose, highly erodible cindery sand, gravel or rock, and when saturated with water become very unstable. As the water moves down the drainage, the flood picks up additional rocks, gravel and wood and triples the volume. Some of the debris would fall out as the flood levels out and dissipates, but up to 1,000-2,000 acre-feet is estimated to reach the town of Sisters, with an estimated flow of 9,800 cfs. The 100-year flood event of 1964 was measured at 1,980 cfs.

The risk of Carver Lake failing has been estimated at 5% per year (Laenen et al., 1992). A flood of this magnitude could have devastating effects on the already unstable channel near Sisters and could affect houses and other developments. Several protection and warning measures were discussed, but sufficient funds were not found and the risk remains.

Stream Channel Conditions

In Squaw Creek upstream of Sisters, wood densities are moderate to high compared to many Cascade streams (Table 8). Removal of wood and channel straightening near Sisters after the 1964 flood lowered habitat quality. Log jams in wilderness streams were frequent in contrast to the section just south of Sisters.

The low bankfull width-to-depth ratio suggests a fairly stable flow regime and good streambank stability (Table 8). Sections of Squaw Creek that have high bankfull width-to-depth ratios are the upper sections where the stream is sheeting over broad outcroppings or where the stream is braided in low gradient areas. The lowest section has a high ratio possibly due to channel alterations and/or severe floods in 1964 and 1968.

Table 8. Habitat measurements from the stream surveys collected from 1990 to 1992. Information was collected according to USFS Region 6 protocol.

Stream Measure	Squaw Creek*	Pole Creek.	Snow Creek.	Park Creek
	1991	1990	1992	1991
Bankfull width to depth ratio	4-15	1-4	5-6	18
% side channels	1-9	<1	1	<1
% pools	3-20	5-23	4	<1
Logs per mile				
Large	16	11	25	19

Small	40	98	68	38
Brush	43	258	127	27
Total	99	366	220	86

* Squaw Creek upstream of Sisters

Alterations to Stream Channels

Pole Creek no longer flows directly into Squaw Creek through Pole Creek Swamp. Most of the flow is directed into the Pole Creek Ditch. One ditch diverts some hillside springs that originally flowed to Squaw Creek, but now flow to the Pole Creek Ditch. Wood is removed from Pole Creek regularly by the city of Sisters to prevent ice damming in winter.

Snow Creek was completely diverted to the Three Creeks drainage until the early to mid-1980's. The water right for that was lost after non-use. The water from Snow Creek now flows into Squaw Creek and is use to fill water rights in the Squaw Creek Irrigation District.

In an attempt to repair damage from the 1964 flood and reduce the future risk from flooding, the Army Corps of Engineers cleaned debris from the channel of Squaw Creek and straightened 11 miles of channel and repaired bridges. This straightening of the channel reduced the ability of the stream to spread out flood flows into side channels and the flood plain. Confining the channel had a destabilizing effect on the stream. For a mile of channel below Highway 20, the stream had increased in width by 150 feet. Debris torrents and large wood complexes were also removed which was detrimental to the natural function of the stream. Since that work, landowners along Squaw Creek have had a constant struggle to reduce severe bank erosion during high flow periods.

Water Quality

The Oregon Department of Environmental Quality rated Squaw Creek as severely impacted by turbidity, low dissolved oxygen, nutrients, streambank erosion, decreased stream flow, and insufficient stream structure. Most of these limiting factors can be linked to reduced flow from irrigation and domestic water use or channel alterations from the 1964 flood and subsequent channel modifications.

Turbidity may result from natural glacial runoff from the wilderness areas. Summer flows can suddenly become gray, brown or red. These sudden sediment pulses occur when features such as moraines slump or glacial streams change course, scouring new deposits. The effect of these fine sediment pulses on Squaw Creek have not been studied.

Water temperatures in the higher elevations of Squaw Creek are low due to snow and glacial melt. Tributaries such as Snow and Pole Creek originally cooled the stream. Pole Creek's role in cooling Squaw Creek has been reduced because of the diversion into Pole Creek Ditch. At the USGS gauging station 4 miles south of Sisters, without the influence of Pole Creek, water temperature in Squaw Creek ranged from 41 to 57^{o}F in June and July (USFS. 1995). However, below the diversions, water temperatures in Squaw Creek can rise to over 70^{o}F. In 1994, Department personnel placed a thermograph in Squaw Creek at RM 6.0, just above USFS road 6360. The unit operated from April 15 to October 1 and showed a mean temperature of 62.1^{o}F, a minimum temperature of 42.8^{o}F and a maximum temperature of 86.0^{o}F. The warmer water temperatures result in lower dissolved oxygen as the stream flows through the dry canyon section. Water quality improves when Alder Springs contributes cold spring water near the mouth.

Riparian Vegetation Condition

Squaw Creek has a broad riparian area in the lower section (downstream of Sisters) comprised of flood plains, willow stands, and cottonwood bottom lands. These riparian flood plains served as a dynamic system of gravel bar deposits and pool formation while floods covered the vulnerable areas. The stability of these flooded channels was dependent on the riparian vegetation. These bottomlands also may have been some of the most productive habitats for steelhead and salmon spawning and rearing. Alterations to these riparian communities from grazing and channelization has reduced the habitat quality, even for the native redband trout.

The most severe riparian condition is within the stream section south of Sisters where channelization work was conducted after the 1964 flood. The straightening and construction of levees removed the riparian vegetation, exposing loose gravel banks to higher gradient stream flows and subsequent erosion. With the risk of large floods on Squaw Creek, the condition of this section is of concern.

Dispersed camping and associated roads has increased along the riparian area of Squaw Creek especially in the area from Sisters south for 3 miles to Weir grade. Off-road recreational vehicle use has contributed to this riparian damage. Some camping and roading is concentrated near the FR 1514 crossing as well. These sites devegetate areas of streambank and create roads which tend to funnel runoff to the stream.

Habitat Limitations

Deschutes River

Habitat limitations in the Deschutes River from Bend to Lake Billy Chinook are:

1. All but 30 cfs of Deschutes River flow is diverted at Bend and reduces trout production area and the waters buffering affect against increases in water temperature.
2. Irrigation diversions at the upstream end of the section are not screened.
3. Natural and artificial passage barriers through the section limit upstream movement of fish.
4. Spawning habitat may not be present in quantities necessary to fully seed the river section.
5. Wide flow fluctuations occurring as a result of irrigation delivery act to redistribute fish on a semi-annual basis.

Tumalo Creek

Habitat limitations in Tumalo Creek are:

1. A large portion of the summer flow is diverted for irrigation thus reducing trout production and raising water temperatures in affected sections.
2. Cold water temperatures limit trout growth, especially in upper stream sections.
3. There is a general lack of pool habitat, especially in lower stream sections.
4. There are stream sections lacking in trout cover (primarily large wood) for rearing and feeding.
5. Irrigation diversions are unscreened.
6. The Tumalo Feed Canal dam is a partial barrier to upstream migrating trout and reduced flows during the irrigation season below the dam make passage difficult.
7. During severe winters, anchor ice forms resulting in stream bottom scouring as the ice breaks up and moves downstream.

Squaw Creek

Habitat limitations in Squaw Creek are:

1. Approximately 3 miles of Squaw Creek through Sisters has been dewatered during the summer months by irrigation withdrawals since 1912.
2. None of the irrigation diversions are screened.
3. Some stream sections, especially those four miles channelized following the 1964 flood, lack large wood for fish cover.
4. Some stream sections lack pool habitat, especially near Sisters and downstream.
5. Lower Squaw Creek Falls (RM 35) is a natural fish barrier.
6. Several Squaw Creek tributaries have been diverted and no longer connect with the main stream further reducing flows and adversely influencing water quality.
7. Water quality has been degraded by naturally occurring turbidity, low dissolved oxygen due to elevated water temperatures in dewatered sections, and streambank erosion.
8. Riparian vegetation was removed in the stream section channelized following the 1964 flood. Alterations to the riparian vegetation has reduced the habitat quality for trout.
9. Riparian vegetation has been damaged in the stream section south of Sisters by dispersed camping, roading and ORV use.

Fish Stocking History

Deschutes River

Fish stocking in the Deschutes River may have begun as early as 1911, but records are not clear. The earliest records confirming fish stocking were found for 1916 (Oregon Sportsmen, January 1916). Fish were stocked above Benham Falls, at Cline Falls, and Bend. They were brook trout, rainbow trout, and steelhead. The brook trout were of East Coast origin, but the source of the rainbow and steelhead is unknown. A few notes were found in the Oregon Sportsman and old hatchery records about fish being stocked "at Bend" from 1929-1935, but it is assumed this was in the area above North Canal Dam. These fish were rainbow and brook trout. Hatchery records revealed 20,000 rainbow were stocked at Tetherow Bridge and 40,000 at Tumalo between 1931-1935. The origin of the fish is unknown. Rainbow were stocked between Sheep Bridge and Twin Bridges in 1936, numbers and origin unknown.

More recent stocking records date to 1945, but it was not until 1954 that fish stocking in the middle and lower Deschutes River were listed separately by area. Rainbow trout, steelhead, and brown trout have been released in the Deschutes River from Bend to Lake Billy Chinook. These have all been legal-size fish except for one release of fingerling rainbow in 1955. Numbers released ranged from 7 fish (16" brown trout in 1956) to 43,042 rainbow trout in 1960.

This section of the Deschutes River is not stocked today. Stocking was terminated after a 1977 release of 1,004 legal-size rainbow trout. The fishery today is entirely supported by natural reproduction and emigration of trout from upstream areas.

Tumalo Creek

Tumalo Creek was first stocked in 1948 with 1,800 rainbow trout and 20,300 brook trout. The brook trout were of East Coast origin but the origin of the rainbow is unknown. It was stocked annually from 1949 through 1972 when stocking ended. All of the rainbow and brook trout have been legal-size except for 1948 and 1949 when fingerling brook trout were stocked. The fish stocked were either rainbow trout or brook trout and numbers varied from 502 to 50,800 fish. Tumalo Creek is not stocked today and the fishery is supported by natural reproduction.

Squaw Creek

Squaw Creek was first stocked in 1952 with 27,817 four to six inch steelhead. Hatchery records do not state the origin of the fish, but Nehlsen (1995) found the Oregon State Game Commission operated a trap (at Camp Polk, operated annually through 1956) for obtaining eggs from Squaw Creek steelhead. These fish were reared at Wizard Falls Fish Hatchery. Steelhead were also stocked in 1953, 1954, and 1955. Numbers ranged from 26,162 to 32,432 fish. They were released as 4-8 inch or 6-8 inch fish. Stocking was terminated after 1955. Eight-hundred fingerling brook trout were stocked one year in 1966. Although spring chinook salmon spawned in lower Squaw Creek, no records were found to indicate any eggs were collected or stocking occurred.

Angling Regulations

Deschutes River

There have been a variety of angling regulations for the Deschutes River between Bend and Lake Billy Chinook. ODFW records date back to 1938, but there were regulations prior to then. This section of the Deschutes (up to Big Falls) originally contained anadromous fish (steelhead and salmon), but they are not present today. Salmon and steelhead regulations were in force up to 1982 when they were listed as Not Present in the Oregon Sport Fishing Regulations. Listed below are the most significant changes:

1938- Trout: unlawful to fish from a boat downstream of Bend; open season April 15 -October 31, minimum size 6 inches, bag limit 15 lbs plus one fish, not to exceed 20 lbs in one day. Salmon and Steelhead: bag limit for fish greater than 20 inches of 3 per day, open entire year; bag limit for fish between 15 and 20 inches (jacks) 15 lbs plus one fish, open entire year.

1942- Deschutes River and tributaries from northern city limits of Bend downstream to mouth open April 18 - September 30. Separate regulations by species and length; game fish (includes trout, salmon and steelhead) not less than six inches in length-open season April 18 - October 31, bag limit 15 fish or 15 lbs plus one fish per day. Game fish (includes trout, salmon and steelhead) not less than ten inches in length- season and bag limit same as for game fish less than 6 inches, this bag limit counts with and part of bag limit for fish less than 6 inches. Salmon and steelhead not less than 15 inches in length- open entire year, from April 18 - October 31 bag limit is 15 fish or 15 lbs plus one fish, from November 1 - April 17, bag limit is 3 fish per day. Salmon and steelhead not less than 20 inches in length- open entire year, 3 fish per day.

1945- Game fish less than or equal to 6 inches- bag limit 15 fish not to exceed 15 lbs and 1 fish per day. Game fish less than or equal to 10 inches- open entire year, 3 fish per day. Jack salmon- first mention of jack salmon specifically, open entire year, no bag limit.

1946- Game fish less than 6 inches includes trout, grayling, whitefish, dolly varden, and salmon and steelhead less than 20 inches, jack salmon listed separately. Game fish greater than 20 inches includes trout, salmon, and steelhead.

1947- Salmon and steelhead greater or equal to 20 inches, bag limit 2 fish per day in aggregate.

1948- Trout bag limit 10 fish not to exceed 15 lbs plus one fish; 10 fish limit for jack salmon.

1949- Regulations divided by region instead of by county; trout bag limit includes jack salmon; salmon and steelhead bag limit of 2 fish per day in aggregate.

1950- Salmon and steelhead tag used for first time, 20 fish per year in aggregate.

1951- Of 10 fish trout and jack salmon bag limit, not more than 2 greater than 12 inches; Deschutes above Warm Springs closed from October 15 - April 27.

1956- Jack salmon have a separate bag limit of 10 per day from October 1 to November 15; Deschutes above Crooked River is closed for winter angling.

1959- Jack salmon included in trout bag limit.

1965- Bag limit for trout changed, limit for trout greater or equal to 20 inches is 2 per day.

1970- Deschutes below Bend (North Canal Dam) open entire year using summer trout regulations.

1971- Bag limit 10 fish per day, not more than 5 greater than 12 inches, not more than 2 fish greater or equal to 20 inches.

1975- North Canal Dam to Lower Bridge open all year, Lower Bridge to Lake Billy Chinook open April 26 - October 31.

1979- North Canal Dam to Lake Billy Chinook open all year.

1980- Open all year from North Canal Dam to Lower Bridge, from Lower Bridge to Lake Billy Chinook open April 26 - October 31; bag limit 5 trout per day.

1981- Open for salmon and steelhead from April 25 - October 31; not more than 2 trout over 20 inches.

1982- Salmon and steelhead listed as not present above Lake Billy Chinook.

1988- Bag limit 2 trout per day, 1 fish over 20 inches; Tumalo Creek bag limit lowered to 2 trout per day.

1992- From Lake Billy Chinook to North Canal Dam, 2 trout per day and only 1 over 20 inches including only 1 bull trout; angling with barbless lures and flies only; open year around.

Tumalo Creek

1988 Bag limit lowered to 2 trout per day. No gear restriction, general April - October trout season.

Prior to this change, Tumalo Creek followed the seasons, bag limits and gear restrictions for streams not listed in the Central Zone of the Angling Regulations.

Currently, Tumalo Creek is open during the April - October general trout season, two trout per day with a 6-inch minimum length. Open season for whitefish is the same and there is no size or bag limit.

Squaw Creek

The last spawning ground counts of salmon and steelhead in Squaw Creek were in 1965. Angling regulations were in place to protect spawning fish. Prior to 1952, there were season closures, generally October - April. From 1952-1968, Squaw Creek and tributaries were closed to all angling from the Camp Polk road bridge (near Sisters) to the mouth.

Following extirpation of the anadromous fish runs, the stream reverted to the general trout season regulations. The current regulation is the general trout season from April - October, six-inch minimum length, no more than 1 over 20 inches, and 5 trout per day.

Fish Management

Deschutes River

Historically, bull trout, redband rainbow trout, and whitefish were the indigenous resident fish in this section of the Deschutes River. Summer steelhead and spring chinook salmon were the indigenous anadromous species with no record of either species going upstream beyond Big Falls (RM 132.2), a natural barrier.

Steelhead could negotiate Steelhead Falls in high winter and early spring flows. After the ladder was constructed in 1922, fish could move upstream through the fish ladder for a period of years to some excellent gravel areas and cool spring-fed flows between Steelhead and Big Falls (Nehlsen 1995). Although fishways were constructed at Big Falls and Cline Falls in the 1920's, no steelhead were ever observed attempting to pass either falls (Mathisen 1985; Nehlsen 1995). As irrigation diversions reached their peak, river flows were good for migrating adult steelhead only during November - April. Summer and fall migrants may have been severely hampered in their attempts to move over these falls.

Spring chinook were found spawning in lower Squaw Creek, but none were observed spawning in the mainstem Deschutes above the mouth of Squaw Creek. However, in 1953, four spring chinook were trapped at Steelhead Falls (Montgomery 1953; Nehlsen 1995), indicating possible spawning. Chinook salmon adults and juveniles have periodically been found in recent years in the section below Steelhead Falls to Lake Billy Chinook. The origin of these chinook is unknown.

Although records are lacking, it is believed bull trout inhabited this entire section of the Deschutes River. It is reasonable that there were bull trout populations between the natural barriers. There were substantial bull trout populations upstream to provide stock for downstream areas. Bull trout have been subjected to serious habitat loss due to extreme fluctuation in streamflows associated with irrigation development in the subbasin. Bull trout were also subjected to water quality degradation, primarily increases in turbidity and fluctuation in water temperatures. They were also subjected to overfishing and competition from introduced brown trout. Today, they are extinct above Steelhead Falls. It is not known if the bull trout population in the Deschutes River below Steelhead Falls is a separate population from the Lake Billy Chinook/Metolius River bull trout population.

Wild fish species currently present in this section of the Deschutes River are redband rainbow trout, whitefish and bull trout (Steelhead Falls to Lake Billy Chinook). Introduced species include brown trout, tui chub, brown bullhead catfish, and three-spine stickleback. In addition, it is possible some juvenile coho and kokanee emigrating from Wickiup Reservoir may pass through this section during the irrigation season, however their survival may be very low due to high summer water temperatures and low flows below Bend. Kokanee migrate upstream in the fall from Lake Billy Chinook to spawn in the river up to Steelhead Falls and lower Squaw Creek.

Nongame fish in the river include chiselmouth and largescale suckers found upstream to Big Falls and Steelhead Falls, respectively. A spawning run of largescale suckers occurs annually up the Deschutes from Lake Billy Chinook. In the 1960's, brown bullhead catfish were abundant in this section of the river, especially from Bend to Lower Bridge, but they are rarely found today. The reason for their demise is unknown. The Department confirmed the presence of a spawning size smallmouth bass at the base of North Canal Dam in the late 1980's, but they also have not become established. Any fish species present in Lake Billy Chinook has unconstrained access to the Deschutes River up to Steelhead falls. Smallmouth bass have been observed in the Deschutes River between Steelhead Falls and Lake Billy Chinook.

Hot weather and low summer flows produce very warm water temperatures (temperatures of 80^{o}F have been recorded in the summer downstream to RM 132) which greatly reduces summer rearing area for trout during most years.

The warm water has nearly eliminated redband trout from RM 155 to RM 132 (approximately Tumalo to Lower Bridge). A large population of whitefish occurs throughout the section from Bend to Lake Billy Chinook. They are normally found in deep pools where cooler water exists.

An excellent brown trout population exists from Odin Falls to Big Falls despite reduced flows. Brown trout populations below Bend display better age class distribution, but individual fish are not as large as those seen upstream of Bend. The Department has not observed fish over 20 inches during inventory activities but anglers report taking a few fish that range up to 26 inches. The riparian zone is generally in excellent condition with bedrock, boulder, and cobble substrate providing a productive, stable habitat. Given the habitat, a slight increase in flow should greatly enhance trout production below Bend. Near Lower Bridge, a natural increase in flow occurs from spring inflow. This area produces excellent redband and brown trout populations.

The general current status of trout populations in this section of the Deschutes River is summarized in Table 9.

Table 9. Status of Deschutes River brown trout and redband trout from Bend to Lake Billy Chinook.

Section	River mile	Population status		Inventory method	Year
		Brown	Redband		
North Canal Dam to Twin Bridges	165-155	Low	Fair	raft electrofish	'91
Twin Bridges to Odin Falls	155-140	Fair	Low	raft electrofish, snorkeling	'89, '91
Odin Falls to Big Falls	140-132	Excellent	Low	raft electrofish, snorkeling	'89, '91
Big Falls to Lake Billy Chinook	132-120	Excellent	Excellent	snorkeling, volunteer creel	'89-'92

Criteria for "low, fair, and excellent" are population status defined by size and numbers of fish. Population data revealed a total of 532 brown trout per mile (excellent) from Odin to Big Falls (63% of fish less than 6 inches) and 115 brown trout per mile (fair) from Twin Bridges to Odin Falls (73% of fish less than 6 inches) with only 10 brown trout per mile (low) from North Canal Dam to Twin Bridges (all fish 6-12 inches).

Redband trout population data gathered in 1989 to 1991 by snorkeling and raft electrofishing surveys is shown in more detail in Table 10.

Table 10. Redband trout inventory from Bend to Lake Billy Chinook by snorkeling and electrofishing, 1989-91.

River section	River mile	Method	Survey miles	Number of fish	Fish per mile	Size range
Bend to Big Falls	167-132	Snorkeling and electrofishing	0.88	68	77.3	3-13"
Big Falls to Lake Billy Chinook	132-120	Snorkel	0.42	1261	3002.0	2-16"

A majority of the angling pressure takes place in areas with the best access including Tumalo State Park, Lower Bridge, Tetherow Bridge, Cline Falls State Park and the Steelhead Falls area. Fishing in these areas target brown trout, redband trout and whitefish. Trout fishing can be outstanding with the "Foley waters" and Steelhead Falls most notable (ODOT 1987).

There is no comprehensive creel census data available for the Deschutes River from Bend to Lake Billy Chinook. Hearsay reports from anglers, OSP reports and ODFW spot checks support our inventory as to species composition and distribution. From Bend to Big Falls, some good angling is reported, especially for brown trout. The brown trout are generally smaller (few fish >20 inches) than those in upstream sections. A general consensus is that fish populations have declined in this section in recent times.

A long term data set from a single group of anglers who fish the Big Falls to Lake Billy Chinook section indicates excellent and stable angling success. Angling pressure is not heavy in this section due to the steep and rugged river canyon. However, a recent opening day angler effort check (even though this section if open year round) recorded over 30 vehicles in the four mile stretch between Big Falls and Steelhead Falls. There is no boating access and only limited primitive camping and parking. An excellent salmon fly hatch occurs in this area in May and is eagerly awaited by fly anglers.

Tumalo Creek

Tumalo Creek is managed for naturally reproducing brook, redband, and brown trout. No hatchery fish are stocked.

The only fish species believed to be indigenous to the stream was the redband rainbow trout. There are no historical records of bull trout or whitefish inhabiting the stream. Tumalo Creek has a lack of deep pools which whitefish prefer and fluctuates greatly in its annual flow pattern. It is believed these habitat characteristics were not suitable for either whitefish or bull trout. Today, the stream is inhabited by redband trout and introduced brook and brown trout. No non-game fish species have been observed in the creek itself but three-spine sticklebacks are present in the off-channel fishing pond at Shevlin Park. This is a flow-through pond with water diverted from Tumalo Creek.

There are no current creel census data for Tumalo Creek, either random creel checks or statistically designed studies. We do know, because of its close proximity to Bend, it receives moderate use by juvenile anglers, especially in the Shevlin Park area. Anglers of all ages also utilize the upper sections of the stream where public access is available. Hearsay reports indicate fair to good fishing especially in the upper sections.

Brown, brook and redband trout all reproduce naturally in Tumalo Creek which has fairly abundant spawning gravel. Inventories have shown the species composition to be approximately 50% brook trout, 48% redband, and 2% brown trout. Figure 5 summarizes fish inventory by snorkeling and electrofishing in Tumalo Creek during the years 1990-95.

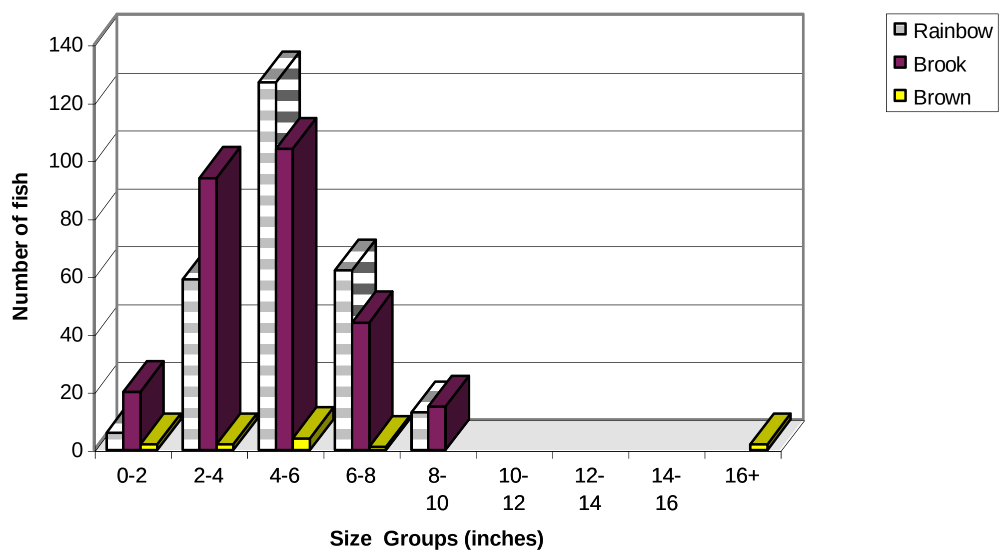


Figure 5. A summary of Tumalo Creek trout inventory by snorkeling and electrofishing showing number of fish by species in 2-inch size groups.

Cold water slows trout growth with 95% of all fish 8 inches or less in length. Large (greater than 16 inches) brown trout migrate from the Deschutes River in the fall to spawn in Tumalo Creek. Their numbers are probably limited by poor passage conditions at the Tumalo Feed Canal diversion dam. No spawning ground counts are done on Tumalo Creek.

Squaw Creek

Squaw Creek is managed for redband trout, whitefish, and introduced brown and brook trout.

Fish species indigenous to Squaw Creek were redband trout, summer steelhead, spring chinook salmon, whitefish, long-nose dace, bridgelip and largescale suckers, sculpin and probably bull trout in lower Squaw Creek. There are no historical records of bull trout in Squaw Creek, but fish inventories in 1991 and 1995 found bull trout in the lower section of Squaw Creek near Alder Springs. These were small adult bull trout which most likely migrated from the Deschutes River in search of spawning habitat or were following spawning kokanee from Lake Billy Chinook.

Fish species found now in Squaw Creek are redband trout, whitefish, introduced brown and brook trout, sculpin, dace, bridgelip and largescale suckers, bull trout (lower Squaw Creek) and spawning kokanee from Lake Billy Chinook. Smallmouth bass have access to Squaw Creek via the Deschutes River above Lake Billy Chinook, but have not been observed, probably because of the cool water temperatures at the mouth.

Anadromous Fish

Sockeye Salmon

Although sockeye salmon were indigenous to the Metolius basin, there are no records of their presence in Squaw Creek. Today, landlocked sockeye (kokanee) migrate from Lake Billy Chinook each fall to spawn in the river and the first two miles or so of Squaw Creek.

Summer Steelhead

In the 1950's, Oregon State Game Commission biologists started spawning ground counts in Squaw Creek. A weir was built near Camp Polk, about RM 16, to collect steelhead eggs for Wizard Falls Hatchery. Egg collections at the Camp Polk weir continued annually from 1951 through the 1956 spawning run. All spawning steelhead were found below the Camp Polk weir except for the first mile or so where chinook spawned.

In the 1950's, the number of steelhead counted in Squaw Creek (trapped at weir and found spawning below the weir) ranged from 62 to a high of 619 in 1953; counts dwindled to lower levels in the 1960's (Table 11) (Nehlsen 1994).

Table 11. Squaw Creek adult steelhead and redd counts, 1950-51 to 1964-1965 (King 1966; Nehlsen 1994).

Year (June - May)	Number of fish in Squaw Creek	Number of redds below Squaw Creek weir
1950 - 1951	39 *b*	23 *a*
1951 - 1952	294	167
1952 - 1953	227	392
1953 - 1954	122	158
1954 - 1955	113 *c,d*	321
1955 - 1956	252	215
1956 - 1957	129 *c*	57 *c*
1957 - 1958	353	229
1958 - 1959	116 *e*	60
1959 - 1960	101	13
1960 - 1961	97	25
1961 - 1962	16	46
1962 - 1963	21	63
1963 - 1964	15	84
1964 - 1965	2 *f*	8

a Includes all observed adults, both spawning and trapped, at the Squaw Creek weir. *b* Incomplete count. *c* Fish movement hindered by establishment of lower weir- 225 steelhead counted at lower weir. *d* Spawning survey was conducted too late for observation of maximum number of steelhead or redds. *e* Log jam near the mouth of Squaw Creek prevented upstream movement. *f* 103 steelhead transferred from Pelton to Wizard Falls, 47 of which were transferred April 27 to Squaw Creek unspawned. Spent fish were released in the Metolius River.

Several factors rendered the counts minimal, however, including problems keeping the weir functional, effects of the weir on upstream migrants, and poaching (King 1966; Nehlsen 1994). These counts were considered as index counts rather than as estimates of total abundance. Montgomery estimated that a minimum of 582 steelhead used Squaw Creek in 1952 (461 counted) and 1,000 spawned in Squaw Creek in 1953 (619 counted) (Montgomery 1952 and 1953; Nehlson 1994).

A 1964 stream survey revealed 90,815 square yards of good gravel and 100,169 square yards of marginal gravel potentially available for spawning steelhead from the mouth to RM 42 (King 1966; Nehlsen 1994). Applying a 10 percent factor to the 90,815 figure results in an estimated 9,000 fish that could potentially spawn in Squaw Creek if gravel were the only limiting factor (Nehlsen 1994).

Chinook

Oregon State Game Commission surveys found consistent numbers of spawning fish and redds in the lower few miles during the early 1950s (Table 12) (Nehlsen 1994). Counts of adult spring chinook and redds in Squaw Creek declined markedly, however, from 3 to 20 spawning fish or redds before 1956, to 0 to 4 fish and 0 to 2 redds from 1957 through 1960.

Table 12. Spring chinook spawning ground survey, Squaw Creek, 1951-60 (OSGC 1954 and 1961: Nehlsen 1994).

Year	Number of spawning fish	Number of redds
1951	14	16
1952	5	15
1953	3	14
1954	10	6
1955	11	6
1956	12	15
1957	0	0
1958	0	0
1959	4	2
1960	0	0

Oregon State Game Commission biologists (OSGC 1960; Nehlsen 1994) found available spawning gravel sufficient for over 13,000 spring chinook in lower Squaw Creek and over 1,000 spring chinook in the upper portion if gravel were the only limiting factor. However, flows in Squaw Creek are severely reduced during chinook spawning times.

Resident Trout

The historical status of trout populations in Squaw Creek is not well documented. Brook trout are an introduced species present in the upper part of the drainage and most likely found their way to Squaw Creek following early stocking of high lakes. There was only one record of brook trout being stocked and that was 800 fingerlings in 1966, stocking location unknown. Brown trout are also an introduced species and most likely migrated from the Deschutes River into lower Squaw Creek. Redband trout are indigenous to Squaw Creek, but their genetic history is not known. Summer steelhead were indigenous and hatchery steelhead were released into Squaw Creek on several occasions and some of the smolts could have residualized and interbred with redband trout. There are no records of any other hatchery rainbow releases.

The most recent trout inventory information was done in 1991 by ODFW personnel who snorkeled and electrofished three stream sections of Squaw Creek between Alder Springs and the mouth (Table 13). A total of 753 gamefish were classified of which redband trout comprised 75% followed by brown trout (19%), whitefish (5%) and kokanee (1%).

Table 13. Summary of gamefish survey information collected by electrofishing and snorkeling in Squaw Creek from Alder Springs to the mouth, ODFW 1991.

	Length frequency (inches)									
Species	2	3	4	5	6	7-9	9-12	12-16	>16	Total
Redband trout	151	79	38	105	85	51	34	22		565
Brown trout	1	95	30	1	2	1	2	9	1	142
Whitefish			1			8	26			35
Kokanee							11a			11
Total										753

a Kokanee were spawning adult fish migrating from Lake Billy Chinook

No fish population estimates were done during these surveys, however, in one survey section of 247 yards near Alder Springs, 463 redband and 117 brown trout were classified. This stream section has good flows, water temperatures and water quality and is an indicator of the potential of Squaw Creek to produce trout if suitable flows were returned to the dewatered sections.

Squaw Creek is lightly fished so there are no creel records. When anadromous fish were present, the stream was closed to angling to protect spawning fish. Public access is limited, but certainly there are good trout populations in the lower sections which offer angling opportunity.

Management Issues

Deschutes River

1. Withdrawal of water at North Canal Dam (Bend) during the irrigation season (April - October) severely reduces the trout production potential for approximately 35 river miles.
2. Bull trout were indigenous to the Deschutes River upstream of Steelhead Falls, but disappeared by the 1950's due to construction and operation of dams, irrigation withdrawals, lack of screening, overfishing, and lack of passage to spawning areas. The potential for a successful reintroduction has not been assessed.
3. Summer steelhead and spring chinook salmon runs were eliminated from the Deschutes system upstream of Lake Billy Chinook following completion of the reservoir in 1964. The potential for a successful reintroduction of anadromy in this section of the Deschutes River and tributaries has not been assessed.
4. Public access by foot or boat to this section of the Deschutes River is poor due to private ownership, flow regulation, and topography. Lack of public access reduces the future potential increase in angling opportunities even if the trout population could be increased by an improved flow regime.
5. Major irrigation diversions at Bend are either unscreened or are equipped with inefficient louvers. Thousands of trout are being lost annually. Many of these trout could emigrate and contribute to downstream fisheries.
6. Fish passage is needed over several man-made and natural barriers. This is a major consideration for the potential introduction of anadromy or bull trout.

Tumalo Creek

1. Withdrawal of water for irrigation limits the trout production potential in approximately 11 stream miles.
2. None of the Tumalo Creek irrigation diversions are screened to prevent loss of trout.
3. Upstream fish passage at diversion facilities is inadequate.
4. There is a lack of riparian vegetation in some stream sections and recovery is slow because of short growing seasons and extreme variations in flows. This lack of riparian vegetation reduces the insulation of the water from icing conditions, reduces input of terrestrial insects for fish food, causes bank instability and subsequent loss of trout rearing cover.

Squaw Creek

1. Overappropriation of water for irrigation has caused approximately 3 miles of Squaw Creek to be dry each year with reduced flows in remaining sections, thus limiting future potential trout and/or anadromous fish production.
2. Squaw Creek irrigation diversions are unscreened with unknown annual losses of resident trout.
3. Squaw Creek had historical runs of summer steelhead and spring chinook salmon. If adequate flows were provided, Squaw Creek still has suitable habitat for substantial anadromous fish production. The feasibility of a successful reintroduction of anadromy has not been fully assessed.

4. Overgrazing by livestock and channel straightening has removed considerable riparian vegetation from several sections of Squaw Creek. Wide variations in flow have compounded the bank instability problem resulting in a loss of fish habitat primarily pool habitat and instream structure.

MANAGEMENT DIRECTION

DESCHUTES RIVER AND TRIBUTARIES FROM BEND TO LAKE BILLY CHINOOK

POLICIES

Policy 1. Redband trout, bull trout and introduced brown trout shall be managed for natural production consistent with the Featured Species Management Alternative for trout (ODFW 1987). No hatchery trout shall be stocked in the Deschutes River from Bend to Lake Billy Chinook.

Policy 2. Mountain whitefish shall be managed for natural production consistent with the Wild Fish Management Alternative for trout (ODFW 1987).

Policy 3. Brook trout will be managed for natural production consistent with the Basic Yield Alternative for trout (ODFW 1987).

OBJECTIVES

Objective 1. Maintain genetic diversity, adaptiveness, and abundance of redband trout, bull trout, mountain whitefish, brown trout, and brook trout.

Assumptions and Rationale

1. Small numbers of redband and introduced brown trout exist in the section from Bend to Odin Falls; more abundant numbers exist in the section from Odin Falls to Lake Billy Chinook. The genetic characteristics and origin of these populations is unknown. Bull trout exist in the section between Steelhead Falls and Lake Billy Chinook.

2. Rainbow trout indigenous to the middle Deschutes River and tributaries have been identified as an inland redband trout and are listed as a sensitive species. Bull trout are also indigenous to this section of river and are listed as a sensitive species.

3. Electrophoretic and morphometric measurements will aid in determining the origin of the redband trout in this section of the Deschutes River. Samples have been collected in this section of the Deschutes River and results are pending.

4. Restrictive regulations and habitat restoration will be needed to protect stock fitness, life history characteristics, and population health of wild trout.

5. Monitoring the distribution and abundance of trout and whitefish will provide an indication of their health and adaptiveness.

6. Habitat effects due to flow alterations in the Deschutes River may be the most critical limiting factors in natural production of trout and whitefish in the section of river from Bend to Odin Falls.

7. Modification of the flow regime and improvement of habitat may be necessary to sustain healthy populations of trout and whitefish. This includes but is not limited to higher base flows, seasonal flow stabilization, screening of water intakes, and habitat restoration.

8. Awbrey, Odin, Big, and Steelhead Falls are complete barriers to upstream movement of fish. It is not known if the ladder at Cline Falls is successful at passing fish upstream. The irrigation diversion dams on Tumalo Creek block upstream passage of fish.

ACTIONS

Action 1.1 Establish baseline data sets on genetic characteristics of redband trout using biochemical (electrophoresis) and phenotypic parameters and compare to existing electrophoretic data from other areas in the Deschutes basin.

Action 1.2 Document and establish life histories and monitor population trends of trout and whitefish. Population trends will be determined by periodic creel surveys, snorkel surveys, electrofishing, and spawning ground surveys. Studies will be developed in cooperation with co-managers.

Action 1.4 Determine the need for and implement additional or modified angling regulations to protect populations of trout and whitefish by monitoring their production, harvest, and catch rate.

Action 1.5 Work to modify the flow regime in this section of river to improve habitat quality and quantity.

Action 1.6 Pursue retrofit of irrigation and hydropower diversions with appropriate fish passage and protection facilities to allow fish movement and reduce fish mortality.

Objective 2. Provide diverse angling opportunities for a fishery on redband trout, bull trout, mountain whitefish, brown trout, kokanee, and brook trout.

Assumptions and Rationale

1. A catch rate of approximately 1.0 trout or whitefish per hour provides an adequate fishery.

2. Under this alternative restrictive angling regulations may be necessary to provide a sustainable fishery on redband and bull trout due to their current population abundance.

3. Whitefish, brown trout, and brook trout are sufficiently abundant in this section of the Deschutes River and tributaries to sustain a recreational harvest

ACTIONS

Action 2.1 Conduct periodic inventories to assess size, growth, abundance, and condition of trout and whitefish to ensure that recreational fishery demands are met.

Action 2.2 Monitor angler effort and catch through creel surveys.

Action 2.3 Publicize information on the desirable attributes of whitefish and opportunities to fish for them.

Action 2.4   Based on inventories and creel surveys, determine the need for additional or modified angling regulations to achieve management objectives.

Objective 3. Provide a fishery for large bull trout from Steelhead Falls to Lake Billy Chinook.

Assumptions and Rationale

1. There is a self-sustaining population of bull trout in this section of the Deschutes River. The Deschutes River has historically produced large bull trout, and there is strong public interest in angling for these fish.

2. Special regulations are necessary to protect stock fitness, life history characteristics and general health of the populations.

3. Both fluvial and adfluvial populations of bull trout occur in the Deschutes basin. They spawn in tributaries and use the mainstem for rearing and as a migration corridor. A healthy population exists in Lake Billy Chinook which migrates up this section of the Deschutes River.

4. Abundance of adult bull trout necessary to meet this objective may be influenced by the fishery in Lake Billy Chinook.

5. Availability of bull trout larger than 24 inches in the Deschutes River is necessary to meet this objective. This minimum size is based on the necessity of allowing female bull trout to reach sexual maturity and spawn prior to harvest in the Lake Billy Chinook fishery in order to meet Objective 1 of this plan. In the Deschutes River system, most female bull trout mature for the first time at age 6 at approximately 24 inches in length.

ACTIONS

Action 3.1 Determine the need for additional or modified angling regulations in the Deschutes River and downstream in Lake Billy Chinook to protect populations of bull trout by monitoring the production, catch rate, harvest, and hooking mortality in Deschutes River and Lake Billy Chinook fisheries.

Action 3.2 Develop an information and education program to enhance angler awareness of the status and life history requirements of bull trout.

Action 3.3 Conduct periodic angler surveys to estimate catch rates and angler effort in order to monitor success of meeting this objective.

Action 3.4 Implement a cooperative enforcement and information and education program with OSP to ensure compliance with regulations.

Action 3.5 Post signs at popular fishing sites informing anglers of how to identify and correctly release bull trout.

Objective 4. Determine feasibility of restoring anadromous fish above Round Butte Dam into the river between Lake Billy Chinook and Steelhead Falls.

Assumptions and Rationale

1. Local stocks (Deschutes River) of spring chinook and summer steelhead would be suitable as parent stock.

2. Restoring these fish would improve the diversity of the fish community.

3. These fish may bring in new diseases.

4. Spring chinook and summer steelhead were historically distributed through this section of the Deschutes River.

5. Providing downstream fish passage through the Pelton-Round Butte Dam complex will be integral to restoration.

6. Restoration would be compatible with Wild and Scenic River designation.

7. The population may need to be started and maintained by hatchery methods if habitat constraints cannot be overcome which would conflict with alternatives specifying wild fish only. However, the ultimate objective would be to develop self-sustaining populations of anadromous fish.

ACTIONS

4.1 A feasibility study will be conducted to determine if it is possible to restore spring chinook and summer steelhead to this section of the Deschutes River.

Objective 5. Protect, enhance, and restore trout and whitefish habitat.

Assumptions and Rationale

1. Modification of the hydrology of the Deschutes River from Bend to Lake Billy Chinook has resulted in low summer flows in what was once a relatively stable river, causing loss of habitat (due to dewatering and high temperatures) which supported natural production of redband trout in significant numbers.

2. The tributaries of Squaw and Tumalo creeks are also affected by irrigation diversions which deplete summer flows and present passage problems that limit natural production of trout.

ACTIONS

Action 5.1 Develop strong partnerships with irrigation districts, irrigators and hydroelectric operators (through education and financial assistance where available) to improve water distribution and application techniques in an effort to use less water more efficiently in order to establish increased minimum flows necessary to maintain aquatic life and retrofit facilities to reduce fish mortality and provide passage.

Action 5.2 Add spawning size gravel at suitable locations in the Deschutes River and tributaries to optimize spawning potential.

Action 5.3 Add wood and/or rock structure to the Deschutes River and tributaries where appropriate to improve habitat productivity for adult and juvenile fish.

Action 5.4 Replant the riparian area with a variety of plant species to provide a source of large and small woody debris, bank stability, and shade.

Action 5.5 Seek opportunities such as water leases, water transfers, and off-stream storage or other conservation measures in order to improve instream flow for this section of the river.

Objective 6. Maintain and improve access.

Assumptions and Rationale

1. Access by foot is limited by the large amount of private land.

2. The low flows and steep gradient of the river are not conducive to safe boat angling opportunities.

3. Bank angling in most parts of this section of the Deschutes River is of a remote nature and it is desirable to maintain this type of seclusion for a quality angling experience.

ACTIONS

Action 6.1 Evaluate opportunities to develop access to private land.

Action 6.2 As opportunities become available, form partnerships with landowners or managers to provide foot access or purchase easements for foot access sites throughout this segment of the Deschutes River.

DESCHUTES RIVER

Wickiup Dam to Bend (North Canal Dam) including the tributaries Fall and Spring rivers

Overview

This portion of the plan includes the Deschutes River from Wickiup Dam (RM 227) downstream to Bend (North Canal Dam, RM 164.8), Fall River, and Spring River. The Little Deschutes River, a major tributary which enters at RM 193, is not included because of its' length and connection with other waters in the basin. The Little Deschutes River will be presented in a separate section of the plan.

In the Habitat and Fish Management sections of the following discussion, the Deschutes River will be divided into two sections; Wickiup Dam to Benham Falls (RM 181), and Benham Falls to Bend (North Canal Dam). The reason for this is based on stream morphology and changes in fish populations. Benham Falls is a high gradient natural cascade which separates the Deschutes River into two logical sections with low gradient above the falls and high gradient below. Similarly, fish population composition changes at Benham Falls with brown trout dominant above and rainbow trout dominant below.

The remaining sections; location and ownership, fish stocking history, angling regulations, management issues, summary of alternatives and alternatives will be presented as (1) Deschutes River, and (2) Tributaries.

In 1987, the State of Oregon passed legislation designating most of the Upper Deschutes River as a State Scenic Waterway. Much of this area was subsequently included in the federal Wild and Scenic River system. The sections included are from the Wickiup Dam stream gauge to General Patch Bridge; and Harper Bridge to the north boundary of the Deschutes National Forest.

In 1988 a statewide ballot measure was passed to include the section from Little Lava Lake to Crane Prairie and the section from the north boundary of the Forest to the Central Oregon Irrigation District diversion structure as part of the state Scenic Waterway program. These sections of the river are not within the federally designated Wild and Scenic River.

At the same time, an amendment to the Federal Wild and Scenic Rivers Act, known as the Omnibus Oregon Wild and Scenic River Act of 1988, included the Upper Deschutes River between Wickiup Dam and the Bend Urban Growth Boundary in that system.

Federally designated Wild and Scenic portions of the Deschutes in this segment include: Wickiup Dam to the north boundary of Sunriver (RM 226.7 to RM 186.2, recreational), north boundary of Sunriver to Lava Island Camp (RM 186.2 to RM 175, scenic), and Lava Island Camp to the Bend Urban Growth Boundary (RM 175 to RM 172, recreational). State Scenic Waterway designations for this section of the Deschutes River include; Wickiup stream gauge to General Patch Bridge (RM 226.6 to RM 199), and Harper Bridge to the Central Oregon Irrigation District diversion (RM 192.6 to RM 171). The USFS is in the process of writing the management plan for the federal Wild and Scenic segment of the river. It is likely the State of Oregon will defer to the federal plan for those State designated river sections.

Location and Ownership

Deschutes River

Streambank ownership for the Deschutes River from Wickiup Dam to Bend (North Canal Dam) is approximately 49% private, 45% federal (Forest Service), 6% state (State Parks), and <1% city (Bend).

A variety of river recreation sites and their proximity to US Highway 97 makes the section from Wickiup Dam to General Patch Bridge (RM 199) a popular recreation area. This upper portion of the river is paralleled on both sides by forest roads. Angler access in the section from Wickiup to the north boundary of LaPine State Park Recreation Area is considered good with a number of public access sites and campgrounds located near the river. They include; Pringle Falls, Bull Bend, Tetherow, Wyeth campgrounds, and Tenino boat launch. LaPine State Park is located just upstream of Fall River. There are two private residential developments located near Wickiup Dam and Pringle Falls.

Private lands adjacent to the Deschutes River between Wickiup Dam and Benham Falls in Deschutes county are intensively developed. South of Sunriver on the Deschutes River, Spring River and Little Deschutes, there are 1,242 private parcels, of which, approximately 50% have been developed (James Lewis. Deschutes County Community Development. personal communication. 1995).

Private land blocks public access at many points from Fall River to Harper Bridge. Two small Forest Service Campgrounds (Besson Camp and Big River) provide public access. The rest of the adjacent lands include the Sunriver area which is private, but accessible by the public. Many of the residences along the river have docks and boat angling is popular. Rental canoes are available at Sunriver.

Boat ramps are located at Tenino, Bull Bend, Wyeth, Tetherow, LaPine State Park, Sunriver Marina, Pringle Falls campground, Big River campground, Harper Bridge, Besson campground, and Benham Falls campground. Below Wickiup Dam, the river is popular for canoeing with most people portaging Pringle Falls and Tetherow log jam. Harper Bridge offers launching for small boats, but has limited parking. The section from Harper Bridge to Benham Falls sustains heavy recreation use.

Land ownership is primarily Deschutes National Forest upstream of LaPine State Park and private ownership downstream. The State Park consists of 2,050 acres of which 1,410 acres is undeveloped. Camping areas and other developments utilize 640 acres. The Deschutes and its tributary, Fall River, meander across the state administered park flowing generally south to north.

Downstream of the park, private lands line the east bank of the river for about 3.5 miles. Sunriver is an unincorporated destination resort area with approximately 1,600 year-round residents and up to 10,000 visitors from Memorial Day through Labor Day (Sunriver Chamber of Commerce 1995).

Private lands adjacent to the Deschutes between Benham Falls and Bend include land within and outside the Bend Urban Growth Boundary. The Urban Growth Boundary is approximately 2 miles outside present city limits. An additional 2 miles of private land outside of this boundary exists along the river. Forest Service recreational sites with public access are located at Meadow Camp (RM 173), Lava Island (RM 176), Aspen Camp (RM 176), Dillon Falls (RM 179), Slough Camp (RM 180), and Benham Falls (RM 181). These access points provide boat and bank angler access to short stretches of water between major falls and rapids.

Boats can be launched below Dillon Falls at Aspen Camp (RM 177). A two-mile whitewater run from Aspen Camp to Lava Island Falls is heavily used by kayakers and three commercial raft outfitters. From March to October there are approximately 42,378 boat-days per year occurring from Harper Bridge (RM 192) to Central Oregon irrigation diversion (RM 171) (ODWR 1991). At least eleven rafting outfitters operate out of Bend. Boating includes use of row boats, small powered fishing boats, canoes, kayaks, and rafts.

Bank angler access is good along the west bank, but lava flows and private lands along the lower four miles of the east bank limit access. Most flatwater boating occurs from Slough Camp to Dillon Falls. Recreation use besides fishing includes boating, hiking, camping, horseback riding, mountain biking, sightseeing, birdwatching, and picnicking (ODOT 1987).

<u>Tributaries</u>

Fall River is approximately 25 miles southwest of Bend. It enters the Deschutes River on the west bank at RM 205. Forest Road 42 provides the primary access. Forest Road 4360 and two private roads provide secondary access. Two gates were built by the Deschutes Mitigation and Enhancement Program in 1992 to limit access downstream of Fall River falls for resource protection. The stream is approximately 8.0 miles long and streambank ownership is approximately 59% federal (Forest Service), 38% private, and 3% state (State Parks). There is one campground near the headwaters and a guard station at the headwaters, both operated by the Forest Service.

The Department's Fall River hatchery is located on the stream at approximately RM 4.75. The hatchery has operated since the late 1920's and provides legal-size trout for Central and Eastern Oregon and fingerling trout for airstocking of the Cascade high lakes. The hatchery grounds also provide angler access to Fall River.

Spring River is approximately 18 miles southwest of Bend. Forest Road 40 provides primary access to the area along with several private roads. The stream is approximately 1 mile in length and enters the Deschutes River on the west bank at RM 191. Streambank ownership is approximately 20% federal (Forest Service) and 80% private. Public access is very limited, especially from the bank. Spring River is accessible by boat from the Deschutes River during favorable flow conditions.

Habitat and Habitat Limitations

Deschutes River-Wickiup Dam to Benham Falls

The Deschutes River from Wickiup Dam (RM 227) to Benham Falls (RM 181) is a low gradient (averages less than 1%), meandering stream, with the exception of Pringle Falls (RM 217).

The dominant riparian vegetation types include ponderosa and lodgepole pine forests, willow thickets, and sedge meadows. Sloughs and oxbows are found throughout this section. River substrate is generally silt, sand, and pumice with an underlayer of clay and siltstone. Alluvial gravel is found mixed with these substrates. In some riffle and higher water velocity areas, gravel is the dominant substrate.

Following construction of Crane Prairie (1922) and Wickiup (1942), major environmental changes took place in the Deschutes River. These reservoirs were constructed for the purpose of storing water during the non-irrigation season (October to March) for delivery to irrigation systems during the growing season (April to September). Today, six irrigation districts, serving 115,000 acres, withdraw water from the Deschutes River near Bend and deliver water as far as 50 miles north of the diversion points (USDA 1994). In the summer, irrigators supplement flows with stored waters for use on their crops. In years when winter snowpacks are light and summers drier than normal, natural flows are lower. Supplementation begins earlier resulting in reservoirs being drawn down to a very low level by the fall, creating extreme concerns for water supplies the ensuing year.

Reservoir management results in considerable stream flow fluctuations. Water storage during winter results in low winter flows, while releases for irrigation result in high summer flows which is opposite of the natural streamflow regime (Figure 6).

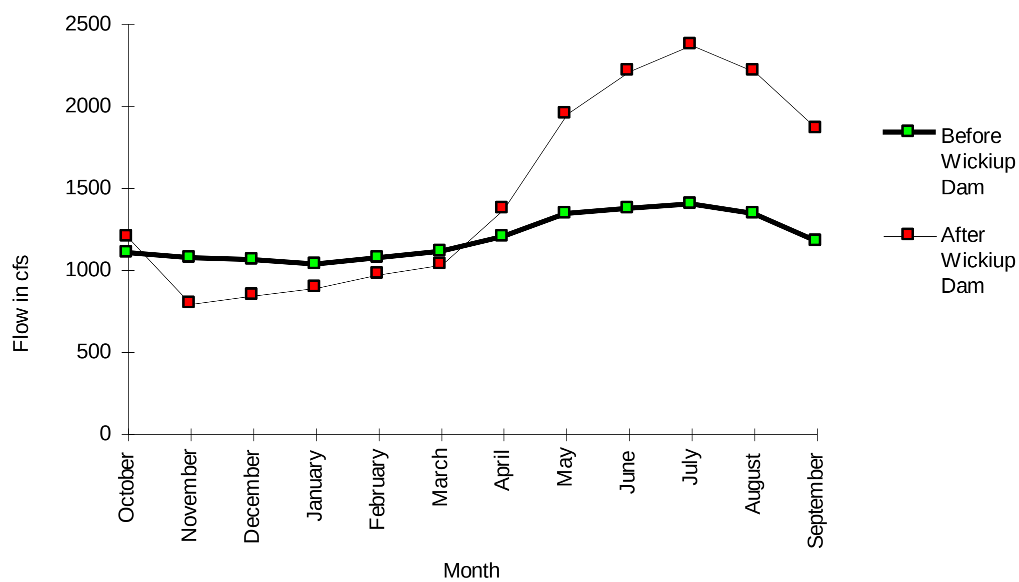


Figure 6. Average monthly flow (cfs) in the Deschutes River at Benham Falls before (1925-1941) and after (1944-1957) construction of Wickiup Dam.

The original flow regime in this section of the Deschutes River was remarkably stable before the dams. The calculated natural flow (median value) of the Deschutes River below the Wickiup Dam site is approximately 700 cfs with the flows rarely dipping below 500 cfs in the low flow months of winter and occasionally rising to approximately 1400 cfs during the peak runoff period in May or June (USDA 1994). Today, flows are subject to extreme variations ranging from less than 20 cfs in winter to over 2,000 cfs during high irrigation demand in summer months. For example, in 1989, flows ranged from a maximum of 1,760 cfs in July to a minimum of 17 cfs in October (USGS 1990). Low winter flows have a long-term impact on the aquatic environment and increase vulnerability of trout to predators. The recent winters of 1989 to 1993 have seen average flows of 20 cfs below Wickiup Dam.

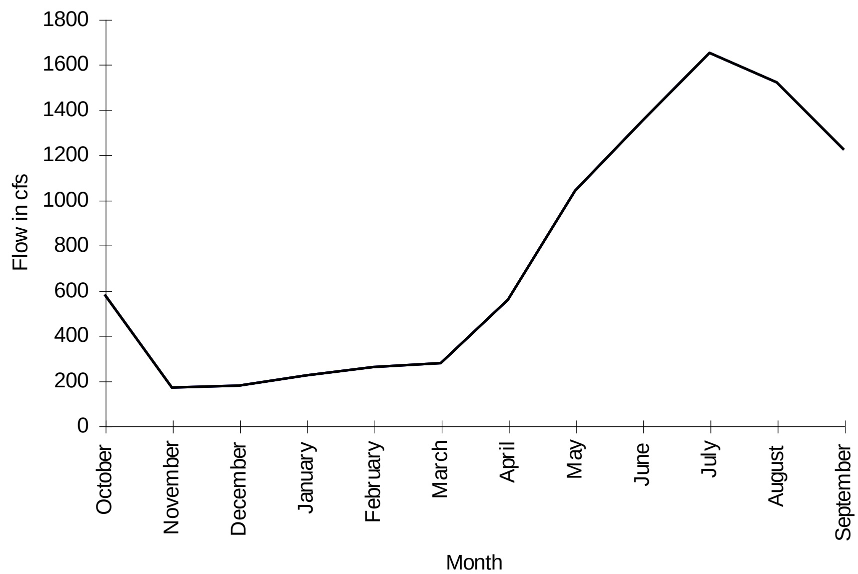


Figure 7. Average monthly flow in the Deschutes River below Wickiup Dam, 1943-1987.

The operational rules for Wickiup Reservoir include the provision for a minimum flow release of 20 cfs (Figure 7).

In the lower half of this section, flows are augmented by Fall River (RM 205), the Little Deschutes River (RM 193), and Spring River (RM 190). Fall River provides a relatively stable flow of about 115 cfs with the Little Deschutes and Spring rivers contributing at least another 200 cfs during the winter low flow period. Flow manipulations still result in extreme variation in water levels and flows in this downstream portion. For the years 1963-82, the maximum discharge was 2,591 cfs and the minimum 487 cfs (River Task Force 1986) at the Benham Falls gauge. The average discharge for a 70-year period (1907-13, 1925-87) has been 1,418 cfs (USGS 1990). The extreme variations in flow for this same period have been 5,000 cfs (estimated in 1909) and 363 cfs in 1962. However, tributary inflows and increasing water flow from the Little Deschutes River in late spring through the summer months creates less fluctuation between minimum and maximum water flows compared to the section above Fall River and historical flows below Fall River.

The aquatic environment in this section has been degraded due to extreme seasonal flow fluctuations caused by irrigation releases and storage in Crane Prairie and Wickiup reservoirs. Low winter flows impose the most serious limitations on fish production and their habitat. The limited spawning gravel along the stream margins is unavailable or barely usable by fall spawning fish such as brown trout and whitefish. Table 14 shows a 93% decrease in good gravels in the section from Wickiup Dam downstream to Pringle Falls (9.0 river miles) when flow was reduced to 37 cfs (Griggs 1972).

Table 14. A comparison of spawning gravel availability at low flow in the Deschutes River from Wickiup Dam to Pringle Falls, 1965 and 1966.

Flow (cfs)	Good spawning gravel (yds^2)	Marginal spawning gravel (yds^2)
unknown	2,890	2,180
37	208	162

Low flows result in poor survival of brown trout eggs through the sac fry stage. On the few occasions where redds have been excavated in Spring River (stable flows), the survival through the sac fry stage has averaged 90 percent; however, this has not been the case in the Deschutes River below Wickiup Dam. In 1970, success through the sac fry stage was 20 percent (Griggs 1972).

In 1983, the Department was issued three instream water right certificates by Oregon Water Resources for the Deschutes River from Wickiup Dam downstream to North Canal Dam. These rights are: 300 cfs from Wickiup Dam to the Little Deschutes River; 400 cfs from the Little Deschutes River to Spring River; and 660 cfs from Spring River to North Canal Dam. These instream water rights have a priority date of November 3, 1983 and are junior to existing water rights. These ODFW instream water rights are not being met on a year-round basis.

Large woody material is lacking in the Deschutes River between Wickiup Dam and Bend (Walker 1992). In the early years of this century, much of the large woody material between Wickiup and Bend was removed from the channel to facilitate the transportation of logs down the river (from Wickiup to 1/2 mile above Benham Falls) (USDA 1994). Wood was removed to minimize the formation of log jams. In 1939, an estimated 10-23 MMBF of logs were transported down the upper Deschutes River (USDA 1994). Large woody material helps prevent bank erosion by reducing water velocities and armoring the channel. Large woody material relocated to the river's margins during high irrigation flows is dewatered in winter, provides little cover for fish, and cannot interact with the aquatic environment.

As flows are severely reduced below Wickiup Dam in early October, small fish as well as aquatic invertebrates are stranded in pools and side channels where they soon perish. Aquatic invertebrates are important fish food items and it takes time to recolonize once their habitat has been dewatered. Populations of all aquatic organisms are forced to exist in restricted habitats only a fraction of their historical size.

Low winter flows and freezing weather result in extremely cold water temperatures with the river occasionally freezing solid in the lowest flow section between Wickiup Dam and Fall River. Obviously, freezing eliminates habitat for all fish and aquatic invertebrates. Eggs deposited in redds by fall spawning fish, such as brown trout, can be lost during severe ice conditions. In severe winters, trout survival is dependent on a small number of deeper pools.

Low winter flows expose much of the streambank to "frost heave" with loosened soil washing downstream when flows are increased in the river during the beginning of irrigation season in April. At a flow of 30 cfs, about 50% of the stream channel is exposed to frost action cycles (USDA 1994). When the river is at the minimum flow of 20 cfs below Wickiup Dam, even more of the channel is exposed.

Nearly 15% of the channel banks of the Deschutes River between Benham Falls and Wickiup Dam are bare and badly eroding (Century Testing Laboratories Incorporated 1978). Bank erosion, averaging 0.2 to 0.4 feet per year, appears to have started subsequent to the operation of Wickiup Dam and may have resulted from changes in the timing of high and low stages. Most of the eroded material is fine grained (less than 2 millimeters) (Cameron and Major 1986). A comparison of 1943 and 1991 photographs reveals that the Deschutes River between Wickiup Dam and Benham Falls widened an average of 20% during this 48-year period (USDA 1994).

A large "slug" of suspended sediment reaches General Patch Bridge (RM 199) in the spring that is at least 10 times background levels measured at Wickiup Dam. This "slug" indicates that as much as 1.7 times the sediment is transported as flows are increased to around 500 cfs at the beginning of the irrigation season than during peak summer flows despite the 70 to 90% lower velocity of the earlier flow (USDA 1994).

A river-study workshop identified high river flows as the cause of excessive turbidity, sedimentation, and bank erosion (Deschutes County River Task Force Committee 1986). This has reduced the quality of mainstem spawning gravels which has decreased brown trout production. On the other hand, brown trout egg survival in Fall and Spring rivers has been better due to higher quality natural gravels, spawning habitat improvement projects, and stable flows. Although the substrate composition of Fall River, Spring River and the Deschutes River is similar, Fall and Spring River experience a lower rate of sedimentation which corresponds to higher trout spawning success.

From spring until midsummer, water quality is very good as it leaves Wickiup Reservoir, but deteriorates rapidly in the first few miles below the dam. Turbidity level, a measure of water clarity, is increased as much as 30-fold when irrigation water is released in early spring (Forest Service Turbidity Monitoring Study, 1991-93 data). As the summer progresses, the turbidity decreases, but remains elevated to nearly twice the background level until late July.

While reservoirs can decrease turbidity by trapping sediment, the Upper Deschutes River reservoirs contribute to mid-and late-season turbidity by enhancing primary productivity. As a result of the sunlight that reaches the unshaded waters of the reservoirs and warming of the still waters, primary productivity (the growth of microorganisms) flourishes. The millions of organisms cloud the water in what is frequently called "algae blooms". In mid-summer these clouds of organisms begin to appear in the river and become the dominant determinant of turbidity. As a result of erosion and primary productivity, turbidity levels do not meet the Oregon water quality standard which defines a water quality violation for turbidity as an increase in excess of 10% over background levels.

There is a concern that existing and future development on the platted lots near the river may eventually lead to pollution problems in the river. Due to the high water table and permeable soils, this potential for contamination of waters by septic systems is high (USDA 1994).

High levels of turbidity can have adverse effects on aquatic invertebrates and newly emerged trout fry by interfering with their food supply and ability to feed efficiently. Gravel containing trout eggs may become plugged with sediment, suffocating the eggs or forming a sediment cap over the redds not allowing fry to emerge. Adult fish can receive gill tissue damage from excessive turbidity for prolonged periods (5-10 days) (EPA CCS 1990).

The constant erosion and water fluctuation creates a "drawdown" zone in the river channel where riparian vegetation is absent. From Wickiup Reservoir to Fall River, the drawdown area occurs between flows of about 30 and 1,000 cfs (USDA 1994). The riparian area is a key habitat for survival of trout, especially juveniles. Inundation of riparian vegetation during the growing season is the primary limiting factor for plant growth.

Natural recruitment of spawning gravel from upstream sources was eliminated by the construction of Wickiup and Crane Prairie dams. Original gravels have been moved downstream by excessively high flows or deposited along stream margins which are dewatered during the fall spawning period. The primary source of alluvial gravels are the streambanks.

Summer water temperatures are suitable for trout in this section of the Deschutes River because irrigation water is released from the cool water layer near the bottom of Wickiup Reservoir. From April through December, 1990, the high temperature was 66.7^{o}F and the low temperature 31.3^{o}F at the Bend Hydroelectric Project (BHPWQS 1991).

In winter, large brown trout are concentrated in a few pools with limited instream cover which increases their vulnerability to predation, harassment, and excessive harvest (legal and illegal) by man.

Small fish typically overwinter in concentrations of woody instream structure or in the interspaces of basalt substrate. Basalt substrate is naturally limited in this section of the Deschutes and low flows further reduce its availability for fish, similar to the dewatering of woody material. In addition, sediment has filled in some of the interspaces of the basalt.

Juvenile trout probably experience high predation rates in areas where basalt is absent and fish are forced to concentrate in pools with adult fish.

The Deschutes River from Fall River to Benham Falls has better fish habitat than upstream sections primarily because of less fluctuation in flows. Tributaries provide spawning grounds and lava (basalt) formations provide winter habitat for juvenile trout. Basalt formations which form the streambank in portions of this section are not subjected to annual frost heave and subsequent erosion. Interspaces in the basalt provide protection for juvenile trout.

Riverbank homeowners have employed a wide variety of measures to protect their banks from erosion. Concrete and plank bulkheads are most commonly used and do a reasonable job of stopping bank loss. However, improperly designed and constructed bulkheads fail after a few years leading to costly repairs. These retaining walls may be inherently faulty because of piping effect and frost action on the grout of masonry walls. In addition, boat docks and boat slips are common. All of these structures have resulted in a net loss of riparian fish, wildlife, and aquatic invertebrate habitat. In other cases, loosely placed large, rock riprap has provided ideal juvenile fish habitat.

Despite intensive residential development, no adverse effects on water quality for fish have been noted to date (Tom Hall. Oregon Department of Environmental Quality. personal communication. June 1992).

Aquatic macroinvertebrate samples collected at three sites from Bend at the COID Diversion area upstream to Wickiup Reservoir Dam indicated moderate organic enrichment (by nutrients, sediment, dissolved oxygen, or thermal impacts) with one sample indicating organically polluted. These designations were attributable to high sediment loads throughout the section. Abundance summaries showed only that species sensitive to changes in riparian condition represented between 0.6 and 1.5% of the total abundance. Species that fed on fine particulate organic matter represented 83.5 to 98.2% of the total abundance and were dominated by members of the black fly, midge, and tubifex worm families. Species of mayfly, stonefly, or caddisfly that are pollution intolerant represented 13.3% of the total abundance. Species that exhibited life cycles greater than 1 year were few and ranged from 0 to 3 taxa (groups) per sample.

In general, species requiring more than one year to complete a life cycle are more dependent on stable conditions than short lived species. Overall, macroinvertebrate analysis indicated high amounts of sediment and fine material in the system with good water quality. Sample results did not allow comparison with other river systems or habitat types for species abundance or richness.

Habitat Limitations

Deschutes River (Wickiup Dam to Benham Falls)

Detrimental impacts of irrigation development on the Deschutes River are due to alteration of natural flow patterns. Flows now range from almost complete dewatering to above-normal flows which result in degradation or complete loss of fish and fish habitat.

Specific impacts on fish habitat from regulated high flows during the irrigation season are:

1. Increases the rate of bank erosion and sediment load. Higher flows are causing changes in the meander sequence of the river.
2. Spawning gravels are moved to stream margins and become imbedded with sediment. Flow regulation has eliminated the short-term spring "flushing" flows that clean spawning gravel under natural flow conditions.
3. Increased bank erosion and sedimentation makes it difficult to maintain riparian and aquatic vegetation and breaks down the chain of primary food production, especially aquatic insects and the vegetation they depend on.
4. Reduces bank angling opportunity due to an increase in flow velocity, increased turbidity, and increased depths.
5. Inundation of streambanks during the growing season impacts growth of vegetation.

Specific impacts on fish habitat from regulated low flows during the non-irrigation season are:

1. Exposes areas of spawning gravel which directly impacts potential trout production.
2. Reduces trout cover used for rearing, feeding, and hiding.
3. Stream channel exposure results in a loss of aquatic invertebrate (trout food) production.
4. Trout are forced to concentrate in a few deeper pools, increasing their vulnerability to predation and harvest (legal and illegal).
5. Increases ice-induced mortality of trout during severe cold periods.
6. Dewaters adjacent wetlands and riparian areas which provide trout food and cover.
7. Exposes streambanks to freeze-thaw action resulting in breakdown and eventual loss when flows are increased.
8. Increases foot access to river sections not fishable at high water levels and concurrently reduces the ability to boat the river.

Deschutes River - Benham Falls to Bend (North Canal Dam)

This section of the Deschutes River courses through basalt formations (lava flows) resulting in falls and copious whitewater (Benham, Dillon, Big Eddy, and Lava Island falls). Lava flows from the eruption of Lava Butte thousands of years ago line the east bank of the river. The river tumbles through a series of cascades over and around these flows. Lava Island splits the river into two channels with the larger channel flowing through a rocky cleft. The two channels converge just downstream of Lava Island Falls near Meadow Camp (RM 173) where the river gradient is lower.

Vegetation includes lodgepole and ponderosa pine, alder, willow, aspen, and various grasses.

River substrate is generally large boulder and cobble in the fast flowing sections and sand, silt and coarse pumice in the pools and low velocity areas. ODFW personnel conducting stream surveys during 1989 and 1990 noted large, woody structure was lacking in all sections surveyed from Benham Falls to Bend. The survey also noted a lack of spawning gravels especially in the section from Benham Falls to Meadow Camp (USFS, ODFW 1992). Survey personnel noted the four major falls comprise approximately 13% of the section from Meadow Camp (RM 173) to Benham Falls (RM 181).

Benham, Dillon and Lava Island falls may be barriers at certain flows to upstream migrating trout. No studies have been done on fish passage for this river section.

This section has a more stable flow regime compared to the section just below Wickiup Reservoir. Inflow from upstream tributaries such as Little Deschutes River, Fall River, Spring River, and various springs maintain a more adequate winter flow. For the water years October 1955 to September 1982, the lowest mean monthly flow at Benham Falls was 731 cfs in October and the highest mean monthly flow was 2,426 cfs in July (USGS 1990). These flow records show an mean yearly difference between low and high flows of 1,695 cfs. The magnitude of this flow variation results in adverse effects on the aquatic ecosystem. Gravel and woody material are pushed into stream margins by high flows and subsequently dewatered during winter months. Aquatic organisms, including fish, are trapped inside channels and backwaters as flows are rapidly curtailed in the fall. The extent of fish loss from stranding is unknown, but reports are received each fall from river users about seeing fish in side channels and pools.

The relatively higher flows in this section do provide deeper pools and considerable turbulence, both of which provide fish cover. The base flows also provide a larger, minimum living space for all aquatic organisms compared to the Deschutes River between Wickiup Dam and Benham Falls.

The higher winter flows in this section help reduce the "icing" problems described previously for the Deschutes River from Wickiup Dam to Fall River. Some of the sediment load has settled out in the flat gradient portion of the upstream river segments below Wickiup Dam. Lava flows, boulders, and rubble armor a considerable portion of the streambed and banks from the erosive action of high irrigation flows.

Water quality in this section of the Deschutes is acceptable for raising coldwater gamefish except for turbidity levels which exceed Oregon water quality standards during portions of the irrigation season (USDA 1994).

In the lower part of this section, major irrigation diversions occur and are shown in the following table:

Table 15. Deschutes River water diversions near Bend.

Diversion	River mile	Maximum diversion	Screening and passage
Arnold Canal	174.5	135 cfs	no screen; passable
Central Oregon Canal	171.0	650 cfs	fixed plate screen; passable
DAW Mill	168.0	18 cfs	shut down; no upstream passage
Pacific Power and Light (Bend Hydroelectric)*	166.2	1,325 cfs	no screen; no upstream passage
Bend Feed Canal (Tumalo Irrigation District)	165.8	150 cfs	agreement to screen, louvers; fish ladder
North Unit Main Canal (NUID)	164.8	1,100 cfs	rotary drum screen; no upstream passage
North Canal (COID- Pilot Butte Canal)	164.8	600 cfs	louvers; no upstream passage
Swalley Canal	164.8	120 cfs	louvers; no upstream passage

***Note:** non-consumptive water right for power generation

Water withdrawals occur during the irrigation season (April to October) and about once a month during the winter to provide livestock water and fill cisterns.

Natural instream water losses in subterranean lava tubes have been identified in the segment from Benham Falls to Bend and are estimated to be approximately 7 percent of the flow (Robert Main. Oregon Department of Water Resources. personal communication, 1990.)

There are no recent estimates of the total quantity of spawning gravel present in this section. Spawning gravel is lacking or of poor quality in this section (Walker 1992) and generally found only in small pockets. This segment has likely been deficient in gravel for thousands of years due to the Benham Falls "dam" created by the lava flows. In 1989, the Department, funded by the COID Mitigation and Enhancement Program, placed 90 whole trees, 300 boulders and 200 cubic yards of spawning gravel in a 0.5 mile section of the Deschutes River in the COID hydroelectric project area. This habitat project was an effort to help correct the deficiencies in spawning gravel and large woody material noted by stream surveyors.

Habitat deficiencies from Benham Falls to Bend (North Canal Dam) are summarized as:

1. A deficiency in spawning gravel and large woody material.
2. High stream gradient and high water velocities limit spawning and rearing of trout.
3. Although the flow regime in this section is improved by the influence of tributaries upstream, flow fluctuations averaging 1,695 cfs annually result in loss and disturbance of fish habitat and fish loss from stranding.
4. Natural water loss through basalt formations result in a 7% flow reduction in this section of the Deschutes River.
5. Benham, Dillon, and Lava Island Falls may be barriers at certain flows to upstream migrating trout. No studies have been done.

6. Existing water rights allow maximum total diversions from this river section of 2,773 cfs during the irrigation season. Not included is the 1,325 cfs for Bend hydroelectric plant because the water is returned. These diversions cause disturbance and loss of fish habitat.

Tributaries

Besides the Little Deschutes River, the other two major tributaries flowing into the Deschutes River between Wickiup and Bend are Fall and Spring rivers.

Fall River

Fall River originates from a spring and flows east to the Deschutes River, entering at RM 204.5. The watershed is relatively small, encompassing 45.1 square miles. Fall River is a first order stream of approximately 11.2 river miles with a very stable flow regime (USDA 1991). The historical mean flow from 1938-1989 was 148 cfs (Figure 8). The maximum discharge was 254 cfs in 1965 and the minimum was 67 cfs in 1969 (USGS 1989).

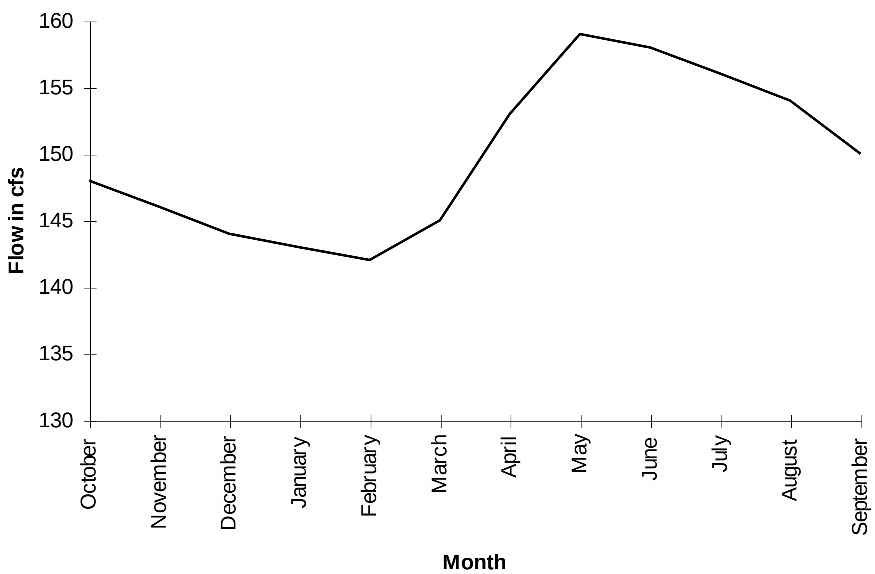


Figure 8. Average monthly flow in Fall River, 1938-1987.

There are no known water quality limitations in Fall River.

The dominant vegetation along the stream is lodgepole pine with lesser amounts of willow, bog birch, and a variety of grasses and forbs.

River substrate is largely sedimented alluvial gravels, sand, pumice, and basalt outcrops. A 1967 Oregon State Game Commission stream survey of Fall River classified a total of 7,071 square yards of spawning gravel of which 2,990 square yards was rated as good and the remainder marginal (Griggs et al. 1967). A Forest Service and ODFW stream survey in 1989 and 1991 noted natural occurring spawning gravel was embedded with fine sediment (Walker 1991). Lower Fall River up to the falls (RM 2.0) is an important spawning area for Deschutes River brown trout. Fall River falls is 12-foot high and a barrier to upstream fish migration. Spawning brown trout from the Deschutes River spawn in this two mile section. The Department, in cooperation with Fish America Foundation, Deschutes River Mitigation and Enhancement Program, Oregon State Parks and Recreation, Trout Unlimited, Central Oregon Flyfishers, and Sunriver Anglers have added approximately 600 cubic yards of gravel in lower Fall River to enhance brown trout spawning habitat. In addition, 90 whole lodgepole pine trees were added in the same area to improve trout hiding and rearing cover.

A physical stream survey by ODFW and Forest Service in 1989 and 1991 revealed fish habitat deficiencies. Large woody material (LWM, 12" diameter or larger, 35' long or longer) averaged only 1 piece per kilometer with a range of 0-2 LWM/km. The percent of pool habitat averaged only 14.8% with a section range of 4.2 - 51.6%. The number of pools per kilometer averaged 5.1 with a section range of 1.2 - 18.1. Pool habitat was poorest in the headwater section and steadily improved in downstream sections. Effective fish cover was rated poor to fair with a section range of 0 - 20%. The Department and the Forest Service have placed boulder structures in upper Fall River to create more pool habitat and additional work is planned.

The stream survey noted cold water at the headwaters (40^{o}F). Daily water temperatures recorded at the Department's Fall River hatchery for the years 1990-94 showed an annual average daily temperature of 45^{o}F with a range of 34-60^{o}F. The highest temperatures occurred on exceptionally warm summer days and were of short duration (diurnal fluctuations).

Macroinvertebrate samples were collected at two sites downstream of Fall River Falls. Samples were collected on natural substrate and on a gravel enhanced area to determine production value of the new gravel. Total invertebrate abundance on the gravel enhanced area was approximately 3 times the abundance on natural substrate. Analysis of the combined sample showed that species feeding on fine organic particulate material represented 69.2% of the total abundance and species that feed on periphyton represented 21.5% of the total. The high percentage of periphyton feeders was heavily influenced by the coarse material in the enhanced area. Pollution intolerant mayflies, stoneflies, and caddisflies represented 49.2% of the total abundance. Only 2 groups were identified that exhibited a life history greater than one year, however, these groups represented 4.1% of the total invertebrate abundance. Those species sensitive to riparian changes represented 6.2% of the total abundance.

Fall River is likely a good indicator of the past production potential of the Deschutes River. Comparison of the two rivers shows much higher percentages of species feeding on fine organic particulate material and a much lower percentage of species sensitive to riparian changes in the Deschutes River.

Spring River

Spring River, which originates from a spring source, is approximately one mile long and flows into the Deschutes River at RM 191. There is no stream flow gauging station on Spring River, however Oregon Water Resources Department personnel have periodically measured flows. Flows at the mouth ranged from a high of 299 cfs on April 13, 1907 to a low of 118 cfs on November 22, 1925. The most recent flow measurement at the mouth was 124 cfs on January 24, 1995. Spring River has a flat gradient and water depth is influenced by fluctuating water levels in the Deschutes River. Unfortunately, the depth of water in Spring River drops substantially during the fall brown trout spawning period as the irrigation season ends and Deschutes River flows are reduced to enable storage in upstream reservoirs.

Vegetation along the river corridor is predominantly pine forest along with sedges, forbs, willow and alder.

A physical stream survey for Spring River has not been done. The following information is based on observations by Department biologists. There is a lack of trout cover in Spring River, both hiding for adult fish and juvenile rearing. What cover exists is primarily in the upper 1/4 mile and is comprised of a few logs and overhanging vegetation. There is an opportunity to add woody material in lower Spring River to increase juvenile brown trout rearing habitat. In 1996 the Department in cooperation with the USFS and Sunriver Anglers placed 75 trees, with roots and crowns attached, into Spring River in the lower 1/4 mile. Fry-size brown trout immediately began using the trees and an evaluation is continuing.

Streambed substrate is composed of alluvial sand, gravels, and silt. Natural spawning gravel is in short supply, imbedded with sand, and confined to a small area near the headwaters. From 1977-79, the Department, in cooperation with local angler groups, placed 117 cubic yards of spawning gravel in the upper 1/4 mile to improve brown trout production. Placement of spawning gravel became increasingly more difficult after 1977-79 because of home development and no public access. In the future, it is unlikely additional gravel could be placed except by boat.

There are no known water quality limitations in Spring River. There are no extensive water temperature records for Spring River, but a maximum temperature of 48^{o}F was shown in the 1970 Stream Habitat Inventory forms (OSGC 1970). It is likely the water temperatures are cold throughout the year, similar to Fall River, a spring-origin stream upstream of Spring River.

Habitat Limitations

<u>Fall River</u>

1. Lack of natural spawning gravel. Gravel embedded with naturally occurring fine sediment.
2. Lack of large woody material for trout cover.
3. Lack of pool habitat.
4. Average daily water temperature at Fall River hatchery was 45^{o}F for the period 1990-94. This cold water reduces growth rates of trout.

<u>Spring River</u>

1. Lack of natural spawning gravel. Gravel embedded with naturally occurring fine sediment.

2. Lack of large woody material for trout cover.
3. Cold water slows trout growth rates.

Fish Stocking History

Deschutes River- Wickiup Dam to Bend (North Canal Dam)

"The Deschutes River is literally full of fish of all sizes, we could stand on the log and throw fish into the frying pan" (Oregon Historical Society 1981). Stearns cabin was along the river at Farewell Bend (former name of Bend). The Deschutes River had excellent populations of Dolly varden and native redband trout. Pringle Falls was a natural fish trap and in July and August (1903) the Dolly varden migrate to spawning grounds and are taken by spear or clubs at night while held up at falls. They weigh between 5 and 20 lbs, length 24-37 inches. Fish were salted and packed in barrels or smoked and packed for winter use.

Many references were found in early newspaper articles about the excellent fishing in the Deschutes River. "Three basketfulls of trout hooked in 2 hours"; "forty to sixty trout brought in for an afternoons' fishing"; "got 13 nice ones and threw back 26 small fish in about an hours' fishing". Bull trout were still being caught during spawning migrations at Pringle Falls in 1923.

Fourth of July fish frys were popular in those days. In 1906 about 3,125 trout were caught on hook and line from four days of fishing by four anglers for the fish fry. In August 1915, 2,000 people were fed with fish caught by six fishermen using hook and line (Mathisen 1985).

Concerns were raised in 1910 about fish populations being depleted and citizens petitioned for a fish hatchery to be built and fish stocked in the river (reasons: stage of water seldom varies by 12 inches, a site can be obtained adjacent to the city, stock is depleted because Deschutes is a popular river and attracts many visitors, money collected from licenses has never been applied locally). The Master Fish Warden announced in 1915 plans to build a hatchery about 3 miles south of Bend on the John Sizemore meadows with an initial capacity of 500,000 eggs. By 1916 the hatchery building was supplemented by 3 outdoor ponds and 300,000 young trout were being raised for release in Deschutes, Jefferson, Crook, and Klamath counties. The old Bend Hatchery was replaced by the Tumalo Hatchery in 1919 which in turn was replaced by Fall River Hatchery in the mid-1920's. In 1913, 100,000 brook trout were stocked in the Deschutes River from Bend all the way up to Fall River and in Fall River itself.

The earliest record of stocking began in 1913 with brook trout, rainbow trout, and steelhead being stocked at Bend and above Benham Falls (Oregon Sportsman, January 1916). Brook trout were stocked in Fall River in 1925 and from 1927-28, numbers unknown. In 1929, brook trout were stocked in the Deschutes at Pringle Falls, Benham Falls, Fall River, and at Bend. Rainbow were also planted that year in the Deschutes River in an unknown location. In 1931, brook trout were planted in the Deschutes at Bend. Fish stocking from 1931-35 included 5,000 coho in Deschutes River, 10,000 steelhead in Deschutes River, 60,000 rainbow at

Vandervert Ranch, and 30,000 brook trout in the Deschutes River. In 1933, brook trout were stocked in Fall River and rainbow in the Deschutes River.

Mathisen (1992) compiled early stocking history in the Deschutes River. He stated rainbow were planted in 1913 at several locations in the Deschutes River: 67,000 two miles above Bend, 27,000 at Robinson Bridge 10 miles above town, and 33,000 at Spring River Bridge, 22 miles above town. They were brought in by the Game Commission rail car (called "Rainbow") probably from the Bonneville Hatchery. On September 4, 1923, 5,000 coho were released into the Deschutes River, location unknown.

Current fish stocking records show legal-size rainbow were stocked in 1950 in the Deschutes River between Wickiup Dam and Benham Falls. This continued to the present time with 10 - 44,000 fish being stocked at different locations throughout trout season. In 1994, 25,000 legal-size (3 per pound) rainbow trout (Fall River, lot 72) were stocked in the Deschutes from Wickiup Dam to Sunriver. The hatchery fish are stocked throughout the summer in easily accessible locations along the entire segment. Approximately 10,000 of these fish are stocked in the segment from Fall River to Benham Falls. They are stocked at four sites with Besson Campground (across the river from Sunriver) being the lowest site stocked.

From 1985-1993, conservation groups made annual releases of Deschutes River stock (Lot 66) rainbow fry at RM 190 and RM 205. Numbers released ranged from a low of 369 in 1993 to a high of 113,039 in 1989. Eyed eggs were provided by Oak Springs hatchery through the ODFW Salmon Trout Enhancement Program. The eggs were incubated in hatch boxes placed by the conservation groups in Spring and Fall rivers. Deschutes stock redband trout were selected for the egg incubation experiment because they are resistant to *Ceratomyxa shasta*, a lethal disease found throughout the mainstem Deschutes River below Wickiup Reservoir. Since there was no practical way to identify these fry, their survival and contribution to the fishery is unknown. The hatchbox program has been terminated with emphasis currently on improving fish habitat.

The section of the Deschutes from Benham Falls to Bend has had somewhat more variation in the stocking. Current records show stocking began in 1954 with the release of 11 - 58,000 legal-size rainbow trout from Oak Springs, Wizard Falls, and Klamath Hatchery. Brown trout were tried with little success from 1965-1968. They were stocked mainly as fingerling, but legal-size fish were tried in 1968. Numbers varied from 9,000 legals to 106,000 fingerling. The brown trout fishery now relies completely on natural production. Stocking returned to rainbow only after 1968 with 2 - 41,000 fish being released annually. Records show stocking ended in 1978. The rainbow came from Klamath, Wizard Falls, Fall River, and Oak Springs hatcheries.

Naturally produced kokanee and hatchery coho are not stocked in this portion of the Deschutes River, but are present as downstream migrants from Wickiup Reservoir. The reservoir has no fish screens and when reservoir water levels recede late in the summer, a portion of these fish pass through the outlet to migrate downstream and can be found throughout the river from Wickiup to Bend. Both species have strong migrational tendencies being from anadromous parent stock.

Tributaries

Fall River

Modern records show stocking of Fall River began in 1946 with rainbow trout of an unknown number. This changed to brook trout in 1947 with 2,000 - 219,000 fish being stocked annually, primarily legal-size fish. From 1957-1965, 7,000 - 8,500 legal rainbow were stocked annually. In 1966 and 1968 small numbers of brook trout were stocked. Rainbow were first stocked as legals beginning in 1957 according to current records and continue to the present. Numbers stocked have ranged from 7,000 to 15,000 annually. Brown trout were stocked in 1974-1976 as fingerlings and legal-size fish, but none are stocked today. Grayling were stocked as an experiment in 1976, but failed to produce a fishery and were discontinued after one year. Currently, Fall River has an annual allocation of 7,500 legal-size rainbow and 7,500 legal-size brook trout (target size of 3 per pound). These fish are stocked weekly in the upper four miles of the river throughout the general trout season.

Stocking of legal-size brook trout began in 1993 as an experiment. The brook trout legal program is proposed by the Department to be discontinued beginning in 1996 because of hatchery pond space problems, and potential addition of non-disease resistant trout to the Deschutes River. The brook trout allocation will be replaced with legal-size rainbow trout.

Spring River

Spring River has a short history of fish stocking. It began in the modern era in 1945 with 5,200 rainbow trout fry being stocked. Rainbow were stocked in 1947 and 1948 as fry or legal-size fish in amounts from 9,900 to 20,043. One-hundred and fifty thousand brook trout were stocked as fry in 1954. Spring River has not been stocked since 1954.

Angling Regulations

Deschutes River

Information for angling regulations was found back to 1942. There have been a variety of changes over the years, the most significant are listed below

1942 Trout season open from April 18- October 31; 15 lbs of fish bag limit

1945 Bag limit changed to 15 fish not to exceed 15 lbs; no limit on whitefish; no fishing from Wickiup Dam to 1/4 mile downstream

1947 Bag limit changed to 10 fish not to exceed 15 lbs; no limit on Dolly varden (bull trout)

1948 Trout season May 1 - September 30

1951 Trout season April 28 - October 14; Bag limit changed to 10 fish/day, no more than 5 greater than 12 inches

1952 Deschutes National Forest trout season opener initiated: May 30- September 30; regular trout season opener: May 3 - October 12

1959 Dolly varden included in trout limit

1965 Bag limit for trout over 20 inches is 2 per day

1974 No longer using a separate national forest trout season opener; bag limit- 10 fish per day, no more than 5 greater than 12 inches and of these no more than 2 greater than 20 inches; Wickiup to 1/4 mile downstream closed to fishing from September 1- October 31

1980 Bag limit changed to 5 trout per day in streams

1982 No minimum on brook trout; no more than 2 trout greater than 20 inches

1990 Bag limit- no more than 1 trout greater than 20 inches; no more than 2 brown trout per day from Bend to Wickiup.

In 1990, a two fish bag limit on brown trout was implemented. Prior to that, brown trout were included in the five trout per day category, with one fish over 20 inches and a minimum size of six inches. The protective regulation was enacted to reduce angler harvest of brown trout.

The current regulations for the Deschutes River from Wickiup Dam to North Canal Dam in Bend are: trout season open from April 22 to October 31, 5 trout per day, 6 inch minimum length with no more than one over 20 inches. Not more than 2 of the 5 fish may be brown trout and there is no angling from Wickiup Dam downstream for 1/4 mile from September 1 to October 31. Open season for whitefish is the same as for trout, but there are no bag or length limits. There are no restrictions on type of angling gear in this section of the Deschutes River.

Tributaries

<u>Fall River</u>

There have been a variety of regulations on Fall River and the most significant changes are listed below:

1942 Trout season open from April 18 - October 31; 15 lb bag limit

1947 Bag limit changed to 10 fish not to exceed 15 lbs; no limit on Dolly varden (bull trout)

1948 Trout season May 1 - September 30

1950 Trout season May 1 - October 15; Fall River closed to angling from hatchery dam to 300 feet below ponds

1951 Trout season April 28 - October 14; Bag limit changed to 10 fish/day, no more than 5 greater than 12 inches

1952 Deschutes National Forest trout season opener started: May 30 - September 30; regular trout season opener: May 3 - October 12

1955 Fall River reopened to fishing by hatchery

1964 Fall River changed to fly fishing only

1965 Bag limit for trout over 20 inches is 2 per day

1977 All grayling caught in Fall River must be released

1979 Fall River grayling regulation gone

1980 Bag limit changed to 5 trout per day in streams

1982 No more than 2 trout greater than 20 inches

1988 Fall River changed to barbless hooks only

1990 Bag limit, 1 trout greater than 20 inches. Fall River closed to all angling October 1 - October 31 below the falls.

The current regulations on Fall River are: open during general trout season (April - October), fly fishing only, barbless hooks, 5 trout per day; no more than 1 over 20 inches, 6 inch minimum length, closed to all angling Oct. 1-31 below the falls. Open season for whitefish is the same as for trout, but there are no bag or length limits. There are no restrictions on boats.

<u>Spring River</u>

The angling regulations for Spring River have followed those for the Deschutes River over with the years with two exceptions: Spring River was closed to all angling October 1 - 31 beginning in 1992, and the two brown trout bag limit imposed on the Deschutes River in 1990 does not apply.

The current regulations for Spring River are: open general trout season, except closed to all angling October 1 - 31, 5 trout per day, 1 over 20 inches, 6 inch minimum length, no special gear restrictions. The season for whitefish is the same as for trout, but there is no bag limit or size restriction.

Fish Management

Deschutes River - Wickiup Dam to Benham Falls

Historically, bull trout, redband trout, and whitefish were the indigenous game fish in this segment of the Deschutes River. Bull trout were last seen in 1954 in the Deschutes River from Wickiup to Bend. They were denied access to spawning and rearing areas by Wickiup Dam, subjected to overfishing, exposed to severe competition from introduced brown and brook trout, and possible interbreeding with brook trout. Bull trout have been subjected to serious habitat loss due to extreme fluctuation in streamflows associated with irrigation development in the subbasin. Bull trout were also subjected to water quality degradation, primarily increases in turbidity and fluctuations in water temperatures.

Wild fish species currently present are redband trout and mountain whitefish. Introduced species include brown trout, brook trout (migrate from Fall and Spring Rivers), tui chub, kokanee, coho salmon, and three-spine stickleback. Three-spine stickleback are not indigenous to the Deschutes River system and were first discovered in 1984 by Department biologists while electrofishing Spring River. It is believed they were illegally introduced to the Deschutes River in the Sunriver area. They are now likely throughout the upper Deschutes River and were discovered in Crane Prairie Reservoir in 1994. Brown bullhead catfish were present in this section in the 1960's and 1970's, but have not been observed in Department surveys in recent years. It is believed brown bullhead catfish found their way into the Deschutes River via the Little Deschutes River and Gilchrist Mill Pond, an impoundment on the mainstem of the Little Deschutes River approximately 47 miles south of Bend.

Fish are able to move upstream as far as Pringle Falls (RM 216.5). Pringle Falls has not been recorded as a barrier to fish passage. It may pass fish only at certain flows levels or may be a complete barrier. Fish have access to nearly 100 stream miles in the Little Deschutes River system, the entire 1 mile length of Spring River and to the lower 2.0 miles of Fall River where a natural 12-foot high falls blocks fish upstream passage. There is a migration barrier at Gilchrist Mill Pond but the old fishway has been rebuilt and is believed to be passing fish. The interaction between the mainstem Deschutes fish and the Little Deschutes fish is poorly understood.

Brown trout were introduced into Oregon in the early 1900's (ODFW 1969). Extensive drift boat electrofishing inventories conducted by ODFW in 1990 and 1991 indicate a good population of older, large brown trout with fish captured up to 12 pounds. Inventory results for the section of river from Wickiup Dam to north of Bend are shown in the following table:

Table 16. Status of Deschutes River brown and redband trout.

Section	Population status		Inventory method	Year
	Brown	Redband		
Wickiup to Fall River	Fair	Low	Drift boat electrofish	90,91
Fall River to Benham Falls	Good	Low	Drift boat electrofish	90,91
Benham Falls to Bend	Low	Excellent	Drift boat electrofish	90,91

Comparable data from ODFW inventories in the late 1960's show similar fish numbers, but fewer large fish and more young fish. The electrofishing technique is capable of capturing only a portion of the fish present.

The brown trout population appears to be amazingly resilient in view of the adverse environmental conditions. In winter, large adult fish are concentrated in a few coverless pools where they are vulnerable to predation, poaching, and angling. The increased vulnerability to legal angling occurs through October, when the flows are shut off.

Adult brown trout in this section of the Deschutes River primarily spawn in the two major tributaries, Fall and Spring rivers (see Fish Management - Tributaries). Brown trout also attempt to spawn in a few suitable places in the Deschutes River, primarily in the first two miles below Wickiup Dam. The spawning ground counts for this area show considerable variability in recent years (Table 17). The precise reason this occurs is unknown, but may be related to water conditions and the number of adult spawners available in any given year. The success of this brown trout spawning is unknown and believed to be of less importance compared to the amount of spawning in the two tributaries. Other than the documented spawning runs into Spring and Fall rivers, the degree of interchange between the river and tributary populations is unknown.

Table 17. Brown trout spawning ground counts in a one mile survey area in the Deschutes River from Wickiup Dam to Tenino boat ramp, 1989-1994 .

	1989	1990	1991	1992	1993	1994
Number of Redds	32	N\C	6	N\C	21	18

N\C - No count made.

In 1993, Department personnel tagged 138 brown trout between Wickiup Dam and Sunriver. Observations from this tagging study showed:

1. There was very little movement of brown trout.

2. Indications from angler-returned tags were that exploitation of brown trout was minimal. Two unknowns increase the rate of exploitation: angler failure to turn in tags, and tag loss, most likely in spaghetti tagged fish.

3. One tagged fish each was observed in both Spring and Fall River. Three tagged fish observed below Wickiup Dam during the spawning season.

The habitat in this portion of the Deschutes under its current condition is more suited for brown trout than redband trout. It has a low gradient and few riffle areas. The redband face the same adverse environmental conditions as the brown trout, although their spring spawning life history may allow them access to spawning areas covered by sufficient water. Competition from brown trout and whitefish may be holding the redband population in check and there is also a lack of winter holding habitat.

Department personnel inventoried rainbow trout (redband and hatchery rainbow) populations in this section of the Deschutes with a boat-mounted electrofishing unit during the period 1989 - 1991. Results showed a low rainbow population (Table 18).

Table 18. Rainbow trout inventory in the Deschutes River from Wickiup Dam downstream to Benham Fall, 1989-1991.

River mile	Survey miles	Rainbow	fish per mile	Size range (in.)
181 to 227	13.43	46	3.4	3-20+*

*-Six of the rainbow were hatchery fish, 4 recently released legal rainbow and two holdover fish.

Small (6 to 7-inch) redband were slightly more abundant in the late 1960's surveys. Three large rainbow (15 to 28 inches in length) were captured and appeared to be holdover hatchery fish. The presence of these apparent holdover hatchery rainbow was surprising because hatchery rainbow trout released in this section of river are not resistant to the fish disease *Ceratomyxa shasta*. Random creel checks, canal sampling and sampling at Bend hydroelectric plant have shown the hatchery rainbow are either caught, migrate downstream, or eventually die from disease. There is almost no holdover of hatchery legal-size rainbow from one year to the next.

Wild mountain whitefish are very abundant. Observations by Department personnel during inventory activities concluded whitefish make up approximately 90 percent of the fish biomass. Few fish are greater than ten inches in length. Whitefish apparently are more successful in dealing with the adverse environmental conditions than trout. They have faced the same environmental pressures as the other species present, but continue to be a large part of the fish biomass in this section of the Deschutes. One obvious advantage the whitefish enjoy is that, despite spawning during the winter low flow period, they are broadcast spawners, do not require clean gravel substrate for the eggs to incubate prior to hatching, and they are the last fish to spawn in the fall and early winter.

Kokanee and coho salmon are transient outmigrants from Wickiup Reservoir. Wickiup Dam is unscreened. Department surveys in fall, 1990 noted both juvenile and adult kokanee, but only immature coho. The mature kokanee were found in the first mile below Wickiup Dam and were probably attempting to spawn. Neither species were observed in the spring. Population surveys in 1991 indicated they moved out of the river or failed to survive. Thousands of these fish emigrate out of Wickiup each summer as the reservoir level recedes. The emigration is maximized during years of extensive reservoir drawdown.

Tui chub and three-spine stickleback are the result of illegal introductions. Chubs can be a serious competitor with game fish in a lake or reservoir, but do not appear to be very adaptable to a riverine situation. The three-spine stickleback, a small (2-inch) fish is thought to be a recent (within the last ten years) illegal introduction to the river. Both species may compete with trout and whitefish of similar size, but both can be a food source for larger trout.

There are no recent comprehensive catch estimates or angler-use estimates available. An extensive 1967 Department creel survey recorded 783 anglers catching 252 wild brown trout or about 0.32 fish per angler. The survey covered the Deschutes River from Wickiup to its confluence with Fall River. Random creel census collected in the Wickiup to Benham Falls section during the years 1970 - 1994 showed mean catch rates of 0.38 fish per hour and 0.84 fish per angler. Similar data collected for the Benham Falls to Bend section showed mean catch rates of 0.35 fish per hour and 0.63 fish per angler. However, the fish per angler catch rate has been declining since 1970 for both sections of the Deschutes (Table 19). It is unknown if the Department's standard of a minimum 40% return of legal-size rainbow to the creel is being met in the Deschutes River between Wickiup and Benham Falls.

Table 19. A comparison of fish per angler catch rates on two sections of the Deschutes River from Wickiup Dam to Bend (North Canal Dam) for the years 1970-94.

	Fish per angler	
Years	Wickiup Dam to Bend	Benham Falls to Bend
1970-1980	1.24	0.78
1981-1990	0.61	0.54
1991-1994	0.47	0.39

The river is boatable during the irrigation release period. Most anglers target the stocked rainbow trout. Brown trout are caught incidentally to rainbow trout, but are more frequently taken by anglers fishing specifically for this species. The most popular brown trout angling segment occurs from Fall River to Benham Falls. In 1977, angling use was estimated at about 14,000 angler-days per year for the area from Wickiup Dam to Bend (ODFW 1977).

Deschutes River - Benham Falls to Bend (North Canal Dam)

Historically, bull trout, redband trout, and whitefish were the indigenous game fish in this section of the Deschutes River. Bull trout were last seen in 1954 in the Deschutes River between Wickiup Dam and Bend. Game fish species currently present are redband trout, hatchery rainbow trout, mountain whitefish, and the introduced species brown trout, kokanee, and coho salmon. Tui chub and three-spined stickleback are illegally introduced species. One major difference is this segment has a higher population of redband trout than upstream of Benham Falls. The majority of this population is less than 12 inches in length with a few fish up to 18 inches.

Brown trout have gradually been displaced by redband trout in this segment; the change occurring over approximately the last 25-year period. Canal bypass trap data and canal pool inventories in the late 1960's and early 1970's indicate a brown-to-redband trout ratio of at least 5 to 1 (Pilot Butte diversion - RM 165, near Bend). Data from 1989-90 shows a redband trout dominance of at least 2 to 1 (redband/brown) in canal bypass trapping and at least 25 to 1 in canal pool sampling in the Central Oregon canal at RM 171 (Campbell and Craven 1991). All ODFW electrofishing and angling inventories concur with these findings. An extensive 1990 catch record compiled by one angler shows he caught 256 trout and only one was a brown trout (Walt Weber. Oregon Department of Fish and Wildlife. personal communication. 1990).

Causes of the transition from a dominant brown to redband trout population are not clear. Stream habitat surveys by ODFW and Forest Service biologists in 1989-91 found spawning gravel lacking in this section of the Deschutes River. Useable spawning gravel was confined to a few tailout areas below rapids or barriers. Even less gravel is available for a fall spawning species such as brown trout because much of the spawning gravel is dewatered and inaccessible to fish. Other than spawning gravel, the habitat appears suitable to sustain brown trout.

The high gradient and riffle dominated habitat found in most of this segment is preferred by redband trout. Population density is high, but fish appear to be sexually maturing at a relatively small size of 9 to 12 inches. The Department's experience elsewhere in the Deschutes basin is that redband trout growth slows substantially upon reaching sexual maturity.

A Department electrofishing inventory (1990-91) in the upper end of this segment did not show an impressive redband population. Results showed 30 trout per mile captured with none exceeding 9 inches and most were less than 6 inches. Pool depth, velocity, and water volume limited the efficiency of the drift-boat mounted electrofishing unit. Access problems prevented sampling of better habitat downstream. The segment sampled has limited riffle area and is not considered good redband habitat.

At the lower end of this section (RM 172) a partial (relatively low percent of population caught) Department inventory recorded between 235 and 310 redband trout per mile. Fifty percent were larger than 6 inches and 11% percent were between 10 and 12 inches.

Recent canal bypass trapping and canal sampling indicates large numbers of redband trout are emigrating downstream out of this segment. This movement suggests the habitat is either overstocked or that rapid increases in irrigation flows are displacing fish to other locations. The 1990 COID diversion bypass trapping estimated approximately 2,000 redband trout were passed downstream with 31,000 total fish entering the canal (Campbell and Craven 1991.) The Department believes this total was very consertive. The redband trout averaged five to nine inches.

A number of the 25,000 hatchery fish released upstream move through this segment. An estimated 378 were collected at the Central Oregon Canal bypass in 1990. Only one hatchery fish was captured in the other 1990-1991 inventories. Apparently, the hatchery fish either continue moving downstream or die of the parasite *Ceratomyxa shasta*. The Central Oregon Canal by-pass trap counts also provide documentation of the tremendous number of kokanee that move through the river after leaving Wickiup Reservoir. In 1990, an estimated 28,000 moved through the bypass trap (Campbell and Craven 1991).

Benham Falls (RM 181) is probably a partial barrier for upstream passage. Dillon Falls (RM 178) and Lava Island Falls (RM 175) are also considered to be partial barriers to upstream fish passage. The Pacific Power and Light Dam in Bend (RM 166) is a complete barrier to fish attempting to move upstream into this segment and the Colorado Street Dam in Bend is a partial barrier. The North Canal Dam is a total barrier to upstream fish migration. Except for downstream movement, these upstream barriers may have created four potentially isolated groups of fish within this segment. They may pass fish only at certain flows or may be complete barriers. The dams are definitely barriers, and have no fish passage facilities.

Currently, the North Unit Irrigation District's Main Canal and Central Oregon Irrigation District Canal are the only diversions screened for fish in this section of river. The North Unit Canal is equipped with a rotary drum screen system. Other main diversions have ineffective louvers or contain no screens at all (see Table 15), with resultant loss of thousands of fish from the Deschutes River into canals.

The intake structure at the Bend Hydroelectric plant is not properly screened and allows fish migrating downstream to be killed or injured while passing through turbines. COID completed constructing a new fixed, perforated-plate fish screen on their main canal in 1995. The Department is currently negotiating with Tumalo Irrigation District to reach agreement on installing an effective screening system for their diversions. Fish populations below Bend would also benefit from screening these diversions upstream and in the vicinity of Bend.

There are no comprehensive catch estimates or angler use estimates available at this time. In 1990, a two-fish bag limit on brown trout was implemented. Prior to that, brown trout were included in the five trout per day category, with one fish over 20 inches and a minimum size of six inches. The protective regulation was enacted to reduce angler harvest of brown trout. There is currently no bag or size limit on whitefish. Currently, there are no restrictions on type of angling gear in this section of the Deschutes River upstream of North Canal.

Whitefish, brown and hatchery rainbow trout provide a sport fishery that receives heavy pressure from Benham Falls to Meadow Camp due to good access and proximity to Bend. This section receives considerable recreational pressure besides fishing such as rafting, kayaking and camping.

Fish-related expenditures by residents and visitors make a significant contribution to the local economy and add a significant element to the livability of Central Oregon (Ragatz Associates 1987). Personal income generated from trout fishing in Oregon in 1980 was estimated to be at least $158 million (ODFW 1987). The net economic value (nonfinancial values or willingness to pay) was estimated to be $63 million in 1984. A 1985 study clearly showed the importance of fishing opportunities to local residents of the Bend area with 66 percent and 62 percent of survey respondents say they lake fish and/or stream fish respectively (Ragatz Associates 1987).

Tributaries

Fall River

Historically, it is known mountain whitefish were indigenous to Fall River, at least up to the impassable falls at RM 2.0. There are no records of whitefish above the falls and they currently are found only in the section downstream of the falls. Redband trout and bull trout may have been present in Fall River below the falls. Bull trout were extirpated from the upper Deschutes River in the 1950's.

In 1973, a viral fish disease, infectious pancreatic necrosis (IPN) and bacterial kidney disease (BKD) were found in hatchery fish at Fall River hatchery. Both diseases were present in rainbow trout stocked from the hatchery into Fall River and IPN was identified in brook trout from below the hatchery. All species and ponds of fish in the hatchery were found to contain infected fish, primarily IPN, and all fish in the hatchery, including 1.8 million fingerling rainbow and brook trout and 71,000 legal-size rainbow trout were destroyed. The hatchery was completely disinfected and did not return to full production until 1974.

Since infected fish were known to be in Fall River, the entire stream was chemically treated in September, 1973, to remove all fish. The treatment was successful and those diseases have not reappeared in the system. Any wild trout present at that time would have perished during the treatment. Whitefish from the Deschutes River repopulated Fall River below the falls. It is not known if any redband trout from the Deschutes River became established in lower Fall River after the treatment. Beginning in 1974, Fall River was restocked with brook, rainbow and brown trout of various sizes. Those three species are present today.

Fall River is managed for hatchery and naturally producing rainbow trout, brook trout, brown trout and wild mountain whitefish. Legal-size brook trout were stocked from 1993 - 95, but are proposed to be discontinued in 1996 due to poor catch rates and potential competition for spawning areas with brown trout in Fall River below the falls.

Fall River is popular for daily, weekend and vacation use because of its beauty, ease of access, fly fishing, presence of the hatchery, Forest Service campground, and close proximity to population centers. For example, in 1992, an estimated 15,000 people visited Fall River hatchery (Phil McKee. Oregon Department of Fish and Wildlife. personal communication. 1995). Hatchery personnel feel the use is increasing each year.

Although no current total angler use or catch estimates are available, the river receives heavy use as evidenced by hatchery visitors, parked cars, campground use, and well-worn trails.

In 1991, a season-long voluntary creel census was conducted on Fall River. The project was organized and conducted with the help of a local fishing group. Results showed excellent angling with 3.7 fish per angler and 2.09 fish per hour. Rainbow trout constituted 86 percent of the catch (Table 20).

Table 20. Summary of voluntary creel census on Fall River for the entire season, 1991.

Total fish caught	1,370	
Total hours fished	654.5	
Total anglers	370	
Fish per angler	3.70	
Fish per hour	2.09	
Number and percent of fish caught by species		
Rainbow trout*	1,175	86%
Brook trout	111	8%
Brown trout	68	5%
Whitefish	15	1%
Unidentified	1	<1%

*- It is believed the majority of these rainbow were hatchery fish.

The catch rates from the voluntary creel census are probably somewhat inflated compared to random creel census collected by Department biologists over the years (Table 21).

Table 21. Random creel census for Fall River collected by ODFW during the period of 1970 - 1980 compared with voluntary creel census collected in 1991.

Year	Fish per angler	Fish per hour	Percent >10 in.	Percent rainbow
1970	1.80	1.13	24	78
1971	0.80	0.63	20	80
1974	1.60	0.48	6	100
1975	1.19	0.35	81	62
1976	0.37	0.22	0	100
Table 21. Continued				
1977	2.29	0.68	41	50
1978	1.90	1.09	36	80
1979	1.25	0.61	10	30
1980	1.67	0.63	0	80
1991	3.70	2.09	33	86

Fall River is one of two major spawning streams for Deschutes River brown trout. Peak spawning occurs in early November and the spawning run has fluctuated during recent years (Table 22). It is believed this fluctuation is due largely to the strength of individual age classes and the vulnerability of spawners in the winter following periods of drought.

Table 22. Fall River brown trout spawning ground counts downstream of Fall River Falls, 1.6 mile survey area*, 1989-1994.

	1989	1990	1991	1992	1993	1994
Number of redds	253	146	124	287	252	178
Number of fish	79	138	37			

*- 1992 reflects a major change in survey technique. Multiple counts are made throughout the spawning season to determine superimposition and obtain a total redd estimate.

Spring River

Spring River is managed as a basic yield fishery for mountain whitefish and introduced brown and brook trout. No hatchery fish are stocked in Spring River.

There is little fishing activity on Spring River because it has poor public access, is only one mile long, and supports primarily sub-legal size trout during the angling season. A few boats fish at the mouth of the stream for whitefish.

The Department does no regular creel census or fish inventory on Spring River.

Spring River is the other major spawning stream for Deschutes River brown trout. Redd counts conducted during the period 1965-1971 ranged from 5-47 redds (Griggs 1972). In recent years, Department survey crews counted fish instead of redds because spawning activity is too concentrated for accurate redd counts in the 0.1 mile of spawning habitat. In recent years, the spawning ground counts in Spring River have been on a downward trend (Table 23). It is believed this downward trend is the product of several consecutive low water years which increases the vulnerability of spawning age brown trout during the winter. Although the trend is downward, the number of spawning fish is likely more than observed in the 1960's. Additional spawning gravel was added in the late 1970's (see Habitat section) which may be responsible for keeping this spawning run productive. Redband trout are not known to spawn in Spring River.

Table 23. Brown trout spawning ground counts* in Spring River, 0.6 mile survey area, 1989-1994.

	1989	1990	1991	1992	1993	1994
Number of fish	118	111	71	63	71	N\C

N/C- no count made

*- superimposition precludes accurate redd counts. Fish count is the peak count from several surveys.

Management Issues

Deschutes River

Management issues for the Deschutes River and tributaries from Wickiup Dam to Bend are:

1. Bull trout were indigenous to the Upper Deschutes basin, but disappeared in the 1950's primarily due to the construction and operation of Wickiup and Crane Prairie reservoirs. The potential for a successful reintroduction has not been assessed.
2. Electrofishing shows redband trout populations are present and abundant in the section from Benham Falls to Bend, but depressed in the Wickiup Dam to Benham Falls section. The redband population in the Wickiup to Benham Falls section may not meet the 300 spawners criteria in the Wild Fish Management Policy. The genetic history of these redband trout is unknown. It is also unknown where these fish are spawning.
3. The brown trout population in the section between Wickiup Dam and Benham Falls is abundant, but spawning habitat is limited to less than 4 total miles of tributaries and mainstem. It is unknown if this spawning habitat is sufficient to permit future expansion of the upper Deschutes brown trout population.
4. Water flow regulation has caused a severe degradation of fish habitat which continues today. There is a lack of good spawning gravel, lack of trout cover, lack of overwintering habitat, and reduced aquatic food production.
5. Water quality is degraded by excessive turbidity during the early portion of irrigation season and by low temperatures in winter.
6. There is a need for a statistically designed study to estimate total angler use and catch on the Deschutes River from Wickiup Dam to Benham Falls. A primary purpose of this study would be to determine the percent return to the creel of hatchery rainbow trout. Other purposes would be to assess catch patterns of brown trout and the impact of the current two brown trout bag limit and contribution of redband trout.
7. The water flow regime has resulted in lost angling opportunities.
8. There are major irrigation diversions near Bend which are either not screened or have ineffective fish diversion louvers, resulting in significant gamefish losses in canal systems annually.
9. There are man-made barriers in the Bend area which either have no upstream fish passage facilities or facilities needing modification.
10. Current habitat conditions favor brown trout above Benham Falls and redband trout below. It is unlikely redband trout will proliferate above Benham Falls without restoration of winter flows.

Tributaries

Fall River

1. The annual contribution of legal-size rainbow and brook trout to the creel is unknown. A statistically designed study to estimate total angler use and catch for the entire season is needed.

2. The lack of pool habitat, especially in the upper 4 miles of Fall River, reduces the holding ability of hatchery trout and subsequent return to the angler. The shortage of pools may also have an impact on the streams ability to carry hatchery trout over to the next year.
3. Cold water temperatures reduce trout growth rates and much of the spawning gravel is embedded with fines, both factors affecting the potential to manage Fall River trout solely on natural production.
4. Brown trout are naturally producing in Fall River. They are very competitive, long-lived, relatively hard to catch in clear water, and most likely are occupying the best fish habitat. Fall River below the falls in an important spawning area for Deschutes River brown trout. It is unknown if rainbow trout spawn in the same area in the spring. There are no historical records of redbands spawning in this area of Fall River.
5. Fishing pressure is high and appears to be increasing even though the entire stream is fly angling only with a barbless hook. To meet future angling demand, more restrictive bag limits or catch and release will be required.
6. Although some natural reproduction of rainbow trout, brook trout, and brown trout occurs above the falls, it does not appear to be able to sustain current and future angling pressure without hatchery fish supplementation.

Spring River

1. This is one of two spawning tributaries for Deschutes River brown trout. Spawning gravel additions are being fully utilized by brown trout, but the limiting factor appears to be a lack of cover for juvenile trout rearing. Projects to increase trout cover are needed to maximize brown trout production.
2. Private development has virtually eliminated the opportunity to add more spawning gravel.
3. Mountain whitefish are indigenous to Spring River and have adapted to the marginal spawning and rearing habitat. They appear to compete with trout for food and space and may be a factor limiting any future increases in trout production.
4. Presently, Spring River provides little in the way of angling opportunities. It is managed as a nursery stream for Deschutes River brown trout, brook trout and mountain whitefish. Future management should consider closing the stream to all angling.

MANAGEMENT DIRECTION

DESCHUTES RIVER AND TRIBUTARIES FROM WICKIUP DAM TO BEND

POLICIES

Policy 1. Mountain whitefish shall be managed for natural production consistent with the Featured Species Management Alternative for trout (ODFW 1987).

Policy 2. Redband and rainbow trout shall be managed for natural and hatchery production consistent with the Featured Species Management Alternative for trout (ODFW 1987).

Policy 3. Brown trout shall be managed for natural production consistent with the Featured Species management alternative for trout (ODFW 1987).

Policy 4. Kokanee and brook trout shall be managed for natural production consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

OBJECTIVES

Objective 1. Maintain genetic diversity, adaptiveness, and abundance of redband trout and mountain whitefish.

Assumptions and Rationale

1. Fall River was chemically treated to remove all fish in 1974. There are no redband trout above the falls and it is presumed they were not indigenous to that section of the river because mountain whitefish have also never been seen or recorded above the falls.

2. Small numbers of redband trout exist in the section from Wickiup Dam to Benham Falls; more abundant numbers exist in the section from Benham Falls to Bend. The genetic characteristics and origin of these populations is unknown.

3. Rainbow trout indigenous to the upper Deschutes River and tributaries have been identified as an inland redband trout and are listed as a provisional wild fish population and a sensitive species.

4. Electrophoretic and morphometric measurements will aid in determining the origin of the redband trout in this section of the Deschutes River. Samples have been collected in this section of the Deschutes River and results are pending.

5. Restrictive regulations and habitat restoration will be needed to protect stock fitness and life history characteristics of redband trout and whitefish.

6. Monitoring the distribution and abundance of redband trout, and mountain whitefish will provide an indication of their health and adaptiveness.

7. Redband trout above and below Benham Falls comprise one population.

8. Survival-to-spawning of stocked *C.shasta* resistant redband trout in the section between Wickiup Dam and Benham Falls will be low enough that breeding interactions risks to the wild population will be minimal.

9. Release of hatchery fish will be done in a manner to maintain genetic diversity of redband trout; however, the abundance of redband trout may not reach maximum potential.

10. Habitat effects due to extreme high summer flows and extreme low winter flows in the Deschutes River above Benham Falls may be the most critical limiting factors in natural production of redband trout.

ACTIONS

Action 1.1 Conduct wild trout life history studies to identify spawning and rearing areas and better define population characteristics including size and age at maturity, spawning frequency, and migration patterns.

Action 1.2 Monitor population trends of fishes in the Deschutes River and tributaries. Population trends will be determined through such methods as creel surveys, electrofishing, trapping, snorkeling, and spawning ground surveys.

Action 1.3 Establish baseline data sets on genetic characteristics of redband trout using biochemical (electrophoresis) and phenotypic parameters and compare to existing electrophoretic data from other areas in the Deschutes basin.

Action 1.4 Modify the numbers, locations, frequency, timing, and types of hatchery rainbow trout stocked in the Deschutes River above Benham Falls to protect the genetic resources of wild fish. *C. shasta* susceptible stocks of hatchery fish will no longer be stocked.

Action 1.5 Monitor survival of hatchery rainbow trout stocked in the mainstem Deschutes to assess potential genetic and ecological risks to redband trout in this section of river.

Action 1.6 Implement angling regulations necessary to sustain sensitive populations of redband trout.

Action 1.7 Pursue means to restore winter flow and minimize flow fluctuations to maintain habitat quality and reduce habitat damage.

Objective 2. Provide diverse angling opportunities for a non-consumptive fishery on redband trout and a consumptive fishery on hatchery rainbow trout, mountain whitefish and naturally-produced brown trout, kokanee, and brook trout above Benham Falls, including Fall River and Spring rivers; provide a non-consumptive fishery on redband trout and a consumptive fishery on brown trout, kokanee, and mountain whitefish below Benham Falls.

Assumptions and Rationale

1. There is a significant demand for a consumptive fishery on hatchery fish as well as for a catch and release fishery on wild fish.

2. A catch rate of approximately 1.0 trout or whitefish per hour provides an adequate fishery.

3. Under this alternative, restrictive angling regulations may be necessary to sustain redband trout due to their current low population abundance, while providing a consumptive fishery on hatchery trout.

4. Changes in the stocking regime necessary to protect the genetic diversity of redband trout may reduce angling opportunities for hatchery rainbow trout.

5. Tackle restrictions necessary to protect wild trout probably will limit angler effectiveness and the ability to meet the 40% catch goal as required by the Trout Plan (ODFW 1987).

6. Mountain whitefish are abundant in the Deschutes River, and current harvest levels can be maintained without affecting sustainability. Many people are not aware of the excellent sporting and eating qualities of whitefish.

7. Natural production of brown trout and brook trout is adequate to sustain a modest consumptive fishery.

ACTIONS

Action 2.1 Stock *C. shasta* resistant, marked hatchery rainbow trout in the mainstem Deschutes River in locations, timing, frequency, and seasons consistent with sustaining wild fish populations. Up to 25,000 fish would be stocked annually.

Action 2.2 Annually stock Fall River above the falls with up to 15,000 legal-size hatchery rainbow trout.

Action 2.3 Observe spawning areas throughout this section of the Deschutes River during spawning season to monitor hatchery/ wild ratio for compliance with WFMP.

Action 2.4 Conduct periodic creel surveys to estimate catch rates, species composition, and angler effort in order to monitor success of meeting this objective.

Action 2.5 Publicize information on the desirable attributes of whitefish as a game fish and associated angling opportunities.

Action 2.6 Develop an information and education program to enhance angler awareness of the status and life history requirements of sensitive species such as redband trout.

Action 2.7 Educate Deschutes River anglers on how to catch and release wild fish unharmed. Post signs at popular fishing sites informing anglers of how to identify and correctly release wild trout.

Action 2.8 Implement a cooperative enforcement and information and education program with OSP to ensure compliance with regulations.

Objective 3. Protect, enhance, and restore trout and whitefish habitat.

Assumptions and Rationale

1. Modification of the hydrology of the Deschutes River from Wickiup Dam to Benham Falls has resulted in wide variations in flows in what was once a relatively stable river, causing loss of habitat (spawning, rearing, and resting) which supported natural production of redband trout in significant numbers**.**

2. In tributaries, such as Fall and Spring rivers, which are unaffected by irrigation diversions, the lack of abundant natural spawning gravel, instream woody structure, and pool habitat currently limits natural production of trout.

ACTIONS

Action 3.1 Continue to work with the irrigators, OWRD, US Forest Service, and the public to restore winter flows, minimize flow fluctuations, and reduce the loss of fish habitat.

Action 3.2 Add spawning size gravel at suitable locations in the Deschutes River and tributaries to optimize spawning potential.

Action 3.3 Add wood and/or rock structure to the Deschutes River and tributaries to improve habitat productivity for adult and juvenile fish.

Action 3.4 Replant the riparian area with a variety of plant species to provide a source of large and small woody debris, bank stability, and shade.

Action 3.5 Seek opportunities such as water leases, water transfers, and off-stream storage or other conservation measures in order to improve instream flow for this section of the river.

Objective 4. Maintain and improve access to the Deschutes River between Wickiup Dam and Bend, Fall River and Spring River for boat and bank anglers.

Assumptions and Rationale

1. Bank access from Fall River to Benham Falls is limited by private land, but boat access is good.

2. Bank access from Benham Falls to Bend is limited by private land and lava flows. Boat access is restricted to short river sections between major falls.

3. Bank access on Spring River is very restricted by private land, however it is accessible by boat from the Deschutes River.

4. Bank access on Fall River is limited by private land. Boat use is virtually non-existent because of lack of access, small size of stream and barriers such as bridges, culverts, and falls.

ACTIONS

Action 4.1 Seek opportunities to develop river access for the public on private lands.

Action 4.2 As opportunities become available, form partnerships with landowners or managers to provide access or purchase easements for bank and boat access sites in the Deschutes River from Wickiup Dam to Bend, Fall and Spring rivers.

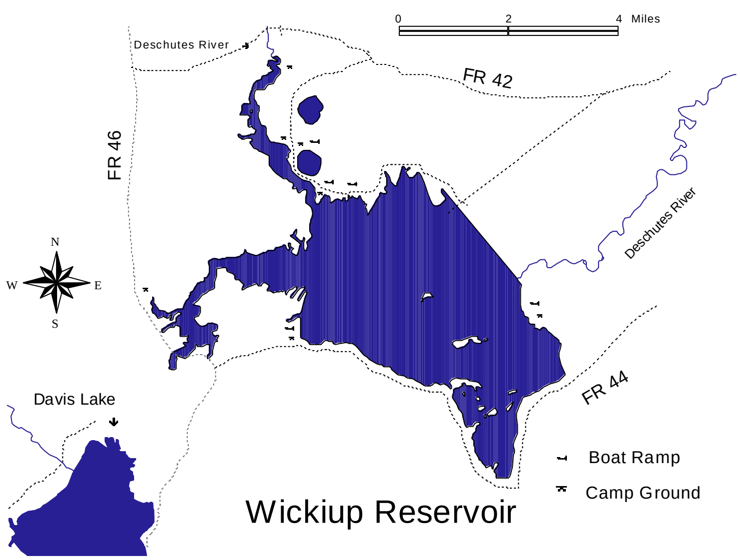
WICKIUP RESERVOIR AND ITS TRIBUTARIES

Overview

Wickiup Reservoir and the Deschutes River from Wickiup Reservoir to Crane Prairie Dam are being combined into one section because this section of the river is very short (two miles long when Wickiup is at full pool), Crane Prairie Dam has no fish passage and is screened, and fish use is closely correlated between the reservoir and the river.

Wickiup Reservoir

Wickiup Reservoir is one of three major storage impoundments (Crescent Lake and Crane Prairie Reservoir) in the upper Deschutes River subbasin. It is a popular



Central Oregon destination for fishing, boating, water-skiing, sailing, swimming, hunting, and camping.

The reservoir has a maximum storage capacity of 200,000 acre-feet and is the largest body of water on the Deschutes National Forest. A dam and two earth-filled dikes contain the reservoir. The main dam, built by the Bureau of Reclamation, is located on the Deschutes River at RM 227. The dam is located in the northeast portion of the reservoir and is 2.5 miles long. A 0.75 mile long dike is located on the east shore and a 0.25 mile dike is located in the southeast portion of the reservoir.

The reservoir began filling in 1942 with 20,000 acre-feet impounded. Reservoir capacity was increased annually until 1949 when the facility became fully operational by reaching its 200,000 acre-feet storage capacity. Water is released through a submerged outlet structure which is unscreened. Water storage rights and reservoir operational responsibility belong to the North Unit Irrigation District. Releases of water from the reservoir are coordinated with the Oregon Water Resources Department.

Location and Ownership

Wickiup Reservoir covers 10,334 surface acres when full at an elevation of 4,338 feet. The reservoir and its tributaries are approximately 45 miles southwest of Bend. Access is provided by Forest Service roads 46 (Century Drive), 42, 44, 4380, and 4260. The reservoir is within four hours drive of Oregon's largest cities.

Wickiup Reservoir and adjacent lands are under jurisdiction of the Deschutes National Forest. Developed Forest Service campgrounds in the Wickiup area include: Wickiup Butte, Gull Point, North Davis Creek, Reservoir, West South Twin, and Sheep Bridge. There are five improved boat ramps around the reservoir. During low water periods in late summer and early fall, boat launching becomes difficult as boat ramps are dewatered. Boat ramps have been extended to permit access during low water, however, they are still dewatered during the worst water years. In addition to the developed campgrounds, there are many dispersed campsites, especially on the east, south, and west shores. Many of these are traditional sites used for years by recreationists. There has been some damage to shorelines and uplands because of these sites and associated primitive roads.

There are no resorts on the reservoir. Twin Lakes Resort is located at South Twin Lake adjacent to Wickiup Reservoir. The resort maintains a few rental boats on the Deschutes River arm for use on the reservoir.

Habitat and Habitat Limitations

Wickiup Reservoir

Primary inflow is provided by release of stored water from Crane Prairie Reservoir via the Deschutes River. The average river flow for the period of record 1907 to 1988 was 209 cfs. The all-time high was 1160 cfs in 1947 and the all-time low was 0.9 cfs in 1977 (Deschutes National Forest, Deschutes River Survey, 1989-91). There is no established minimum flow for the Deschutes River below Crane Prairie Dam. Average monthly flow below Crane Prairie Dam and Wickiup Dam is shown in Figure 9.

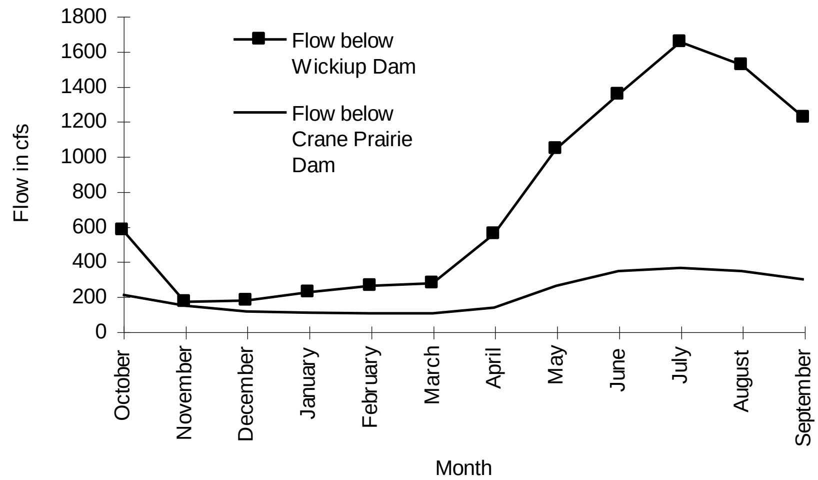


Figure 9. Average monthly flow in the Deschutes River below Wickiup Dam (1943-87) and Crane Prairie Dam (1922-87).

Other principal tributaries are Browns Creek and Davis Creek. Davis Creek is formed by flow from several large springs which collectively discharge an average of 250 cfs. The mean annual average flow for Browns Creek is 39 cfs (McCammon 1979). Numerous seeps and springs occur in the Deschutes and Davis Creek channels. The largest springs in the upper Deschutes River channel are Sheep Springs. For the years 1966-1992, Sheep Springs flows ranged from 200-420 cfs. The maximum flow ever recorded was 528 cfs and the minimum flow was 88 cfs (Kyle Gorman, ODWR personal communication 1995). Subterranean water loss associated with Wickiup averages 50 cfs (Robert Main, ODWR personal communication 1991).

The shoreline of Wickiup Reservoir is 50.5 miles in length and is very irregular in shape. Ninety-three percent of the shoreline is composed of pumiceous sand and the remaining seven percent is rock, primarily on the dam and dikes. Nearly all of the reservoir is surrounded by lodgepole forest.

About 85% of the reservoir bottom is composed of pumice. The remaining 15% is comprised of gravel and mud. The gravel is found in the stream channels along with mud banks. The bottom of the reservoir is very irregular. The Deschutes and Davis channels account for most of the irregularity. Many potholes are formed each summer as the water level drops; however, most of these potholes are dry by September.

Much of the reservoir bottom contains scattered tree stumps left when the reservoir site was logged. These stumps provide excellent habitat for aquatic insects, crayfish and fish cover. The Department is concerned about the loss of tree stumps from the reservoir. As the reservoir is drained each irrigation season, the water-logged stumps are exposed to the air, dry out and are uprooted as the reservoir fills. The stumps float and are carried by prevailing winds to be deposited on the shore. Many of the stumps collect on the dams and are annually removed and burned for maintenance purposes. During drought years, the amount of stump loss appears to increase because of longer exposure periods.

To offset the loss of stumps, the Department in cooperation with the Deschutes National Forest, began adding structure to the reservoir in 1991. By 1994, a total of 187 structures (rocks, whole trees, root wads) had been placed in the Deschutes and Davis Creek channels and Browns Creek.

Reservoir surface area and volume changes significantly during each irrigation season (April 15 - October 15). Maximum volume, up to 200,000 acre-feet occurs in April, and the minimum is reached in September to October. The lowest month-end content in the reservoir from water years 1965 to 1995 was recorded in September 1970 at 8,840 acre-feet. The mean storage contents for the same years at the end of September was 56,958 acre-feet. There is no minimum pool requirement for fish or recreation. Maximum depth is 70 feet, but will not exceed 50 feet from mid-August to November due to water withdrawal. The deepest part of the reservoir is in the Deschutes River channel which contains sufficient water for fishing even at maximum drawdown. Average depth of the reservoir at full pool is 20 feet (Johnson et al. 1985).

Favorable water temperatures and chemistry for aquatic production exist in Wickiup throughout the summer. The conductivity (51 umhos/cm) is higher than in most other Cascade lakes. The phosphorus concentration (0.033 mg/l) is also higher than in Cascades lakes generally, and much of it is probably derived from Crane Prairie Reservoir which has very high concentrations of phosphorus (.108 mg/l). The pH of the reservoir is 7.6, slightly alkaline (Johnson et al. 1985). Tributaries such as Browns Creek, Sheep Springs, and Davis Creek supply 40-50^{o}F water.

Aquatic vegetation in the form of low-growing submerged species is abundant in Wickiup. Shallow flats support willow stands. Emergent and floating species are not common because of water fluctuation. Plankton at Wickiup is composed mostly of phytoplankton. About 5% of the plankton is zooplankton. In spite of the moderate amount of phytoplankton, the water transparency of 26 feet is very good (Johnson et al. 1985). The abundance of plankton in the reservoir appears to be primarily related to outflow from Crane Prairie Reservoir.

The most abundant fish food organisms found in the reservoir are aquatic worms, clams, and larval flies. Although no specific studies have been done, it is believed the submerged stumps are significant producers of aquatic insects. Dragonfly, damselfly, mayfly, and caddis fly larvae are abundant in these areas. The reservoir also has a population of crayfish, a favorite food of brown trout.

Small Tributaries

Browns Creek, Davis Creek, Sheep Springs, and the Deschutes River provide spawning habitat for brown and rainbow trout, kokanee, whitefish, and brook trout. Coho salmon, although present in Wickiup, have never been observed spawning in the tributaries. It is believed water temperatures may be too cold for coho reproduction.

A 1967 Oregon Game Commission stream survey of Browns Creek showed 2,315 square yards of spawning gravel present in 2.25 stream miles. Of the total, 1,314 square yards was rated as good and 1,001 rated as marginal. In 1986, the Department and volunteers from Central Oregon fishing clubs added 40 cubic yards of spawning gravel to the upper sections of Brown's Creek.

There is no estimate of the amount of spawning gravel in Davis Creek. Observations indicate spawning habitat is very limited and is primarily used by whitefish. Trout have not been observed spawning in this tributary. Sheep Springs is heavily used for spawning, primarily by kokanee. Brown trout and whitefish have also been observed spawning in the spring area. There are no estimates of the amount of spawning gravel, but it appears to be abundant and useable.

Habitat limitations at Wickiup Reservoir are:

1. Severe water storage drawdown in some years- occurs during the fish growing season, reduces aquatic food production, increases competition between and among fish species, impacts recreational use of the reservoir.
2. No legal minimum pool for aquatic or recreational use.
3. Loss of pine and lodgepole stumps reduces fish cover and aquatic food production.
4. Outlet of reservoir is unscreened, allowing substantial loss of fish from reservoir, especially during severe drawdown years.

Deschutes River

This section varies in length due to fluctuations in the Wickiup Reservoir pool, but averages 2.5 miles. It may be up to 6 miles in late summer when the Wickiup pool level is down. The gradient averages 2% and the river bottom is composed of cobbles, boulders, and gravel. Shoreline vegetation is composed of Douglas fir, douglas spirea, ponderosa pine, lodgepole pine, white fir, and various forbs and grasses.

This section of the Deschutes River is characterized by generally good water quality. However, water quality in the mid-summer period deteriorates because of warm water releases from Crane Prairie Reservoir. An extensive amount of algae is released from Crane Prairie during the summer which discolors the river and triggers an algal bloom in Wickiup Reservoir.

The Deschutes River between Wickiup Reservoir and Crane Prairie Dam is used for spawning by brown and rainbow trout, whitefish, and kokanee. In 1967, Oregon State Game Commission personnel estimated the amount of spawning gravel present at different river flows in the section between Sheep Springs and Browns Mountain crossing, approximately 1.5 river miles (Table 24).

Table 24. Estimated square yards of spawning gravel in the Deschutes River between Browns Mountain crossing and Sheep Springs measured at three different flows, 1967.

	Square yards of spawning gravel	
Flow (cfs)	Good	Marginal
328	22,360	9,778
210	10,113	8,823
46	8,990	5,714
Total	41,463	24,315

A 1990 stream survey by the Deschutes National Forest (Walker) was conducted on the Deschutes River between Browns Mountain crossing and Crane Prairie Dam, approximately 0.65 river miles. Spawning gravel was not quantified, however the survey described substrates. The dominant streambed substrate type was cobble and the subdominant type was small boulders. Generally, the gravels and cobbles were not embedded. Spawning gravels were found at the beginning and the end of the section. The dominant streambank substrate was small boulder and the subdominant was cobble. The survey found trout cover was poor overall (0-5%) as the section was nearly all riffle. Woody material provided some additional cover, however the surveyor surmised that large woody material had been removed from the channel in the past and that the section is lacking in this cover type. The surveyor also commented that Crane Prairie Dam had eliminated recruitment of spawning gravel from upstream sources. It is also probable that gravel was washed out of this section by high irrigation flow releases and deposited in the Deschutes River channel of Wickiup Reservoir.

In 1992 and 1994, the Department and Deschutes National Forest completed fish habitat projects to correct deficiencies in spawning habitat and trout cover as noted in the earlier survey. A total of 1,000 cubic yards of spawning gravel and 40 whole trees were placed in approximately 1/4 mile of the Deschutes River just downstream from Crane Prairie Dam. An additional 37 whole trees were added in 1995.

Habitat limitations in the Deschutes River are:

1. No minimum flow release below Crane Prairie Dam for aquatic life or recreational use
2. Crane Prairie Dam has blocked recruitment of spawning gravel from upstream sources
3. Stream surveys have noted a lack of trout cover, pool area, and spawning gravel
4. Flow fluctuations below Crane Prairie Dam can significantly alter the amount of useable spawning gravel and trout rearing cover
5. Water temperatures rise in the summer due to release of warm surface water from Crane Prairie Reservoir

Fish Stocking History

Prior to construction of Wickiup Reservoir, this portion of the Deschutes River and tributaries was inhabited by indigenous redband trout, bull trout, and mountain whitefish. No bull trout have been reported from Wickiup since 1957. There is a small population of rainbow in the reservoir today, but their origin is unknown. Mountain whitefish still remain in large numbers.

In addition to the indigenous mountain whitefish and a small population of redband trout, the reservoir and its tributaries currently contain introduced brown trout, kokanee, coho salmon, brook trout, and tui chub.

Fish stocking began in 1947 with rainbow trout. Rainbow trout were stocked annually through 1979. The domestic rainbow stocks from Roaring River Hatchery (Lot 72) and Oak Springs Hatchery (Lot 53) were stocked during this period. No rainbow trout were stocked during the years of 1980-81. Although many rainbow were stocked in Wickiup, they did not consistently produce acceptable fisheries. The Deschutes River stock of rainbow (Lot 66), reared at Oak Springs Hatchery, were stocked during the period 1982-89. These fish were resistant to the disease *Ceratomyxa shasta*, known to occur in Wickiup Reservoir and prevalent throughout the mainstem of the Deschutes River below Crane Prairie Reservoir. It was believed these fish would survive at higher rates and produce consistent fisheries. This did not occur and no rainbow trout have been stocked in Wickiup since 1989.

Brown trout stocking started in 1951 and continues to the present. Brown trout are stocked to augment natural reproduction and replace lost fish production from the annual egg collection at Browns Creek. In some years, brown trout have not been available for stocking because fish could not be captured in Browns Creek for egg collection. No hatchery brown trout brood exist. Historically, the stocking program has been maintained by spawning fish at East and Suttle lakes and Browns Creek (Wickiup Reservoir). Since 1990, the sole source of brown trout eggs for Oregon has been Browns Creek. Presently, 6,000 brown trout at a size of 6 per pound are allocated annually for Wickiup Reservoir.

Kokanee were stocked beginning in 1958 and continued until 1986. The kokanee stock used was the product of blending Montana, British Columbia, and Washington stocks. Presently, the kokanee population is maintained solely by natural reproduction.

Coho salmon (Sandy River stock, *C. shasta* resistant) were first stocked in 1966. They have been stocked annually, through 1993, at a rate of 100,000 fingerlings at 100 per pound. Due to a shortage of Columbia River coho, none were available for stocking in 1994 and 1995.

Brook trout stocking began in 1950 and continued until 1963. They are not resistant to *C. shasta* and did not produce acceptable fisheries. Today, brook trout are found primarily in the cold tributaries.

Two brown bullhead catfish were captured in Department gillnets in 1987 and 1988. They were likely illegal introductions, but their present population status is unknown.

Largemouth bass have been observed by Department personnel in 1993 and 1995 while snorkeling in the Deschutes River below Crane Prairie Dam. Anglers have reported catching largemouth bass in the reservoir, but the Department has no verification. The outlet screens at Crane Prairie Dam would permit bass fry to pass downstream. The emergency overflow spillway is also unscreened and has the potential to allow bass (and other fish) downstream. There was flow through this channel in the spring of 1996 for a few days until ODWR personnel increased flow through the dam outlet.

Tui chub were first documented in Wickiup in 1950, most likely as a result of illegal introduction. Their population has remained relatively stable, most likely fluctuating with water cycles.

Angling Regulations

There have been a variety of angling regulations for Wickiup Reservoir and its tributaries (including the Deschutes River) since the reservoir began filling in 1942. Listed below are the most significant changes:

1948 Deschutes River closed to all angling from Crane Prairie Dam downstream to Sheep Bridge.

1949 Bag limit of 5 fish, but not to exceed 15 pounds and 1 fish per day.

1951 Bag limit changed to 5 fish per day, 10 in possession.

1955 Bag limit changed to 10 fish per day, 5 over 12 inches.

1961 Deschutes River closure extended to 1/4 mile below Sheep Bridge September 5 - October 31.

1965 Bag limit changed to 10 fish per day, 5 over 12 inches, 2 over 20 inches.

1966 Deschutes River closure extended to 1/2 mile below Sheep Bridge.

1968 Deschutes River closed to angling from Crane Prairie Dam downstream 1/4 mile to cable crossing. Cable crossing downstream to Sheep Bridge closed to angling September 1 - October 31.

1974 Deschutes River closed to angling from Crane Prairie Dam down to Department marker 100 feet below mouth of Browns Creek September 1 - October 31. Browns Creek closed to angling September 1 - October 31.

1980 New stream bag limit; 5 trout per day, 2 over 20 inches.

1988 Bonus bag limit of 25 for kokanee and coho, in addition to trout limit, in Wickiup Reservoir.

1990 Reservoir trout bag limit reduced to 5 per day, 1 over 20 inches.

1994 Deschutes River closure extended downstream to Gull Point boat ramp.

Presently, the reservoir is open to fishing from the traditional late April opener to October 31. The Deschutes River is closed to angling from Crane Prairie Dam downstream to Gull Point boat ramp September 1 - October 31. Browns Creek is closed to angling September 1 - October 31. The trout bag limit is 5 fish per day, 6 inch minimum, with 1 over 20 inches. An additional 25 kokanee and/or coho, no size limits, are allowed in addition to the trout limit. There is no limit on whitefish. The bass limit is 5 per day, no more than 3 over 15 inches. There is no boat speed limit in the main reservoir, however, the Deschutes River and Davis Creek arms are restricted to 10 mph.

Fish Management

Wickiup Reservoir and its tributaries are heavily used by anglers throughout the season. It is a large reservoir (10,000 surface acres when full) and has excellent public access with an abundance of developed and dispersed camping opportunities. It is within 3-4 hours driving time of Oregon's population centers. The predominant use of the reservoir is for fishing. Other recreational uses include water skiing, swimming, and waterfowl hunting. The majority of anglers fish from boats. However, there are bank angling opportunities, especially early or late in the season from the dams and the shore of the Deschutes River channel. Recreational use of the reservoir is affected by the degree of summer drawdown, however, there is sufficient water remaining in stream channels to provide angling opportunities even in the worst years.

Wickiup Reservoir and its tributaries have been managed as Basic Yield fisheries for indigenous whitefish, introduced hatchery and naturally-producing populations of brown, rainbow, and brook trout, kokanee, and coho salmon.

The reservoir has a reputation for producing large brown trout and until 1993, it held the official Oregon record with a fish weighing 24 pounds, 14 ounces. Brown trout anglers generally troll lures or flies with best success early or late in the day. Best success for brown trout occurs early in the season when the fish are in shallow water and late in the season when they are concentrated in stream channels. The primary fishery is for kokanee and coho. These fish are harvested by boat anglers trolling flasher/lure combinations, jigging lures or still fishing with bait. Whitefish are generally caught incidentally by anglers using bait, however, there is a target fishery in upper Davis Creek channel during the summer where whitefish concentrate in the cold spring water. Redband and brook trout appear as incidental catch each year. The redband fishery has declined substantially through the years. Rainbow trout stocking was reduced and eventually terminated because of poor returns to the creel.

A total angler use and catch study has never been done on Wickiup Reservoir and its tributaries. In 1979, Department biologists made angler use and catch estimates (not statistically valid) for all waters in the state. At that time, it was estimated 25,000 gamefish were caught annually in Wickiup and its tributaries by an estimated 25,000 anglers or an average of 1.0 fish per angler. Random creel checks at Wickiup Reservoir and its tributaries during the years 1970-90 showed anglers averaged 0.36 fish per hour and 1.13 fish per angler (Table 25).

Table 25. Catch rates from random creel checks, Wickiup Reservoir and its tributaries, 1970-90.

Anglers checked	Hours fished	Total fish caught	Fish per angler	Fish per hour
3,507	10,899	3,960	0.36	1.13

Of the total gamefish caught, 79 percent were comprised of kokanee and coho, (Table 26).

Table 26. Composition of catch by species from random creel census at Wickiup Reservoir and tributaries, 1970-90.

Species	Fish caught	Percent of total catch
Kokanee	2,488	63%
Coho	648	16%
Rainbow trout	463	12%
Brown trout	292	7%
Whitefish	58	>1%
Brook trout	11	<1%

The fish population in Wickiup Reservoir is inventoried using multiple-mesh gillnets. Data collected includes fish per net, size class distribution in one-inch increments, weight, and length of each fish. In addition, the fish are examined for sexual maturity, body condition, stomach contents, and parasites. Kokanee spawn naturally in tributary streams and springs. Lengths of spawning kokanee are sampled each fall in Browns Creek and lengths of spawning brown trout are taken during the annual egg collection. Periodic spawning ground counts are made in the Deschutes River between Crane Prairie Dam and Sheep Springs. The recent addition of spawning gravel in the Deschutes River below Crane Prairie Dam has resulted in a dramatic increase in brown trout spawning (Table 27).

Table 27. Brown trout redd counts on a 1/4 mile section of new spawning gravel in the Deschutes River below Crane Prairie Dam, 1991-94.

Year	Number of redds
1991	7[a]
1992	50
1993	147
1994	83[b]

a Pre-project count
b Low flows in the Deschutes may have forced fish to spawn downstream near Sheep Springs.

The outlet of the reservoir is unscreened and allows fish to escape when water levels are drawn down. The outlet's depth is approximately 70 feet which rules out the use of conventional fish screening. It does not appear to be technically feasible to screen such an outlet at this time.

When the reservoir drops below 40,000 acre-feet of storage the loss of fish through the outlet increases, as fish become concentrated in the Deschutes River channel of the reservoir. These are primarily kokanee and coho, fish with strong migrational tendencies.

Thousands of kokanee and coho salmon and lesser numbers of brown trout can be lost from the reservoir annually. Evidence of kokanee loss from the reservoir to the river has been demonstrated by trapping the bypass at the Central Oregon Irrigation District canal near Bend. The trap was operated during the irrigation season in 1984, 1989, and 1990. The number of kokanee captured in the trap were 17,367, 58,625, and 38,665 respectively (Craven 1991). Of all fish trapped during the three years, kokanee comprised 92.5% of the total. The accelerated loss of kokanee during severe drawdown years can be demonstrated by comparing the above trap catches with the reservoir storage level at the end of September for corresponding years (Table 28).

Table 28. A comparison of Wickiup Reservoir storage level at the end of September with the number of kokanee caught in the Central Oregon Irrigation canal bypass trap, 1984 and 1989-90.

Year	September 30 storage (af)	Number of kokanee trapped
1984	117,600	17,367
1989	35,590	58,625
1990	33,008	38,665

Untold additional kokanee and other gamefish from Wickiup Reservoir are lost annually in other unscreened or inefficiently screened canals on the Deschutes River near Bend.

During a period of high water years, natural production of kokanee results in too many fish for the available food supply and the size of the fish declines rapidly. Conversely, in the low water cycles, fish losses through the outlet increase and remaining fish have an abundant food supply resulting in larger fish (Figure 10).

Sheep Springs kokanee spawning ground counts for the early period of 1958-62 showed 26 to 900 redds and 48 to 4,000 fish. Spawning ground counts for kokanee are no longer done at Sheep Springs because the large number of fish precludes accuracy. It is estimated that several hundred to several thousand kokanee spawn at Sheep Springs each fall. Several hundred kokanee also spawn in Browns Creek, but no annual counts are done.

The Department has collected brown trout eggs from spawning fish at East Lake, Suttle Lake and Browns Creek in past years. Since 1991, all brown trout eggs for statewide use have been collected at Browns Creek. In 1994, 36 female brown trout were spawned producing 144,000 eggs.

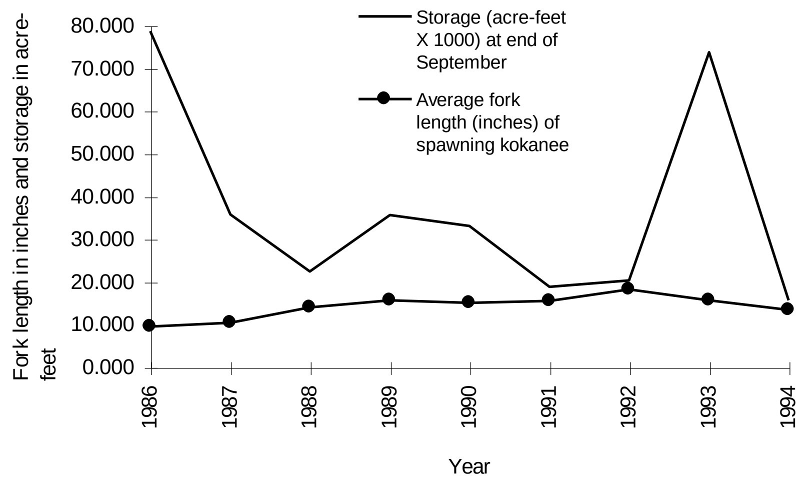


Figure 10. A comparison of the average fork length of spawning kokanee with storage (1,000s of acre-feet) at the end of September in Wickiup Reservoir, 1986-1994.

Historically, redband trout were indigenous to that portion of the Deschutes River now inundated by Wickiup Reservoir. It is not known if or to what extent a variety of hatchery rainbow stocks and the indigenous redband trout may have interacted since the first rainbow stocking in 1947. Since the reservoir was built, there have been no established redband trout spawning ground counts in tributaries, suggesting the historic redband spawning occurred upstream of Crane Prairie. Rainbow trout from the reservoir and its tributaries have not been examined for genetic characteristics. Today, rainbow trout are not abundant, appearing only occasionally in angler creels. However, Forest Service biologists doing stream surveys of the Deschutes River below Crane Prairie Dam, found 16 redds in the spring of 1990 which they presumed were made by rainbow trout (Walker 1991). Department biologists observed a few large rainbow trout spawning just downstream of the Browns Mountain bridge in April of 1994. Recent and future improvement of spawning habitat in this section of the Deschutes River may lead to an improvement of the rainbow population in Wickiup Reservoir.

There are no known chronic parasite problems in Wickiup Reservoir fish populations. Tapeworms appear occasionally, but are not fatal. The disease *C. shasta* is known to exist in the reservoir and is thought to be the major limiting factor for production of hatchery rainbow and brook trout. The disease does not appear to impact other species in the reservoir or its tributaries. In the spring of 1985, a massive die-off of kokanee occurred in the reservoir for the first time. Tens of thousands of kokanee and a handful of large brown trout died in the span of a few weeks. Eventually, Department pathologists concluded the cause was a rare combination of a large kokanee population stressed by a previous severe winter, starvation, and the common fish fungus *Saprolegnia* which attacked the weakened fish and spread throughout the population. No such losses have been observed 1985.

Management Issues

Fish management issues for Wickiup Reservoir and the Deschutes River are:

1. There is no hatchery brown trout broodstock, and in some years brown trout cannot be stocked because of a lack of brown trout in Browns Creek for taking eggs. This area receives special protection.
2. Bull trout were indigenous to the Upper Deschutes basin, but disappeared in the 1950's primarily due to the construction and operation of Wickiup and Crane Prairie reservoirs. The potential for a successful re-introduction has not been assessed.
3. It is unknown if any indigenous redband trout remain in this portion of the Upper Deschutes subbasin. The extent of interaction and possible interbreeding between hatchery rainbow and redband trout since rainbow were first stocked in 1947 is unknown. Rainbow trout have not been sampled for genetic analyses.
4. The fish production potential is limited by reservoir pool level. There is no minimum pool level for fish life or recreation. There is also no minimum flow for the Deschutes River below Crane Prairie Dam.
5. A total estimated angler use and catch study for the reservoir and its tributaries has never been done, so the current magnitude of the fishery and catch composition is unknown.
6. There is an annual loss of tree stumps from the reservoir resulting in lost aquatic food production and fish cover. Projects to replace structure have been done, but are relatively small in scope. The overall fish production capability of the reservoir may decline in the future.
7. The outlet of the reservoir is unscreened, resulting in substantial fish losses, especially during severe drawdown years. However, periodic losses of kokanee through the outlet may be a factor in controlling population levels in harmony with available food. Loss of other gamefish, such as brown trout and coho may limit fishery potential.
8. Brown bullhead catfish and largemouth bass have been observed in the reservoir and Deschutes River. The present status of these populations is unknown. It is believed the catfish were illegally introduced and the bass probably moved downstream from Crane Prairie Reservoir as fry which could easily pass through the outlet screens. The potential impact of catfish and/or bass on salmonids in Wickiup and its tributaries is unknown.
9. The whitefish population in Wickiup Reservoir and its tributaries is healthy and probably under-utilized by anglers. No studies on whitefish have been done.
10. Stream surveys have shown fish habitat in tributaries is limited in spawning gravel, pool area, and cover. Some spawning gravel is imbedded with fine sediment. Projects to improve spawning and rearing habitat for trout have been done in Browns Creek and the Deschutes River. More work is needed.

MANAGEMENT DIRECTION

POLICIES

Policy 1. Brown trout will be managed for natural and hatchery production consistent with the Trophy Fish Management Alternative for trout (ODFW 1987).

Policy 2. Rainbow trout, kokanee, and mountain whitefish will be managed for natural production consistent with the Basic Yield Management Alternative for trout (ODFW 1987). No hatchery rainbow trout, kokanee, or mountain whitefish will be stocked.

Policy 3. Coho will be managed for hatchery production consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 4. Brook trout will not be stocked in Wickiup Reservoir and its tributaries.

OBJECTIVES

Objective 1. Maintain the genetic diversity, adaptiveness, and abundance of redband trout, mountain whitefish and naturally produced brown trout.

Assumptions and Rationale

1. It is not known if a self-sustaining population of redband trout is present in Wickiup Reservoir and its tributaries.

2. Redband trout indigenous to the Upper Deschutes River and its tributaries have been identified as a provisional wild fish population.

3. Extensive numbers of non-indigenous hatchery rainbow have been introduced into Wickiup Reservoir since 1947. These fish may have interacted with the redband trout upstream in the river, possibly reducing their genetic fitness.

4. Electrophoresis will be used to determine what effect hatchery stocks may have had on the redband trout and what genetic stock of rainbow currently exists.

5. Special regulations will be needed to protect stock fitness, life history characteristics, and population health if electrophoresis proves the existence of redband trout.

6. Monitoring abundance, size, structure, and distribution of redband trout will provide an indication of their health and adaptiveness.

7. Wickiup Reservoir and its tributaries support an abundant and healthy population of wild mountain whitefish.

8. Monitoring abundance, size, age-class, structure, and distribution of mountain whitefish will provide an indication of their health and adaptiveness.

ACTIONS

Action 1.1 Establish baseline data sets on genetic characteristics of redband trout using biochemical (electrophoresis) and phenotypic parameters and compare to existing electrophoretic data from other areas in the Deschutes basin.

Action 1.2 Verify, document, and establish population trends of redband trout if electrophoresis establishes evidence of their existence. Population trends will be determined through conduct of periodic creel surveys, net inventories, spawning ground and snorkeling surveys.

Action 1.3 Hatchery rainbow trout will not be stocked in this portion of the Upper Deschutes basin if genetic analyses establishes evidence of redband trout.

Action 1.4 Determine the need for additional or modified angling regulations to protect populations of redband trout by monitoring the production, harvest, and catch rates.

Action 1.5 Establish population trends of mountain whitefish during annual inventory activities of trout populations.

Objective 2. Provide a trophy fishery for naturally produced brown trout as measured by the proportion of fish examined in the creel over 20 inches in Wickiup Reservoir and its tributaries.

Assumptions and Rationale

1. Wickiup Reservoir and its tributaries have historically produced trophy brown trout.

2. There is strong public interest in angling for these trophy brown trout.

3. Special regulations (catch limits, size restrictions, and/or gear restrictions) will be necessary to achieve this objective. Special regulations are currently in effect to protect fish while spawning in the tributaries.

4. Restricting harvest to one fish greater than 20 inches will allow brown trout to spawn at least once prior to harvest and maintain desirable natural reproduction.

5. The Department lacks recent creel information on brown trout including the proportion of those fish caught which exceed 20 inches. Information obtained by monitoring the catch will provide an indication of the proportion of the population that is greater than 20 inches as well as compliance with this regulation.

ACTIONS

Action 2.1 Verify size and age at maturity for brown trout to determine if the angling regulation (only one fish greater than 20-inch catch limit) is adequate to provide spawning escapement.

Action 2.2 Monitor abundance, size, age-class, structure, and distribution of brown trout by conducting periodic creel surveys and periodic netting.

Action 2.3 Maintain angling regulations to protect spawning brown trout in staging areas, and restrict harvest to one fish greater than 20 inches.

Objective 3. Provide diverse angling opportunities for a consumptive and/ or non-consumptive fishery on naturally producing mountain whitefish, brown trout, rainbow trout, coho, and kokanee. Provide viewing opportunities for spawning fish.

Assumptions and Rationale

1. These fisheries will be of a general consumptive nature, however opportunities will be examined for non-consumptive use such as viewing spawning fish.

2. Year-class abundance of kokanee varies with the amount of water in Wickiup Reservoir. In good water years, juvenile kokanee survival is enhanced and that year-class is more abundant when they enter the fishery three years later.

3. A catch rate of approximately 1.0 fish per hour provides an adequate fishery.

4. Very restrictive angling regulations may be required to maintain naturally producing fish populations.

5. Population levels of whitefish appear to vary with the amount of water in Wickiup Reservoir, but the average population level can be more fully utilized in the reservoir and tributaries. Many people are not aware of the excellent sporting and eating qualities of whitefish.

6. There is no known natural reproduction of coho although more surveys are needed.

7. Wickiup supports an abundant and healthy population of naturally reproducing kokanee.

8. Special bonus bag limit regulations have been enacted to increase utilization on coho and kokanee.

9. Sheep Springs is heavily utilized as a spawning area by kokanee. Eagles and osprey feed on these spawning fish. The area provides a viewing opportunity for fish and birds.

10. Estimates of total angler use and catch for Wickiup Reservoir and its tributaries are not available and a statistically designed creel study has never been done.

ACTIONS

Action 3.1 Monitor abundance, size, age-class, structure, and distribution of trout and whitefish by conducting periodic creel surveys, electrofishing, snorkeling, spawning surveys, and periodic net inventories.

Action 3.2 Publicize information on the desirable attributes of whitefish, angling techniques, and opportunities.

Action 3.3 Work in cooperation with USFS and ODFW wildlife managers to publicize the opportunity for fish and wildlife viewing at Sheep Springs. Develop in partnership with USFS a public viewing facility near Sheep Springs that has a minimum impact on eagles and ospreys.

Action 3.4 Conduct a season-long statistical creel study to estimate total angler use and catch in Wickiup Reservoir and its tributaries.

Objective 4. Protect, enhance, and restore trout and whitefish habitat in Wickiup Reservoir and its tributaries.

Assumptions and Rationale

1. The annual loss of tree stumps, the pumice substrate, fluctuating water levels, lack of aquatic vegetation and structure in Wickiup Reservoir reduces aquatic food production and fish rearing habitat.

2. Spawning habitat in the Deschutes River and tributaries was lost due to inundation by Wickiup Reservoir. Construction of Crane Prairie Dam terminated gravel recruitment from upstream sources. Flow releases from Crane Prairie have flushed gravel from the river above Wickiup Reservoir downstream into the Wickiup pool area where its value for successful fish spawning is largely determined by reservoir levels each year.

3. The outlet of Wickiup Reservoir is unscreened. It is not technically feasible to screen the outlet. Loss of fish through this unscreened outlet will continue to affect fish production in the reservoir.

4. Modification to the operations of Crane Prairie and Wickiup reservoirs may be necessary to sustain optimum natural production of fish. These modifications may include, fish screening, minimum flow release below Crane Prairie Dam, flow release timing, minimum reservoir pool, and adjustments in reservoir filling schedules.

7. Maximum benefits from habitat restoration will only occur with stable flows in the river channel and physical restoration of riparian and instream habitat.

ACTIONS

Action 4.1 Encourage irrigation districts and irrigators, through education and financial assistance where available, to conserve water by improved water distribution and application techniques. Water conservation will be essential to provide minimum stream flows necessary to maintain aquatic life.

Action 4.2 Add spawning-size gravel at suitable locations in the Deschutes River below Crane Prairie Dam and tributaries to maximize the spawning potential of wild fish.

Action 4.3 Add wood and/or rock structure to the Deschutes River below Crane Prairie Dam, Wickiup Reservoir and other tributaries to restore habitat productivity for adult and juvenile fish.

Action 4.4 Replant degraded riparian areas with a variety of suitable plant species to provide a source of large and small woody debris, bank stability, shade, and other riparian benefits.

Action 4.5 Continue to be informed about technological developments in screening of deep water outlets with the goal of eventually screening the Wickiup outlet.

Action 4.6 Conduct a feasibility study on providing fish passage at Wickiup Dam.

Action 4.7 Coordinate with irrigation districts and Oregon Water Resources Department to provide desirable flow releases from Crane Prairie Reservoir necessary for spawning fish and egg incubation in the Deschutes River below.

Action 4.9 Identify Browns Creek and the Deschutes River below Crane Prairie Dam as high priority law enforcement areas through the Coordinated Enforcement Program (OSP). The enforcement priority would be during spawning periods.

Objective 5. Work with the land managers and irrigation districts to maintain and improve public access.

Assumptions and Rationale

1. Public access is adequate at the present time, but may change in the future due to growth in recreational demand or changes in land use.

2. Dispersed camping and boat access at Wickiup Reservoir may need to be more controlled to prevent damage to shoreline areas.

3. Boat launching is difficult during periods of severe drawdown. New boat ramps or modification to existing facilities may be required.

ACTIONS

Action 5.1 Coordinate with the USFS, State Marine Board, and irrigation districts to maintain or improve public access to the reservoir and its tributaries.

Objective 6. Determine the feasibility and desirability of restoring bull trout in Wickiup Reservoir and its tributaries.

Assumptions and Rationale

1. Bull trout were historically distributed throughout the Upper Deschutes River.

2. Restoring bull trout may eliminate some existing fisheries and create new fisheries with subsequent economic losses and benefits.

3. The range of bull trout will be expanded which would reduce the risk of extinction in the future.

4. Bull trout may be an effective predator on introduced tui chub. They may also be an effective predator on kokanee which may jeopardize a popular sport fishery in some years.

5. Stock from the Metolius River are suitable and available in adequate numbers for reintroduction.

6. Brook trout populations are present in the Wickiup Reservoir and its tributaries which would present difficult problems related to hybridizing and competition with bull trout.

7. Bull trout are very susceptible to harvest by angling.

8. The outlet of Wickiup Reservoir is unscreened resulting in annual losses of gamefish.

ACTIONS

Action 6.1 A feasibility study will be conducted to determine if the reintroduction is technically possible and what biological, social, and economic factors would be involved.

CRANE PRAIRIE RESERVOIR AND TRIBUTARIES

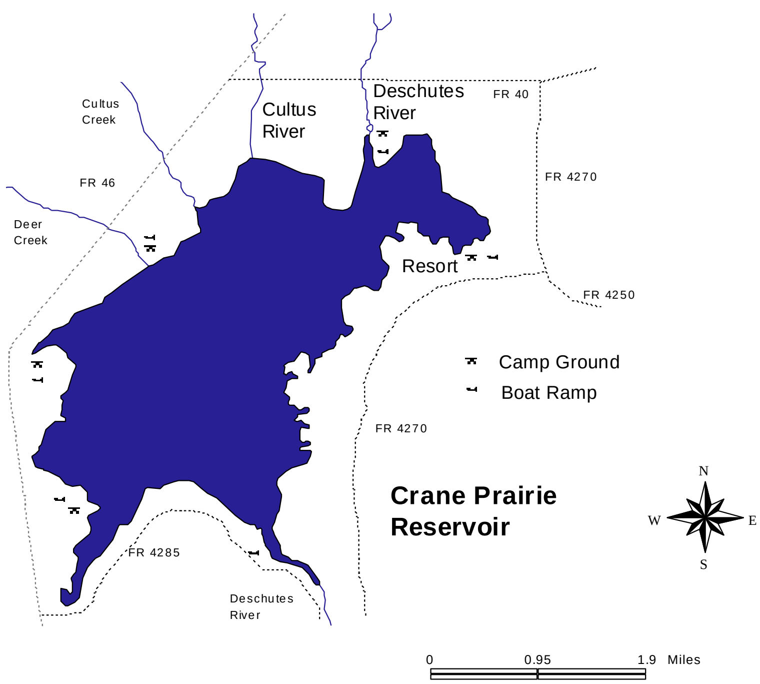
Introduction

Because of the physical and biological connections of the waters, this section combines Crane Prairie Reservoir with its tributaries. Natural reproduction of Crane Prairie fish occurs in the tributaries and, conversely, management of the streams may directly affect the reservoir populations. Of the tributaries, the Deschutes River is the most significant and it receives the primary emphasis in the following material.

Location and Ownership

Crane Prairie Reservoir is a large, shallow impoundment on the upper Deschutes River approximately 30 miles southwest of Bend and is accessible from Century Drive (Forest Road 46), and Forest Roads 40, 42, and 4270. The reservoir is on Deschutes National Forest land at an elevation of 4,445 feet.

There are four Forest Service campgrounds and five public boat ramps on the reservoir. A private resort, private boat ramp, and RV park are located on the northeast shore.



These facilities are operated under Forest Service permit. Crane Prairie Reservoir was first created in 1922 by a rock-filled dam constructed by the Bureau of Reclamation. The reservoir was built to provide irrigation water for three Central Oregon irrigation districts- Lone Pine, Arnold, and Central Oregon.

The portion of the Deschutes River addressed here (RM 252-243), lies entirely on Deschutes National Forest land and is approximately 41 miles southwest of Bend. Access is excellent due to the river's proximity to the Cascade Lakes Highway (Forest road 46), which closely parallels the river for approximately three miles. Four developed campgrounds are adjacent to the river. They include Little Lava Lake, Mile, Deschutes Bridge, and Cow Meadow campgrounds. Two other all-weather roads providing excellent access are Forest roads 40 and 620. Access to the headwaters is provided by the road to Little Lava Lake. Forest road 4270 crosses the river at the Deschutes Bridge and Forest road 40 crosses one mile north of Crane Prairie Reservoir. Primitive roads also provide access to the river in several locations. Access to Snow Creek is reached via the Cow Camp Campground and road 4270.

Habitat and Habitat Limitations

<u>Crane Prairie Reservoir</u>

Crane Prairie was a natural meadow in which the Deschutes River, Cultus River, Rock Creek, Cold Creek, Quinn River, Deer Creek, and Cultus Creek converged. The Deschutes River originates approximately 8.4 river miles north in Little Lava Lake, a spring-fed body of water. Cultus River emerges from a spring approximately three miles northwest of the reservoir. Cultus Creek begins at the outlet of Big Cultus Lake approximately 2.5 miles northwest of the reservoir. Deer Creek, the outlet of Little Cultus Lake, begins approximately 2.5 miles west of Crane Prairie. Quinn River originates from a spring on the west shoreline of the reservoir and flows approximately 0.25 miles before intercepting impounded water. Cold and Rock Creeks, shown on old survey maps, are entirely inundated by the impounded waters. Springs in the southwest and northwest portions of the reservoir provide small quantities of inflow. Seeps and natural ditches contribute water from Crane Prairie Meadow at the north end of the reservoir.

In 1940, a new dam was built on the Deschutes River at RM 239 by the Bureau of Reclamation, replacing the original structure because of leakage and safety concerns. The dam and reservoir are operated by Central Oregon, Arnold, and Lone Pine Irrigation Districts. The dam is an earth-filled structure 36 feet high and 285 feet long at the crest. The outlet structure at Crane Prairie Dam is screened to prevent fish losses. Although holes in the screens have been noted by Department biologists on a least two occasions, the irrigation districts routinely inspect the screens and replace any defective screen panels. Screen inspection and repair is necessary on a regular basis to prevent fish loss. There are no fish passage facilities at Crane Prairie Dam.

The reservoir has a maximum capacity of 55,330 acre-feet covering 4,960 surface acres. At full pool, the average depth is 11 feet with a maximum of 20 feet. The shoreline has a length of 22.3 miles. It is 4.9 miles long and 2.2 miles wide.

When the reservoir was first filled, waters flooded most of Crane Prairie and part of the adjacent forest, killing most trees. For several years, the reservoir was drained to allow harvest of marketable timber. Today, the reservoir shows the result of flooding the meadow and uncut timber. Lodgepole and ponderosa snags and stumps are prominent features. These snags provide nesting, roosting, and feeding sites for large numbers of osprey. The Crane Prairie Osprey Management Area, covering 10,600 acres, was established in 1970. The reservoir also supports large numbers of other water-associated birds such as bald eagles, blue herons, cormorants, mergansers, kingfishers, ducks, geese, and swans.

The dead timber is also important as fish cover and as a producer of aquatic insects. A study by the Oregon State Game Commission in 1967 (King) showed that submerged lodgepole pine produced an average of 90.5 insects per square foot. In comparison, sampling of the reservoir bottom produced an average of 27.9 insects per square foot. The most prevalent invertebrates in the reservoir are the Diptera (two-winged flies), Hirudinea (leeches), Emphemeroptera (mayflies), Gastropoda (snails), and Annelida (worms). Extensive hatches of Odonata (dragonflies, damselflies) occur frequently. Bottom sampling in 1962 showed invertebrate production to be as high as 102 pounds per acre. Dragonfly and damselfly (nymph stage) are collected by anglers at the reservoir for trout bait. Aquatic insect inventories have not been conducted to determine the affect of this insect collecting, but no changes have been observed in trout body condition or growth, two indicators of changes in insect food supply. Much of the aquatic insect habitat is found in inaccessible log debris and aquatic vegetation mats. These areas serve as aquatic insect refuges. Anglers gather dragonfly and damselfly nymphs primarily along the shore by turning over logs.

Cover and food production provided by the dead trees is also vitally important for maintenance of the reservoir bass population. Aquatic insects comprise a large proportion of the bass diet, especially when tui chub numbers are low. The importance of woody structure as cover for juvenile, adult, and spawning largemouth bass has long been acknowledged. As a result, any significant decrease in the amount of submerged timber could negatively affect the survival, growth, and reproductive success of Crane Prairie largemouth bass, and ultimately, the associated fishery.

Over the years, much of the standing dead timber has fallen due to a combination of wind, ice, and exposure to the air during low water. Trees that go down either float or sink. Those that float are either deposited on the shoreline or carried by current and wind toward the dam. There, they accumulate in debris jams providing habitat for fish and waterfowl. However, the Bureau of Reclamation has ordered the irrigation districts to remove these jams for dam safety reasons. Trees which sink provide excellent fish habitat and aquatic food production, but can be hazards for power boats. Eventually, the entire character of Crane Prairie Reservoir will change as all the trees go down. The stream channels lose their definition, wind sweep intensifies, windward bank erosion accelerates, boat navigation becomes more difficult, and angler use patterns change.

The shallowness of Crane Prairie Reservoir affords optimal conditions for the growth of submergent and emergent vegetation including *Elodea canadensis*, *Ceratophyllum demersum*, and various species of *Potamogeton*. Bottom types vary around the shoreline, but the main body of the reservoir has a silt and detritus bottom. The river channels are composed of sand and gravel mixed with detritus. Portions of the southern and eastern shorelines have sandy beaches. The lava formations in the southeast portion of the reservoir provide lava bedrock as a substrate.

Dense algae blooms in summer reduce underwater visibility to almost zero. At other seasons, the bottom is generally visible in most areas.

Sharp water temperature changes occur between the stream channels and the main body of the reservoir. It is possible to record temperatures from 44-75^{o}F in mid-summer, depending on location. This variety of temperatures provides habitat for various salmonids, largemouth bass, and tui chub. Generally, all portions of the reservoir contain ample dissolved oxygen with mid-summer readings of 7.5-9.4 parts per million.

The water has a moderate alkalinity and moderate mineral content, slightly higher than other lakes and reservoirs of the region. However, in the summer, the pH is exceptionally high, frequently in excess of 9 and, at times, approaching 10. The high pH is caused by the growth of phytoplankton which frequently reach bloom proportions. The concentration of phosphorus is well above average for Cascade mountain lakes, and encourages algal blooms (Johnson et.al 1985).

The total inflow to the reservoir in any given water year can vary considerably depending on wet or dry precipitation cycles. For example, for the water years 1966-92, the total annual inflow to Crane Prairie ranged from a low of 122,984 acre-feet in 1992 to a high of 311,932 acre-feet in 1972. The average annual inflow for these years was 188,809 acre-feet. Accordingly, storage levels in the reservoir reflect the inflow patterns. For example, for the water years 1965-1993, storage in the reservoir at the end of September ranged from a low of 9,470 acre-feet in 1980 to high of 46,510 acre- feet in 1984. For these years, at the end of September, the mean storage was 21,794 acre-feet (Robert Main, Oregon Department of Water Resources, personal communication, 1994).

Broken lava flows are a prominent geologic feature, especially on the east shoreline of the reservoir. Water losses into these lava flows is substantial and increase with water storage level. Reservoir surface areas of 3,620, 3,970, 4,290, and 4,960 acres have associated water losses of 22, 38, 65, and 135 cfs (Kunkel and Marx 1991). A dike was constructed by the irrigation districts in 1961 and a second dike in 1967 in an attempt to reduce water loss. A Forest Service study in 1981 concluded the dikes saved an average of 1,960 acre feet per month during drawdown months and 1,436 acre feet per month during fill months (McCammon 1981). The effectiveness of the dikes today is unknown. It is likely they have eroded and need repair if this type of water loss were to continue. There may be other water loss areas which could be sealed.

Habitat limitations at Crane Prairie Reservoir are:

1. Severe water storage drawdown in some years; occurs during the fish growing season. Impacts bass spawning, reduces food production, increases competition between and among fish species and reduces volume of trout rearing area.
2. Water loss in lava formations; increases with storage increases.

3. No legal minimum pool for aquatic or recreational use.
4. Loss of standing dead timber reduces fish cover and aquatic food production.

Smaller Tributaries

The tributaries to Crane Prairie Reservoir provide varying amounts of trout spawning and rearing habitat for both reservoir and resident fish populations. Of the approximately 13.5 total miles of tributary habitat available in the Cultus and Deer Creeks and Cultus, Quinn, and Deschutes rivers, over three quarters of it is in the Deschutes River. Consequently, the small amount of habitat available in each stream, except the Deschutes River, may in itself limit the amount of potential fish production. A 1979 Forest Service stream survey (Satterthwaite) classified spawning gravel found in each of the tributaries (Table 29).

Of the total spawning gravel classified, only 19.3% was rated as good and of that amount, 61% is located in the Deschutes River above Crane Prairie Reservoir. According to 1989 Forest Service stream surveys (USFS), much of the available spawning gravel in these tributaries is embedded with naturally occurring fine sediment. Other factors, including low or non-existent stream flows during the summer and fall in Cultus and Deer creeks, render these streams unusable for fall spawning species such as brook trout, whitefish, and kokanee. Limitations in Cultus River include: little useable spawning gravel, the available gravel is embedded with sand, water velocities are too low to keep gravel clean, and the water may be too cold for maximum trout rearing potential. Limitations in Snow Creek include: cold water temperatures (constant 44^{o}F at the headwaters) that may limit trout rearing potential, most of the substrate is comprised of sand, and available gravel is embedded with sediment.

Habitat improvement work was done in Cultus River by ODFW and the Deschutes National Forest in 1971, 1989, and 1992. Work included placement of spawning gravel, adding trees for trout cover and construction of low head rock structures to create scour pools. Placement of spawning gravel and construction of low-head check dam structures would improve use of Quinn River by fall spawning kokanee, brook trout, and whitefish. Additional summer and fall stream flow might be possible in Cultus Creek by building a low-head check dam at the outlet of Big Cultus Lake. Additional structures to accelerate water velocities and create scour pools could be added to Cultus River. The best trout spawning and rearing habitat is found in the Deschutes River above Crane Prairie and is used by redband trout, brook trout, whitefish, and kokanee. The Department and the USFS placed 158 trees in the river between the reservoir and the FR 40 bridge in September of 1996.

Table 29. Spawning gravel survey Crane Prairie tributaries, 1979.

	Square yards spawning gravel		
Tributary	Good	Marginal	Total
Cultus Creek	1,140	1,580	2,720
Deer Creek	110	620	730
Quinn River	0	50	50
Cultus River	395	1,395	1,790
Snow Creek	270	895	1,165
Deschutes River	3,000	15,990	18,990
Total	4,915	20,530	25,445

Deschutes River

The Deschutes River originates at Little Lava Lake and flows south for approximately 8.4 miles before entering Crane Prairie Reservoir. The sources for the groundwater inflow to Little Lava Lake are snowfields in the Mt. Bachelor and Three Sisters area. In extremely high water years, water flows from Big Lava Lake to Little Lava Lake in a shallow overflow channel. That there is usually no surface inflow to Little Lava Lake indicates a very large groundwater reservoir upslope of the lake (McCammon 1984). One of the most dominant controls over streamflow is the prevalence of groundwater inflow. This is due to past volcanic activity within the basin. The complex geology of lava flows, pumice, thick ash layers and glacial activity is conducive to subsurface flows traveling in large quantities and at relatively rapid rates.

In dry years, an active outlet to Little Lava Lake is not readily seen, but water still flows below the streambed. The "Blue Lagoon" or "Blue Hole" is a massive spring located at approximately RM 251 and appears to be the head of the river in low water years although there are subterranean water flows moving south in the basin upstream from this spring area. The Blue Hole is a major source of cold water. This and other springs in Lava and Little Lava Lakes and along the stream, influence downstream water temperatures. The result is a very stable hydrologic regime in which daily, monthly, and even annual fluctuations in water flows and temperatures are minimal compared to rivers dominated by surface runoff (Mathisen 1990). Springs are also the primary contributors to the excellent water quality found in this upper section of the Deschutes River.

The flow of this reach of the Deschutes River is measured by a stream gauge located near the confluence with Snow Creek. Unlike most streams in Oregon, flow is lowest in the winter and peaks in August to early September (Figure 1.) This figure also includes the flow below Crane Prairie Dam for comparison (this includes all tributaries listed in Table 29).

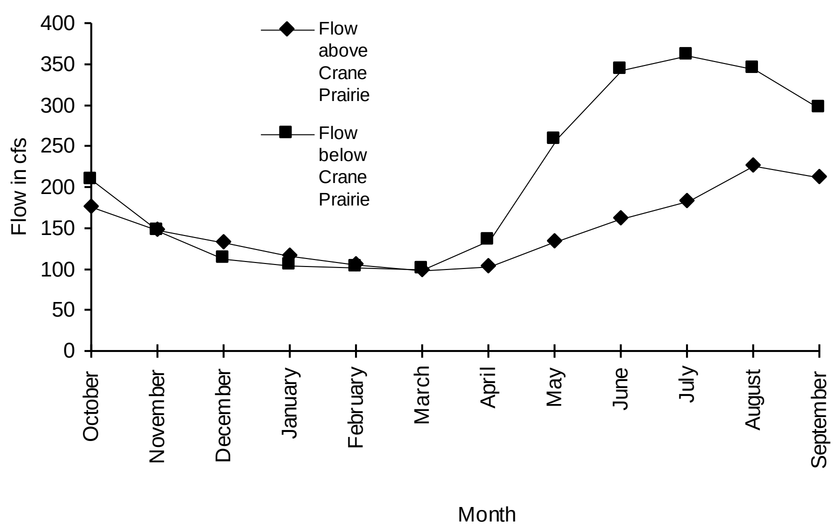


Figure 11. Average monthly flow in the Deschutes River above (1938-87) and below (1922-87) Crane Prairie Reservoir. Note: flow below the reservoir includes all tributaries.

Average monthly flows for water year 1989 ranged from 64 cfs to 222 cfs, peaking in late August (USGS 1990). Mean flow for the period 1938 through 1986 was 152 cfs. The all-time high was 480 cfs on August 19, 1974 and the record low flow was 40 cfs on December 22, 1959 (USFS 1989). River levels peak late in the season as snowmelt from the Mt. Bachelor and Sisters snowfields finally works it way down into subterranean flows and joins flows from numerous spring sources.

ODFW has identified minimum flows of 60 cfs during January, February, June, July, and August and 100 cfs during the remaining months of the year and recommended to the Oregon Water Resources Department they be maintained in this reach of the Deschutes. Flows are needed to protect fish during spawning, incubation, rearing, and passage. This upper portion was adjudicated in 1928 and has had supplemental adjudication completed in 1958.

Water temperatures for this reach of the Deschutes River are higher during the summer months than most other Crane Prairie tributaries. Forest Service stream surveys in 1989 showed temperatures of 48-63^{o}F from June to August.

Snow Creek is the only tributary in this section of the Deschutes River and contributes approximately 25% of the flow. It is a spring-fed, stream flowing southerly for 5.35 miles from the headwaters to its confluence with the Deschutes River. Flow was measured by the Forest Service in 1989 at 45 cfs during summer and fall months.

This eight miles of the Deschutes River is the only reach of a total 252 miles where the flow regime remains unaltered by dams and, except for grazing, recreation sites and hiking impacts, the section remains relatively natural.

The Deschutes National Forest conducted field surveys of the area in 1979 and 1989. The stream is dominated by lodgepole pine forests and riparian meadows. Grasses include Kentucky bluegrass, blue-joint reed grass, tufted hairgrass, and blue wildrye. Lupine, false hellebore and a variety of rushes and sedges are also present (USFS 1989). Mountain alder and spruce are found along with lodgepole pine.

Cover for fish is predominantly woody material, usually found near banks and overhanging vegetation. Occasional large trees provide scour pools. Streambed substrate is predominantly gravel and cobble with a relatively even distribution of pools, riffles, and glides. The 1979 Forest Service stream survey (Satterthwaite) found a total of 18,990 square yards of gravel in the Deschutes River upstream of Crane Prairie. Of that total, 3,000 square yards was rated as good and 15,990 square yards as marginal.

Adult fish observed during the surveys were utilizing woody material associated with some depth. Side channels are numerous and are used extensively for rearing by juvenile trout. Cover for fish is provided predominantly by woody material and undercut banks in these areas. Results of recent stream surveys conducted by the Forest Service (USFS 1989) suggest large woody material should be added to the Deschutes River upstream of Crane Prairie to increase trout rearing cover. Additional large woody material would also provide more cover for large spawning redband trout which are vulnerable to predation, primarily by otter.

All known mainstem barriers to fish migration (such as culverts) have been removed so the entire upper reach is accessible to fish. The Forest Service and National Guard have completed the barrier removal over a period of years. Two culverts exist on Snow Creek, one at FR 40 and another at road 4270. Upstream fish passage may be of concern at road 4270 and needs further evaluation.

The reach of the Deschutes River from the headwaters downstream to Crane Prairie Reservoir was designated as a State Scenic Waterway in 1988. A management plan has not been completed by Oregon State Parks for this river reach, but it has received an interim classification of "Recreational". There are no dams or diversions in this waterway. Future land use changes within 1/4 mile on either side of the river must be evaluated for their potential to impair the natural character of the stream according to state law.

In *Diack vs. City of Portland* (Oregon State Supreme Court 1988) the court ruled that before authorizing a diversion of water within a scenic waterway the Oregon Water Resources Commission must find the requirements of the Scenic Waterways Act are met. The principle requirement is that the free-flowing character of these waters will be maintained in quantities necessary for recreation, fish, and wildlife. The Scenic Waterways Act declares recreation, fish, and wildlife as the highest and best water uses in scenic waterways (ORS 390.835 (1)) . The Oregon Water Resources Department is required to insure that new water rights issued within scenic waterways be used only for human consumption, livestock, fish, wildlife, and recreation.

Habitat limitations in the Deschutes River are:

1. Shortage of large woody material for trout cover in the first mile upstream of Crane Prairie Reservoir. Future timber sales may deplete the supply of trees available to enter the stream by natural downfall unless adequate uncut buffer strips are provided. Continual addition of woody material is essential because it is lacking and is an integral part of the natural process providing fish cover, aquatic food, and controlling hydraulics within the stream.
2. Of 18,990 square yards of spawning gravel, only 3,000 or about 16% was rated as good.
3. Recreation use in this section of the Deschutes River is moderate to heavy throughout the season. Any future expansion of recreational facilities by the Forest Service could result in additional stream bank damage.

Fish Stocking History

Crane Prairie Reservoir

Bull trout, redband trout, and mountain whitefish were the indigenous fish species present in the Deschutes River when Crane Prairie Reservoir was created in 1922. Bull trout are no longer found in this portion of the river due to blockage of fish passage by the dam, stocking of non-native fish, harvest by angling, and changes in hydrology of the river. The last bull trout observed at Crane Prairie reservoir or tributaries were recorded during angler creel checks in 1955.

Crane Prairie Reservoir presently contains hatchery rainbow and redband trout, brook trout, kokanee, mountain whitefish, largemouth bass, tui chub, and three-spined stickleback. Hatchery-reared brook trout, rainbow trout, and kokanee are introduced species. Tui chub first appeared in 1953 and proliferated in the shallow, productive waters. They generally comprise over 80% of the reservoir fish population. Tui chub are the prey base for all fish in the reservoir (except kokanee and whitefish) and for a large population of fish-eating birds.

Largemouth bass were illegally introduced into the reservoir in the late 1970's or early-1980's. They were found by Department personnel while electrofishing in May 1986. Three-spined stickleback were first discovered in 1994 by Department biologists. Stickleback are not indigenous to the Deschutes basin, but are now found throughout the Deschutes River between Wickiup Dam and Bend. They were illegally introduced.

The earliest stocking of Crane Prairie Reservoir was with steelhead and silver (coho) salmon in 1923 as noted in diaries by Lloyd Wilson, Fall River Hatchery manager. Although no early stocking record could be found, it is most likely hatchery-reared brook trout found their way into the reservoir via Little Cultus Lake/Deer Creek which was stocked in 1936 (according to diaries from the old Bend Hatchery). Current stocking records date to 1945. There was no stocking of fish into the reservoir during the years 1945-51.

Brook trout were stocked beginning in 1952 and have been stocked periodically to the present. Brook trout stocking rates have varied from zero to a high of 302,930 two-inch fingerlings in 1955. Stocking rates were varied in response to fluctuations in the brook trout population. In high water cycles, natural reproduction and good survival have been sufficient to maintain the fishery. In low water cycles, hatchery brook trout fingerling and brood-size fish have been stocked to bolster the population. The last brook trout were stocked in 1993 with a release of 11,000 at 55 per pound and 1,349 at 1.3 per pound. The current stock of brook trout used are from Hosmer Lake reared at Wizard Falls Hatchery.

Rainbow trout were stocked beginning in 1955 and continue to the present. The current rainbow stocking rate is 200,000 fingerlings per year with a target size of 25 per pound. These rainbow are the Oak Springs Hatchery domestic stock (Lot 53).

Kokanee were first released in 1957, stocked through 1961, discontinued until 1981 and continued to the present. Up to 30,000 kokanee have been stocked periodically to augment natural production. The current stocking rate for kokanee is 20,000 fingerling annually with a target size of 80-100 per pound. Kokanee are raised at Wizard Falls Hatchery from eggs collected at Paulina Lake.

Coho salmon were stocked during the years 1966-72, but failed to produce acceptable results.

During the 1960's, hatchery-reared (fin-clipped) lake trout were found in small numbers in the Cultus Creek channel of Crane Prairie Reservoir. They stayed in the Cultus channel and reached large size. These lake trout were fish originally introduced into Big Cultus Lake of which an unknown number migrated to Crane Prairie Reservoir via Cultus Creek. Hatchery releases of lake trout were discontinued at Big Cultus Lake after 1965. The introduced lake trout eventually began reproducing in Big Cultus Lake and their progeny preferred to remain in the lake. Today, the naturally reproducing lake trout in Big Cultus do not leave the lake and Department personnel have not observed them in Crane Prairie Reservoir since the late 1970's.

Deschutes River

Today, populations of redband and hatchery rainbow trout, brook trout, juvenile kokanee, and wild mountain whitefish inhabit the Deschutes River above Crane Prairie Reservoir.

The Oregon State Game Commission Lake Survey Report (Newcomb 1941) reported Little Lava Lake contained abundant whitefish and roach. They were not able to net any other fish species, but said brook trout, rainbow trout, and Dolly Varden were reportedly in the lake. They also reported rainbow were stocked in Little Lava Lake during 1935-39, stock unknown, but most likely from Odell Lake or Crane Prairie Reservoir. All of these fish species could have entered the Deschutes River.

Modern stocking records date to 1972 when legal-size rainbow trout were first stocked. Legal-size rainbow were stocked through 1990 at rates of 6-10,000 annually. These fish were Cape Cod rainbow stock (Lot 72) reared at Fall River Hatchery. The stocking was terminated after 1990 in response to the Wild Fish Policy and concerns of impacts to redband trout in the Deschutes River above Crane Prairie Reservoir. Potentially, the hatchery brook and rainbow trout (Oak Springs domestic stock, Lot 53, reared at Wizard Falls Hatchery) currently stocked in Little Lava Lake could move down into the Deschutes River. The extent of that potential movement is unknown.

Angling Regulations

Crane Prairie Reservoir

The Oregon State Game Commission lake survey report (Newcomb 1941) reported Crane Prairie Reservoir was closed to angling in 1940. The report also states the "state game commission has established a rainbow egg taking station in the north end." It is presumed the angling closure was thought necessary to protect adult rainbow trout needed for egg collections. The reservoir was opened to angling in 1949 with a season from June 15 to September 15, including the tributaries. The bag limit was 5 fish, but not to exceed 15 pounds and 1 fish in any 1 day, and 10 fish, not to exceed 30 pounds and 2 fish in any 7 consecutive days. This bag limit and season remained unchanged until 1951 when the bag limit was changed to 5 fish per day, 10 in possession with a season of June 1 to September 30. In 1955, the reservoir trout bag limit was changed to 10 fish per day of which no more than 5 could be over 12 inches. In 1962, the season was changed from the May opening to the April general trout season opening date. In 1965, the trout bag limit was changed to 10 fish per day, 5 over 12 inches, of which 2 over 20 inches were allowed. The seasons and bag limits remained unchanged until 1988, when the trout bag limit was reduced to 5 fish per day, with 1 fish over 20 inches.

Today, the trout bag limit remains unchanged and the season is from the late April opening date through October 31. There are no special gear restrictions. Following discovery of largemouth bass in the reservoir, the general statewide bass bag limit of 5 bass per day, no more than three over 15 inches, was implemented in 1986 and the season corresponded to the trout season. In 1990, bass angling was restricted to the same angling hours as for trout. Those regulations continue today. The Oregon State Marine Board has placed a 10 mph boat speed limit on the reservoir. A motor may be used while angling from a boat.

Small Tributaries

Historically, the tributaries to Crane Prairie Reservoir have been managed under numerous restrictions to protect spawning and juvenile fish. While current regulations follow the general trout season, in 1992, tributaries to the reservoir other than the Deschutes River received additional protection through a closure (September 1 to October 31) to protect fall spawning brook trout and kokanee.

Deschutes River

Since the 1940's, this portion of the Deschutes River has seen a variety of angling regulation changes. The most significant changes are listed below:

1945 - Fly fishing only, Little Lava Lake down to Deschutes Bridge. Closed to all angling below Deschutes Bridge. No angling from a floating device. Bag limit- 15 fish, but not to exceed 15 lbs. and 1 fish in any one day. No bag limit for whitefish.

1947 - No bag limit for Dolly Varden. Bag limit reduced to 10 fish, but not to exceed 15 lbs. and 1 fish in any one day.

1949 - Little Lava Lake downstream to Deschutes Bridge closed to fishing. Bag limit reduced to 5 fish, but not to exceed 15 lbs. and 1 fish per day. Fly fishing only. No angling from a boat. No bag limit for whitefish and Dolly Varden.

1955 - Fly fishing only, no angling from a boat. Bag limit of 10 fish per day, 5 over 12 inches.

1959 - Dolly Varden included in trout bag limit.

1962 - Fly fishing only dropped. All gear legal. Angling from boats prohibited from Little Lava Lake down to Deschutes Bridge.

1965 -Bag limit changed to 10 per day, 5 over 12 inches, 2 over 20 inches.

1967 - Angling from a boat permitted.

1976 - Closed to angling from slack water at Crane Prairie Reservoir upstream to gauge station, September 1- October 31.

1978 - Closed to angling from Crane Prairie Reservoir up to Little Lava Lake, April 22 - May 19.

1980 - Season changed to May 16 - October 31 from Little Lava Lake down to Crane Prairie Reservoir. Bag limit changed to 5 per day, 2 over 20 inches.

1988 - Bag limit changed to 5 per day, 1 over 20 inches. Season changed to June 1 - October 31.

1992 - Season changed to June 1- September 1.

The current regulations are: 5 trout per day of which 1 may be over 20 inches, 6 inch minimum length; open season from Crane Prairie Reservoir upstream to Little Lava Lake, June 1- September 1; no gear restrictions; no bag limit on whitefish; and no restrictions on fishing from a floating device. The seasonal restrictions were intended to protect fall and spring spawning fish.

Fish Management

Crane Prairie Reservoir

With the diversity of fish and wildlife in and around Crane Prairie Reservoir, the area receives a great deal of recreation pressure. Typically, most reservoir related recreation is dependent on boat access. Thus, recreation use is affected by fluctuating reservoir levels (i.e., boat ramps become dewatered and anglers become disinterested, according to Kunkel and Marx 1991). As water levels decline, it gets harder to launch boats, water temperatures rise, algae growth increases, access becomes limited, maneuverability within the lake decreases, and birds have less area in which to feed.

Crane Prairie Reservoir has long been recognized by the Department and anglers as one of Oregon's premier trout producing waters and the fishery is popular with residents from all areas of Oregon and non-residents throughout the country. The fishery has been managed as basic yield (ODFW 1987) for hatchery and naturally produced trout, whitefish and largemouth bass. It is especially well known for producing large rainbow trout. Rainbow trout up to 13 pounds have been taken and 3-5 pound fish are common.

In 1990, the Department conducted a season-long, statistically designed study to estimate total angler effort and total catch (Buckman unpublished 1990). This was the first study of its kind attempted at Crane Prairie Reservoir. Prior to the study, in 1989, all hatchery trout (rainbow, brook) fingerlings released into the reservoir were marked with a finclip (adipose fin). In addition, hatchery kokanee and rainbow fingerlings released in the study year, 1990, were all finclipped. The fish were marked to differentiate hatchery fish from wild fish in the creel for comparison of their respective contribution in the fishery. Wild versus hatchery ratios were **only** estimated for fish under 20 inches because older fish were unmarked and could have been stocked hatchery fish, naturally produced fish, or wild fish. Because angling from the bank is minimal at Crane Prairie, the study was conducted for boat anglers only. The study was conducted for only one year, therefore, the total contribution by hatchery fish through a life cycle is unknown.

The following series of tables and figures summarize results of the study. Table 30 shows over 40,000 boat angler-trips were made in 1990 throughout the season. A total of nearly 60,000 fish of all species was caught for a season average of 1.47 fish per angler. Based solely on the 1990 fishery, it appears that hatchery rainbow trout comprised 36.4% of the rainbow kept under 20". Further, when compared between early and late season, the creel survey suggests that the contribution of hatchery fish increases late in the summer. This apparent increase suggests that the hatchery fish stocked in the spring of the fishing season grow to legal-size by late summer.

Table 30. General summary of the 1990 Crane Prairie Reservoir creel study.

Number of anglers sampled	3,360
Estimated number of angler trips	40,418
Estimated number of boat trips	18,398
Estimated total fish caught (all species)	59,422
Estimated average fish per angler	1.47

Over 80 percent of the boat anglers fished in private boats and over 80 percent fished with bait or a combination of gear types (Tables 31, 32, & 33).

Table 31. Crane Prairie creel survey, boat anglers, percent of anglers using different gear types, 1990.

Gear type	Percent
Combination	45.3
Bait	37.0
Fly	7.4
Lure	7.2
Aquatic insects*	3.1

* Aquatic insects were not identified as separate gear type until July 27. Prior to that they were considered "bait".

Table 32. Crane Prairie creel survey, boat anglers, percentages of effort of different trip types, 1990.

Trip type	Percent
Private	83.2
Rental	10.8
Guided	3.6
Float tube	2.4

Approximately half of all rainbow trout caught in 1990 were released and of those over 20 inches in length, 40 percent were released. Surprisingly, only 12.3 percent of the largemouth bass caught were kept. Anglers kept 66% of brook trout caught and over 94% of kokanee. Of the total rainbow caught, 4.6% were 20 inches or greater in length.

Table 33. Summary of Crane Prairie creel survey for boat anglers in 1990. Estimated total catch and harvest of rainbow trout, brook trout, and largemouth bass by size (<20" and >20"). Incidental catches of whitefish and Tui chub are also shown.

Species	Number caught	Number released	Number harvested	Percentage harvested
Rainbow				
<20"	25,818	13,819	11,999	46.5
>20"	1,240	502	738	60.0
	27,058	14,321	12,737	47.0
Brook				
<20"	2,872	972	1,900	66.2
>20"	7	7	0	0.0
	2,879	979	1,900	66.0
Kokanee				
<20"	205	12	193	94.1
Largemouth bass				
<20"	29,103	25,537	3,566	12.3
Whitefish				
<20"	42	26	16	38.0
Tui chub				
<20"	135	135	0	0.0

Interviews revealed that of the 40,418 angler trips, 54.6% stayed overnight, and 45.4 % were day use only. Figure 12 shows the contribution of marked and unmarked rainbow trout under 20 inches in length kept in the creel.

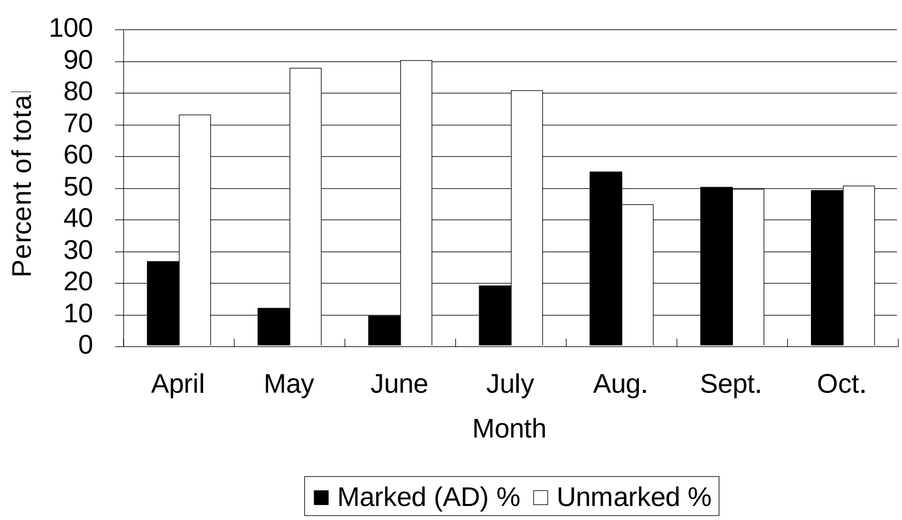


Figure 12. Summary of marked vs unmarked rainbow trout less than 20 inches in length in a Crane Prairie Reservoir creel survey, 1990.

For accuracy, only rainbow kept were compared. The number and percent of unmarked rainbow trout is probably high because trout sizes were only recorded as over or under 20 inches. Unmarked hatchery rainbow fingerlings stocked prior to 1989 could have entered the catch and were recorded as unmarked trout.

Inventories for trout are generally conducted annually with multiple-mesh gillnets set in the spring. Bass populations are monitored by electrofishing at night in the spring and fall. Information collected during inventories include: individual fish length, weight, sex, and sexual maturity. The fish are examined for stomach contents, parasites, and general body condition. Annual rainbow trout spawning ground counts are made each spring on the Deschutes River upstream of Crane Prairie (see Deschutes River Section). Recently, special studies, such as bass distribution and food habits have augmented standard fish inventories.

Figure 13 shows the average number and size (one-inch size groups) of rainbow trout taken per gillnet for the years of 1960-91.

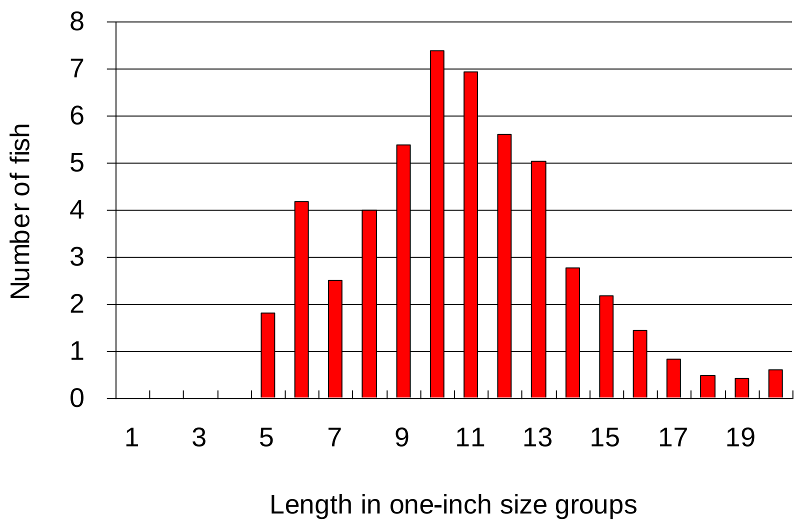


Figure 13. Average number of rainbow trout per net in Crane Prairie Reservoir during annual gillnet sampling, 1960-91.

The figure shows good size-class distribution and depicts at least 4 age groups of rainbow.

Historically, redband trout were indigenous to the Deschutes River inundated by Crane Prairie Reservoir and provided eggs for local hatcheries for many years. The eggs were collected by capturing adults at weirs on Cultus Creek and the Deschutes River. Unfortunately, the complete records of these egg takes and resultant fish distributions are not available. It is not known if or to what extent a variety of hatchery rainbow stocks and the indigenous redband trout may have interacted since the first rainbow stocking in 1953. In 1993, naturally-produced rainbow were collected from the Deschutes River upstream of Crane Prairie for genetic analyses. It is hoped this analysis will provide information regarding the origin of the naturally-reproducing rainbow population in Crane Prairie and will clarify management implications related to the hatchery program. The abundant, naturally-spawning redband trout which run into the Deschutes River above Crane Prairie may provide a locally adapted broodstock for future hatchery programs aimed at minimizing genetic risks. The feasibility and desirability of such a program is contingent on overcoming logistical problems with egg collection during the winter and uncertainties regarding the abundance of hatchery fish in the spawning population.

In an effort to further understand the ratio of hatchery fish to natural or wild fish in the creel, fingerling rainbow released starting in 1994 have been marked with a clipped adipose fin. Local anglers who frequently visit the reservoir have been asked to record the number of hatchery versus wild fish in their personal catch records.

Kokanee have been present in the reservoir since 1957 and have been naturally reproducing. Up to 30,000 fingerling kokanee have been stocked periodically to augment natural reproduction. The kokanee fishery at Crane Prairie provides diversity to the reservoir angling opportunity, but has always been a minor compared to the rainbow fishery. Kokanee typically concentrate in Cultus River and Quinn River channels during the warm summer months and provide a good sport fishery for anglers still fishing with bait. Kokanee quality is excellent and fish often reach 14-16 inches at maturity. Kokanee are also harvested by anglers trolling the main body of the reservoir early in the season when the fish are scattered. Kokanee populations appear to fluctuate with water level patterns in the reservoir. During consecutive years of high water, zooplankton (primary kokanee forage) populations remain high, access to spawning areas is good and kokanee populations and resulting sport fisheries flourish. Yet, in 1990, a poor water year, it was estimated boat anglers caught only 205 kokanee.

Brook trout have been in the reservoir since at least the 1930's and provide species diversity for anglers. Brook trout fingerling and surplus brood fish have been stocked periodically to augment natural reproduction. As with kokanee, the brook trout fishery is minor compared with the rainbow fishery. In 1990, an estimated 2,879 brook trout were caught. The brook trout fishery is best early in the season when the fish are scattered throughout the reservoir. As the season progresses, brook trout seek out cooler channel waters and become increasingly more difficult to catch. Crane Prairie brook trout can reach large size (up to 5 pounds) and are popular with anglers. Their numbers also tend to fluctuate with wet and dry cycles.

Mountain whitefish are indigenous to Crane Prairie Reservoir and are harvested incidentally by trout anglers. In 1990, an estimated 42 whitefish were caught. As with other fish species in the reservoir, whitefish are robust and the new Oregon record was set in 1994 with a 4 pound 14 ounce specimen. No specific studies have been done on whitefish in Crane Prairie, but gillnet inventories indicate their numbers may also fluctuate with wet or dry cycles.

History of Largemouth Bass in Crane Prairie

Largemouth bass were illegally introduced during the late 1970's or early 1980's. The population quickly expanded and reached a maximum density based on electrofishing inventories in 1989 (Shrader 1993). In years immediately following introduction, bass growth was phenomenal for an eastern Oregon reservoir (4-5 inches/year). Abundant food (insects for younger bass and tui chub for larger fish) and habitat were probably responsible for high survival and good growth of the bass population. Five and six pound bass were relatively common. The trophy nature of the fishery made Crane Prairie very popular with bass anglers. In 1990, over

29,000 bass were caught, although only about 13% were harvested (Buckman, unpublished, 1990).

Decline of tui chub numbers, angler harvest, and drought-associated factors are probably responsible for the recent reduction seen in the density of largemouth bass. Although the density of smaller bass has decreased markedly since 1989, the reduction in trophy bass (> 15 inches) has been rapid and very noticeable. Angler complaints regarding the scarcity of bass, especially the trophy fish were fairly numerous in 1994.

Interaction between Bass and Trout

Concerns have been raised over interactions between the expanding bass population and the historic blue-ribbon trout fishery ever since bass were first seen in the reservoir in the 1980's. Bass predation on stocked trout and decreases in trout growth and survival due to competition for food are two potential negative interactions that needed to be addressed. In a 1989-90 Department study Shrader (1993) identified tui chub as the most prevalent fish in the diet of Crane Prairie largemouth bass. They were approximately 21 times more common than salmonids (trout, kokanee, and whitefish) in bass stomachs. Yet, it was estimated that over 25,000 salmonids were probably consumed by bass each year prior to seasonal water temperature changes in the reservoir that influenced species distribution and likely segregated the populations.

A recent Department study (Shrader, in preparation, 1994) has provided additional information that bass predation on trout is much less of a problem than earlier suggested. Bass predation on trout is only heavy in certain areas of the reservoir following stocking and occurs over a much shorter time period than concluded in the previous study. Even though tui chub (primary bass forage) have declined drastically in the reservoir and stocked hatchery rainbow were present in the same areas as bass for much of the year, insects (dragonfly and damselfly larvae) and stickleback were the most common food items in diets of bass greater than 8 inches long (Table 34).

Table 34. Percentage of diet by volume for largemouth bass in Crane Prairie Reservoir, 1994.

Month	Hatchery rainbow	Other salmonids	Sticklebacks	Amphipods	Crayfish	Damselfly	Dragonfly	Other
				8-12 inch largemouth bass				
May	0	0	12.8	6.4	4.0	22.0	41.5	13.3
June	41.0	4.0	14.7	1.5	11.0	21.2	3.6	3.0
July	36.0	0.0	0.7	2.3	0.0	6.2	30.7	24.1
August	0	0	25.9	45.3	7.4	0.6	7.4	13.4
September	0	2.5	70.7	2.0	0	1.5	8.9	14.4
October	0	0	11.0	20.2	5.4	53.2	7.1	3.1

Table 34. Continued

				12-16 inch largemouth bass				
May	0	4.8	16.3	9.0	0	33.8	26.7	9.4
June	67.8	10.1	2.1	0.3	0.9	15.5	2.4	0.9

July	10.7	87.5	0	0.1	0	0.4	0	1.3
August	0	0	5.3	0.8	92.1	0.2	0	1.6
September*	0	73.8	2.0	0	0	0	4.2	20.0

*- September and October combined due to small sample size

Preliminary results suggest that although there is significant diet overlap (Table 35), competition between bass and trout is not a factor. However, the threat of bass predation appears to influence rainbow trout foraging strategies. Rainbow trout may be foraging elsewhere, foraging on other prey species, or foraging less frequently.

Table 35. Percentage of diet by volume for rainbow trout in Crane Prairie Reservoir, 1994.

Month	Amphipods	Damselfly	Dragonfly	Snails	Zooplankton	Mayflies	Caddisfly	Other
June	11.3	37.4	0	0	13.3	0	16.1	21.9
July	44.2	4.8	0	0	5.8	6.0	2.2	37.0
August	24.9	0.4	0	54.4	0	0.6	3.2	16.5
September	19.5	0.3	0	4.1	29.4	0.5	31.6	14.6
October	12.7	8.1	4.4	55.5	17.1	0	0	2.2

Results indicate diet overlap occurs between trout and bass, but is not biologically significant. Results investigating aspects of competition between bass and trout are not yet available. However, the productivity of Crane Prairie Reservoir may prove to be adequate to support both populations under present conditions.

An additional concern raised by anglers is predation on trout by a variety of fish-eating bird species at Crane Prairie Reservoir. The primary species of concern have been cormorants and osprey. Other fish-eating species present include; bald eagles, great blue herons, mergansers, kingfishers, gulls, grebes, and goldeneyes.

A number of studies have been conducted on the food habits of osprey and cormorants at Crane Prairie Reservoir. A Master's Thesis study in 1970-71 found ospreys caught a total of 15,963 salmonids weighing 5,103 pounds and 12,230 tui chubs totaling 3,127 pounds in 1971 (Lind 1976). The author also estimated osprey caught 14 percent of the number and 8 percent of the weight of salmonids caught by both fishermen and ospreys.

In 1981-82, Department biologists collected 78 cormorants from Crane Prairie Reservoir for analyses of stomach contents. Cormorant stomachs contents were analyzed by both Department biologists and the Oregon Cooperative Fishery Research Unit at Oregon State University. Fifty-eight (72 percent) of the stomachs contained fish or unidentified remains of fish. Stomach contents were 44% tui chub (2-8"), 24% empty, 17% unidentified fish remains, 11% trout (3-9"), and 4% rocks. Biologists also learned that water levels appeared to be the key factor in determining numbers of cormorants at Crane Prairie Reservoir. When the reservoir was low, more cormorants came to the reservoir to take advantage of the concentrated food supply. Cormorant counts dropped sharply in high water years. For example, a high count of 730 cormorants was reached in 1981, a poor water year (11,260 acre feet end of September). In 1982, a good water year (33,160 acre feet end of September), the high count of cormorants was 295.

A study on osprey and cormorants in 1982-83 (Anderson 1985) showed cormorant diets in August-September, 1983 were comprised of 35-65% tui chub, 10-20% salmonids, and 15-55% unknown. That study also found that the daytime count of cormorants at Crane Prairie Reservoir was about half of the evening roost count, indicating cormorants were feeding in other waters adjacent to Crane Prairie.

There are no known bacterial or viral diseases affecting fish populations at Crane Prairie Reservoir. However, parasites such as tapeworm (*Dibothrium cordiceps*), roundworms, flukes, nematodes, and parasitic copepods were recognized as early as 1940 (Newcomb 1941). Of these parasites, tapeworms are the most common today and have been found in all fish species in the reservoir. No report could be found of extensive fish mortalities from these parasites in Crane Prairie Reservoir.

Deschutes River

The river's beautiful setting, ease of access and relatively short driving time from major population centers of the state makes it popular for both daily, weekend, and vacation use. Recreation activities in the area include fishing, sightseeing, and camping. Angling is the predominant water-dependent recreation activity. Although no current total angler use or catch estimates are available, the river receives high angler use as evidenced by well-worn trails, parked vehicles at access points and campground use. Angling for small trout by experienced anglers can be exceptional as indicated by the random creel results for three anglers in June of 1992. These three fly fishermen caught 113 brook and rainbow trout in 11 hours of angling or 10.3 fish per hour. The fish ranged in size from 4-10 inches. The river is popular for all types of anglers, especially juveniles because of its small size and good access. Since the open season for angling has been shortened over the years to only three months now, the daily angler use appears to have increased based on casual observation.

This reach of the Deschutes River is managed as a basic yield fishery for redband trout, naturally reproducing brook trout, and mountain whitefish. Stocking of legal-size rainbow was terminated after 1990, but hatchery rainbow and brook trout fingerlings are still being released into Little Lava Lake. The extent of trout exchange between the lake and the river downstream is unknown.

Rainbow trout are indigenous to the entire Deschutes River and are classified as inland redband trout. Their abundance was well recognized and eggs were collected from spawning adult rainbow in this reach of the Deschutes River and Cultus River. During the years 1926-29, over 18 million Crane Prairie rainbow eggs were collected by Fall River hatchery workers (Lloyd Wilson diaries, Fall River Manager). Hatchery rainbow trout have been stocked for many years in this reach of the Deschutes, Crane Prairie Reservoir, and Little Lava Lake. The degree to which a variety of hatchery stocks and redband trout may have competitively interacted is unknown. In 1993, wild rainbow were collected in this reach of the Deschutes River for genetic analyses at Oregon State University. Results are not yet available, but the analyses should help identify the origin of redband trout in Crane Prairie Reservoir and the Deschutes River above.

The river is recognized as an important spawning and nursery area for redband trout, brook trout, kokanee, and whitefish migrating upstream from Crane Prairie Reservoir. The river is only open to angling for three months during the summer when adults spawners from Crane Prairie Reservoir are not present. In 1990, two sections of the stream were electrofished to determine species composition, relative abundance, and size class distribution. A total of 262 trout and whitefish were collected. Brook trout comprised 47% of the total followed by redband trout at 39%, whitefish at 28%, and hatchery legal-size rainbow at 3%. The brook trout ranged in length from 2-17 inches with 76% in the 3-6 inch size group. The redband trout ranged in length from 1-11 inches with 96% in the 1-6 inch size group. Whitefish ranged in length from 3-15 inches with 86% greater than 6 inches in length.

The Department has conducted redband trout spawning ground redd counts on 1.5 miles of the river since 1988. Those counts have ranged from a low of 202 redds in 1989 to a high of 524 redds in 1991. There appears to be a strong correlation between number of redds and water levels in Crane Prairie Reservoir as shown in Figure 14. In 1994, the redband spawning run began in late January, peaked in mid-March, and was completed about the first of May.

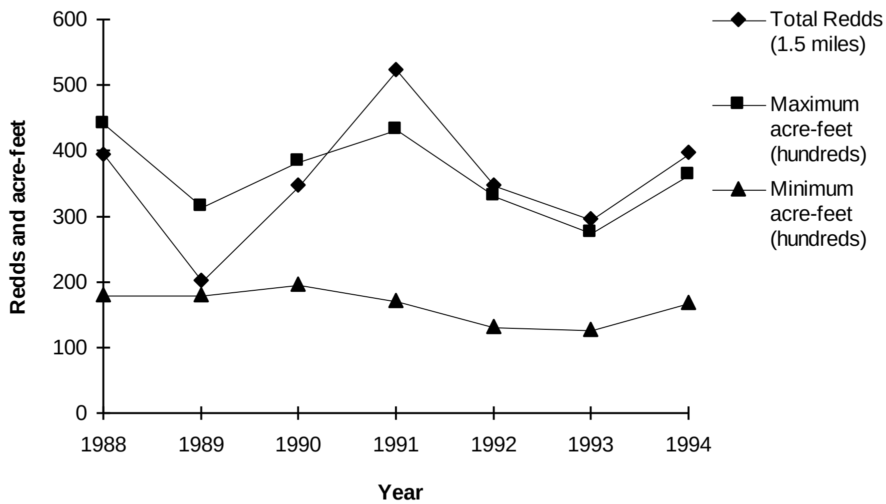


Figure 14. Total number of redband trout redds vs minimum and maximum pool (acre-feet) in Crane Prairie Reservoir, 1988-94.

Management Issues

1. Bull trout were indigenous to the Upper Deschutes basin, but disappeared in the 1950's primarily due to the construction and operation of Wickiup and Crane Prairie reservoirs. The potential for a successful reintroduction has not been assessed.
2. It is not well understood whether trophy-size rainbow trout individuals in Crane Prairie are primarily naturally or hatchery produced. Further studies are needed to assess hatchery versus wild fish contribution to the catch. The 1990 study lasted one year and did not track the marked hatchery fish through a life cycle.

3. Related to the above concern, it is unknown whether the present allowed harvest rates of younger (< 20 inches) rainbow trout or the amount of water in the reservoir is the primary factor affecting the availability of older trophy-size trout.
4. The fish production potential in Crane Prairie Reservoir for all species is apparently limited primarily by reservoir pool level. There is no minimum pool level for fish life or recreation and excessive water is lost from the reservoir through leakage.
5. Largemouth bass and trout interactions are not completely understood. Studies have been conducted with some preliminary results available suggesting the potential for high predation levels of bass on hatchery rainbow fingerlings. Additional work is needed, especially during high water cycles.
6. The popularity of "catch and release" and the reported mossy flavor of bass during the summer may influence the harvest of that species. The 1990 creel study showed only 12.3% of the bass caught were kept. This result suggests that efforts to control the bass population through angler harvest may be limited.
7. Casual observations indicate angler use is high on this easily accessed portion of the Deschutes River, however, there have been no statistical angler use or catch studies done since stocking of legal-size rainbow was terminated after 1990. Angler use has probably intensified because of the short three-month angling season. Additional angling restrictions may be necessary to protect redband trout populations.
8. Fish habitat in the Deschutes River is generally good, although stream surveys have noted a lack of large woody material for trout cover and much of the spawning gravel is rated as marginal. Both of these habitat deficiencies could be enhanced with cooperative projects between the Department and Deschutes National Forest. Adequate buffer strips of timber must be maintained along the river corridor to provide a future supply of woody material.

MANAGEMENT DIRECTION

CRANE PRAIRIE RESERVOIR AND TRIBUTARIES

POLICIES

Policy 1. Rainbow trout shall be managed for natural and hatchery production consistent with the Featured Species Fish Management Alternative for trout (ODFW 1987). Hatchery rainbow trout will be stocked annually into Crane Prairie Reservoir.

Policy 2. Mountain whitefish, brook trout, and kokanee shall be managed for natural and hatchery production consistent with the Basic Yield Management Alternative for trout (ODFW 1987). Hatchery brook trout and kokanee will be stocked periodically into Crane Prairie Reservoir.

Policy 3. Largemouth bass shall be managed for natural production consistent with the Basic Yield Management Alternative for warmwater fish (ODFW 1987).

OBJECTIVES

Objective 1. Maintain genetic diversity, adaptiveness, and abundance of redband trout and whitefish in Crane Prairie Reservoir.

Assumptions and Rationale

1. Self-sustaining populations of redband trout, mountain whitefish and introduced brook and rainbow trout and kokanee salmon occur in Crane Prairie Reservoir and this portion of the Deschutes River.

2. Rainbow trout indigenous to the Upper Deschutes River and tributaries have been identified as an inland redband trout and are listed as a state and federal sensitive species.

3. Extensive numbers of non-indigenous hatchery rainbow have been stocked into Crane Prairie since 1955.

4. The redband trout from Crane Prairie are presumed to spawn and rear in the Deschutes River upstream of the reservoir.

5. Electrophoresis will be used to determine the impacts that spawning hatchery stocks have had on wild fish.

6. Special regulations may be necessary to protect stock fitness and life history characteristics and to maintain healthy redband trout populations with multiple age classes.

7. Monitoring of redband trout and whitefish in Crane Prairie Reservoir and tributaries will provide an indication of their stock fitness and population level.

8. Loss of rainbow trout and whitefish by predation (primarily birds) occurs, but the impact on abundance is unknown.

9. Development of a "wild-type" hatchery brood may be required to meet Wild Fish Management Policy if electrophoresis studies find the rainbow trout are wild fish. Regardless, development of a local broodstock for use at Crane Prairie Reservoir will likely improve hatchery fish survival and contribution to the fishery.

10. Crane Prairie supports a population of wild mountain whitefish.

11. Releases of hatchery fish will not decrease the genetic fitness or significantly affect the population abundance of whitefish.

ACTIONS

Action 1.1 Establish baseline data sets on genetic characteristics of rainbow trout and whitefish in Crane Prairie and the Deschutes River above the reservoir using biochemical (electrophoresis) and phenotypic parameters and compare to existing electrophoretic data from other areas in the Deschutes basin.

Action 1.2 Verify, document, and establish population trends of wild rainbow trout and whitefish in Crane Prairie if electrophoresis establishes evidence of their existence. Population trends will be determined through conduct of periodic creel surveys, periodic netting and spawning ground surveys in the Deschutes River and other tributaries to the reservoir.

Action 1.3 Determine the need for additional or modified angling regulations to protect populations of redband trout and whitefish by monitoring the production, harvest, and catch rates.

Action 1.4 Verify and document distribution and upper limits of rainbow and brook trout, kokanee, and whitefish in the Upper Deschutes River and tributaries.

Action 1.5 Assess the status of redband trout in the Upper Deschutes River and tributaries in conjunction with Action 1.2.

Action 1.6 Establish population trends of mountain whitefish in Crane Prairie during annual inventory activities of trout populations.

Objective 2. Provide a consumptive and nonconsumptive, featured species fishery for larger-than-average-size natural and hatchery-produced rainbow trout.

Assumptions and Rationale

1. Crane Prairie Reservoir historically has produced large rainbow trout.

2. There is strong public interest in angling for these large rainbow trout.

3. Special regulations (catch limits, size restrictions, and/or gear restrictions) may be necessary to achieve this objective. Special regulations are currently in effect to protect fish while spawning in the tributaries.

4. A 1990 creel survey showed almost 5 percent of all rainbow caught for the season were 20 inches or greater in length.

5. Few waters in Oregon produce rainbow trout over 20 inches in length. Waters capable of consistently producing numbers of large rainbow trout include Klamath and Davis Lakes, Thompson Valley and Chickahominy Reservoirs.

ACTIONS

Action 2.1. Annually stock up to 150,000 to 200,000 hatchery fingerling rainbow trout at 20 to 30 per pound during May.

Action 2.2 Monitor abundance, size, age-class, structure, and distribution of trout and whitefish in Crane Prairie Reservoir by conducting periodic creel surveys, electrofishing, and netting.

Action 2.3 Develop a broodstock from naturally spawning rainbow trout in the Deschutes River above Crane Prairie Reservoir.

Action 2.4 Continue marking hatchery rainbow trout with an easily distinguishable mark.

Objective 3. Provide diverse angling opportunities for a consumptive and nonconsumptive fishery on naturally and hatchery produced kokanee and brook trout, and naturally produced whitefish in Crane Prairie Reservoir and tributaries.

Assumptions and Rationale

1. These fisheries will be of a general consumptive nature, however opportunities will be examined for non-consumptive use.

2. Year-class abundance of kokanee and brook trout varies with the amount of water in the reservoir. In good water years, juvenile kokanee and brook trout survival is enhanced and that year-class is more abundant when they enter the fishery.

3. Population levels of whitefish also vary with the amount of water in the reservoir. The current population is relatively low due to successive drought years.

4. Whitefish are probably not being fully utilized in the reservoir. Many people are not aware of the excellent sporting and eating qualities of whitefish.

5. A catch rate of approximately 1.0 trout and whitefish per hour provides an adequate fishery.

ACTIONS

Action 3.1 Stock as needed, up to 30,000 hatchery kokanee no smaller than 100 per pound during June or July. Stocking will only be done when natural production of kokanee is insufficient to generate a fishery.

Action 3.2 Periodically stock up to 30,000 hatchery fingerling and excess brood brook trout to augment natural production.

Action 3.3 Monitor abundance, size, age-class, structure, and distribution of trout and whitefish in Crane Prairie Reservoir by conducting periodic creel surveys, electrofishing, and netting.

Action 3.4 Publicize information on the desirable attributes of whitefish and angling opportunities.

Objective 4. Maintain the bass fishery in Crane Prairie Reservoir to provide diverse warmwater angling opportunities in Central Oregon.

Assumptions and Rationale

1. The effects of bass on trout populations in terms of predation or competitive interaction is not fully understood, however studies have shown bass consume less than 5% of hatchery stocked rainbow trout fingerlings annually. It is not practical nor feasible to eliminate bass from the reservoir.

2. The bass population in Crane Prairie appears to have reached carrying capacity for present conditions (low water cycle).

3. Maintenance of a both a trout and bass fishery in Crane Prairie Reservoir is desirable.

4. During high water years, the amount of suitable bass habitat will increase resulting in a larger bass population.

ACTIONS

Action 4.1 Determine the need for additional or modified angling regulations to protect populations of bass by monitoring the reproduction, population abundance by age class, harvest, and catch rates.

Action 4.2 Continue to monitor impacts of the bass population on the trout fishery with changes in water level conditions, changes in trout management, and changes in other habitat conditions.

Objective 5. Protect, enhance, and restore trout and whitefish rearing and spawning habitat in Crane Prairie Reservoir and tributaries.

Assumptions and Rationale

1. Habitat management is the basis of wild fish and natural production fish management. Management objectives for natural fish production cannot be obtained without all the elements of habitat to support fish production. Habitat protection is more effective than restoration or enhancement, but habitats that have been degraded should be restored to return fish production to optimum levels. Habitat restoration and enhancement can increase natural production, but should not be considered a substitute for habitat protection.

2. Protection and enhancement of trout and whitefish populations can be achieved principally through habitat protection and improvement.

3. The annual loss of trees in the reservoir has resulted in the loss of fish and wildlife habitat. This loss of trees is also accelerating the shoreline erosion by allowing more wind sweep and

resulting wave action. Many trees that are sheared off at the water level are carried toward the dam by wind and water currents and are subsequently removed by the irrigation districts for dam safety purposes.

4. Reduced reservoir levels during poor water years results in loss of aquatic food production, cover for juvenile fish rearing and access to spawning areas.

5. Standing dead timber in the reservoir is lost at an accelerated rate during low water years. Exposure to the air accelerates wood decay and trees are subsequently sheared at water level by a combination of ice and wind.

6. The outlet of Crane Prairie Reservoir is screened. Screen inspection and repair is necessary on a regular basis to prevent fish loss.

7. During low water years, kokanee, and brook trout have difficulty accessing tributaries to spawn due to excessive vegetative growth.

8. Subterranean water losses occur annually and increase with water storage level.

ACTIONS

Action 5.1 Encourage irrigators (through education and financial assistance where available) to improve water distribution and application techniques in an effort to use less water more efficiently.

Action 5.2 Add spawning size gravel at suitable locations in tributaries to maximize the spawning potential of wild fish.

Action 5.3 Add wood and/or rock structure to the tributaries to maximize cover for spawning adults and rearing habitat for juvenile fish.

Action 5.4 Add woody structure to the reservoir to replace the annual loss of trees through a variety of habitat improvement programs and funding such as R&E, COID, M&E, challenge grants, etc.

Action 5.5 Plant willows and other vegetation to enhance aquatic food production, fish rearing and cover, soil stability, and terrestrial production of wildlife.

Action 5.6 Coordinate with irrigation districts to assure outlet screens are inspected frequently and repaired as needed.

Action 5.7 Investigate with the USFS, BOR, and irrigation districts the possibility of plugging subterranean water leaks in Crane Prairie Reservoir.

Action 5.8 Support enforcement of existing Forest Service standards, guidelines, laws, and regulations concerning habitat protection.

Action 5.9 Encourage USFS to discuss future review of the grazing allotment management plan, recreation plan, and proposed timber sales with ODFW on land adjacent to the Upper Deschutes River and tributaries.

Action 5.10 Coordinate and provide technical input in management of all riparian areas along the Upper Deschutes River and tributaries to achieve vegetative potential to optimize fish production.

Action 5.11 Identify habitat deficiencies and sites for habitat improvement projects.

Action 5.12 Develop habitat improvement plan for the Upper Deschutes River and tributaries.

Action 5.13 Work with volunteers, sport clubs, and the USFS to implement habitat improvement projects.

Action 5.14 Implement habitat protection actions outlined under objectives for Habitat Protection.

Objective 6. Provide adequate upstream and downstream passage for fish at road culverts and other artificial obstructions in streams above Crane Prairie Reservoir.

Assumptions and Rationale

1. Adequate fish passage is necessary at road crossings and other obstructions to provide access to upstream spawning and rearing areas upstream of Crane Prairie Reservoir.

ACTIONS

Action 6.1 Inventory culverts on Snow Creek at Forest roads 40 and 4270 for fish passage problems. Make recommendations to the USFS to improve passage if necessary.

Objective 7. Provide better boat access at Crane Prairie Reservoir.

Assumptions and Rationale

1. Boat ramps at Rock Creek and Quinn River campgrounds are unusable at low water conditions (lower than 13,000 acre-feet of storage).

ACTIONS

Action 7.1 Coordinate with the USFS and Oregon State Marine Board to improve (extend into deeper water) boat ramps at Crane Prairie Reservoir.

Objective 8. Determine the feasibility and desirability of restoring bull trout in Crane Prairie Reservoir and its tributaries.

Assumptions and Rationale

1. Bull trout were historically distributed throughout the upper Deschutes River.

2. Restoring bull trout may eliminate some existing fisheries and create new fisheries with subsequent economic losses and benefits.

3. Existing fish screens at Crane Prairie outlet will have to be maintained to prevent loss of bull trout.

4. The range of bull trout will be expanded which would reduce the risk of extinction in the future.

5. Restoration would be compatible with Wild and Scenic River designation.

6. Bull trout may be an effective predator on introduced tui chub.

7. Stock from the Metolius River may be suitable and available for reintroduction.

8. Brook trout populations are present in the upper basin and would present difficult problems related to hybridizing and competing with bull trout.

9. Bull trout are very susceptible to harvest by angling.

ACTIONS

Action 8.1 A feasibility study will be conducted to determine if the reintroduction is technically possible and what biological, social, and economic factors would be involved.

LITTLE DESCHUTES RIVER AND TRIBUTARIES, CRESCENT LAKE, SUMMIT LAKE

LITTLE DESCHUTES RIVER AND TRIBUTARIES

Overview

This portion of the plan includes the Little Deschutes River in its entirety, the primary tributary of Crescent Creek, Big Marsh Creek (primary tributary of Crescent Creek), three headwater tributaries (Burn, Clover and Hemlock Creeks), Crescent Lake and Summit Lake (outlet flows into the Crescent Lake basin). East Lake, Paulina Lake, and Paulina Creek are not included because Paulina Creek no longer flows into the Little Deschutes River. These waters will be presented in another section.

The Little Deschutes River, an extensive major tributary to the Deschutes River, enters at RM 193 approximately one mile upstream of Harper Bridge. In 1988, Congress designated a 12-mile section (RM 84 to RM 97) of the Little Deschutes River as Wild and Scenic under the Omnibus Oregon Wild and Scenic River Act (P.L. 100-557). The section begins at the river's headwaters and ends just downstream from its confluence with Hemlock Creek. A 10-mile section of Crescent Creek (from Crescent Lake Dam downstream to County Road 61 crossing), a tributary to the Little Deschutes River is also designated as a Federal Wild and Scenic stream.

Big Marsh Creek was also designated as a recreation stream under the Federal Wild and Scenic Act from the headwaters to its confluence with Crescent Creek, a distance of 15 river miles.

In July 1979, a fish management plan was adopted by the Oregon Fish and Wildlife Commission for the Little Deschutes River from the Gilchrist Mill Pond to its headwaters (RM 63 to RM 97). This plan supersedes the 1979 document. Species of principle fish management interest in the Little Deschutes River are brown trout, redband trout, brook trout, and mountain whitefish.

Location and Ownership

The river headwaters in Klamath County and flows north into the Deschutes River near Sunriver (RM 193) in Deschutes County.

Overall, land ownership along the Little Deschutes River is 83% private and 17% federal (USFS, BLM). The majority of federal lands (USFS) are located from the headwaters (RM 97) downstream to near Crescent Junction (RM 65).

Public road access to the Little Deschutes River is restricted to a few forest roads south of Crescent and where main highways cross the stream. Private access is provided by numerous roads within subdivisions.

Historically, large tracts of private ranch land were sold and subdivided into residential homesites. While a fishable trout population exists, fishing opportunity is severely restricted by a lack of public stream frontage, public access roads and public boat access points. This lack of public access is a major concern to the Department relative to the Little Deschutes River. The Department has acquired four parcels of land adjacent to the Little Deschutes River in the Lazy River subdivision approximately five miles north of LaPine. These sites were purchased to provide bank angling and boat access, however the sites have been vandalized (signs removed and trees cut down) and are difficult for the public to find. In addition, there are a few scattered parcels of federal land (USFS, BLM) along the river, but they are difficult to identify without detailed maps. The USFS has one public campground, Rosland, located west of Wickiup Junction near RM 25.

Two tributaries to the Little Deschutes, Big Marsh and Crescent creeks, are in mixed National Forest and private ownership.

Over 80% of Big Marsh Creek is federally owned (USFS) with the remainder in private ownership. Big Marsh Creek is accessible by Forest Roads 5825, 6020, and 6030, all south of US Highway 58.

Over 80% of Crescent Creek is privately owned with the remainder under federal (USFS) ownership. The Forest Service has one campground located at the Highway 61 crossing. Public road access is provided by Highway 61, FR 60, US Highway 58, FR 190, and a number of secondary fire roads. Private roads provide the remaining access.

Habitat

The Little Deschutes River originates near Mule Peak in Klamath County (T26S, R6.5E, Sec.23) and flows approximately 97 miles north to its confluence with the Deschutes River (RM 192.5). Crescent Creek entering at RM 57.3 is the largest tributary of the Little Deschutes with several smaller tributaries entering upstream.

The Little Deschutes River subbasin comprises approximately 60 percent of the Deschutes River watershed above Benham Falls. It drains an area of 1,020 square miles. The Crescent Creek drainage, a tributary to the Little Deschutes River, comprises about 12 percent of the Little Deschutes subbasin area. Crescent Creek is about 30 miles in length.

The Little Deschutes River was first surveyed in 1871 by William Odell who designated the river as the East Fork Deschutes. That name was used by topographers until the name was officially changed in 1926 to the Little Deschutes River. More recently the river was surveyed by ODFW in 1965 and again between 1989 and 1990 by ODFW and the USFS.

Habitat surveys conducted in 1989-90 divide the Little Deschutes into 3 major sections: Deschutes River confluence to Gilchrist Mill Pond, Gilchrist Mill Pond to Highway 58, and Highway 58 to headwaters.

Section 1 -- Deschutes River confluence to Gilchrist Mill Pond

This section of the Little Deschutes flows into the Deschutes River at RM 192.5 (Deschutes River) and extends upstream to RM 63 at the spillway of the Gilchrist Mill Pond.

Land ownership is primarily private with a few scattered parcels of BLM and USFS lands. Land use is a mixture of residential, livestock grazing, and timber management with a small amount of the river corridor remaining in a semi-natural state. Heavily eroded streambanks and degraded riparian areas are common in the first 38 stream miles due to historic cattle use and residential development along the stream corridor. Cattle grazing continues in the stream subsection between RM 44.6 and 58.2. Willows become sparse and active bank erosion is common through that section. The area does, however, have some of the best spawning habitat due to low silt content within the gravels. Undeveloped lands dominate in the remainder of the section and have intact riparian areas.

Spawning habitat is generally lacking, but increases upstream in the section. For example, 1989-90 surveys did not classify any riffle habitat in the first 30 stream miles of the section (pool tailout areas were noted), but increased to 17% in the upper 2 stream miles. Heavy siltation of gravels is common throughout the section except for the area previously noted.

The riparian zone classification is the willow and sitka sedge association (USFS 1987) common throughout the Upper Deschutes Subbasin in areas with low gradient at mid-to-low elevations. Sitka sedge and willows dominate in the active floodplain with lodgepole pine in the inactive floodplain. Soils consist of peat created from sedge and have a high capacity for water retention.

ODFW personnel surveyed this river section in 1989-90 using a modified Hankin-Reeves methodology. River gradient is very low at 0.17%. Habitat type distribution is classified as 86.4% glide, 10.8% primary channel pool, 1.0% side channels, and only 0.9% riffle. Backwater pools and cascades made up the remaining habitat types. Stream channel substrate is predominately sand (81%) followed by gravel (14%), hard pan (4%), cobble (1%), and small boulders (1%). Wood material is lacking throughout with only 531 pieces classified in the entire section and includes only 115 pieces designated as large. There is an average of 0.99 pieces of wood per 100 yards of stream. Effective cover averaged 2.9% (percentage of total unit area) with overhanging vegetation providing 1.2%. Other cover types classified, in order of abundance, were: wood material, undercut banks, aquatic vegetation, and substrate.

Stream gauge readings are taken at RM 26.8 near LaPine, Oregon. Flows to some extent are regulated at Crescent Lake which is used as an irrigation storage reservoir by Tumalo Irrigation District which distributes water to lands north of Bend. The Little Deschutes River is unlike the Deschutes River subbasin upstream of Bend because it receives substantial surface runoff compared with spring inflow throughout most of the subbasin. Typical hydrograph peaks occur between April and June (Figure 15) with maximums in May. The average flow was 385 cfs between 1924 and 1987. Mid-summer flows are supplemented by irrigation releases at Crescent Lake (Figure 15).

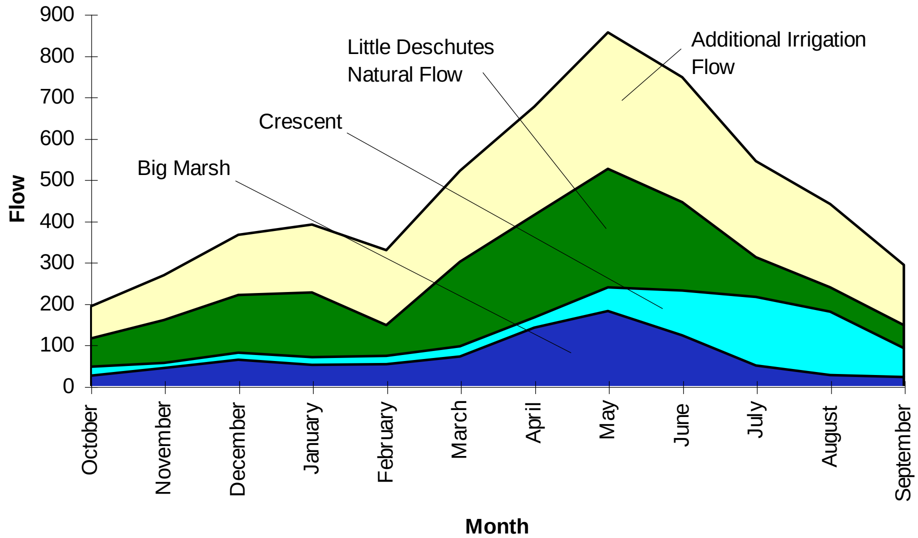


Figure 15. Irrigation releases in the Little Deschutes River, near LaPine, Oregon shown as total flows versus the natural flow in the river (1966-1995). Also shown are average monthly flows in Crescent (1928-1987) and Big Marsh creeks (1938-1987),

Hydrograph lows occur in October with average flows of 85 cfs between 1924 and 1987. Of hydrological interest was the abundance of small seeps and springs entering the lower portion of Section 1 that were documented in the 1965 ODFW surveys, but not observed in 1989-90 surveys. The Walker Basin canal near LaPine (RM 56) is the only major irrigation diversion on the Little Deschutes River. The canal is currently unscreened and has a maximum diversion rate of 37.5 cfs. Several other smaller diversions exist with maximum diversion rates below 2 cfs.

<u>Section 2 -- Gilchrist Mill Pond to Highway 58</u>

This river section begins at the spillway on the Gilchrist Mill Pond (RM 63) and extends upstream to Highway 58 (RM 79.8).

The Gilchrist Mill Pond dam has a fish ladder which was rebuilt in 1993 by the mill owner, Crown Pacific. The old ladder was dilapidated and not functional for passing upstream migrating trout.

River ownership is approximately 50% private and 50% USFS. Land use is recreation, grazing, and forest management. A number of the large private parcels have been subdivided into smaller pieces and used as recreation sites by families and individuals. Livestock grazing only occurs on one land parcel at the downstream end of the section. In the grazed area, riparian vegetation is lacking and streambank erosion is prevalent. Upstream of this area, riparian condition is good with limited degradation occurring from human disturbance.

The riparian association is willow/sitka sedge. Willows are the dominate riparian vegetation type in the active floodplain with sedge secondary. The floodplain is narrower than Section 1 and the river has more lodgepole pine influence. Soil type is sedge peat.

Habitat surveys were not completed for this river section during 1989-90. Qualitative observations by ODFW show this section has a good habitat distribution for fish production. There appears to be a more equitable distribution of habitat types including pools, riffles, and glides. Numerous side channels and backwater areas exist throughout the section. Spawning habitat is abundant with numerous tailouts and riffles with good quality gravel present. Overhanging vegetation and undercut streambanks associated with the riparian area provides the dominate cover type for fish. Beaver sign is prevalent throughout the section. This section should be surveyed using the current ODFW Restoration and Enhancement Program Stream Survey methodology to adequately identify habitat deficiencies.

Section 3 -- Highway 58 to Headwaters

This section begins at Highway 58 (RM 79.8) and ends at the headwaters of the Little Deschutes River (RM 97).

Land ownership is approximately 85% USFS and 15% private. Most private lands exist just south of the town of Mowich. Riparian areas are in fair to good condition. Cattle use is prevalent through most areas with surveys noting extensive damage from cattle in the 1989 surveys. Surveys in 1990 were done before pasturing of cattle. In a least one area, logging has removed most of the riparian vegetation. Tributaries entering the Little Deschutes in this section include Burn, Clover, and Hemlock Creeks.

This section was surveyed by the USFS in 1989 and 1990. Gradient through the section averages less than 1% except for 2.4 stream miles in the lower portion that average 1.7%. Habitat distribution is predominately glide with pool habitat secondary. Riffle habitat dominates in higher gradient areas. Dominate fish cover in downstream areas of the section are overhanging and aquatic vegetation which transitions to predominantly wood moving upstream. Wood in the upper 7 stream miles averages 104 to 124 pieces per mile. A large amount of wood was not classified due to its decayed condition. Sand is the dominate substrate and gravel is subdominant through most of the section. Spawning areas are lacking, especially in the lower gradient areas. A thermograph placed by ODFW in 1995 recorded average water temperatures of 50.0^{o}F with a minimum of 33.6^{o}F and a maximum of 65.8^{o}F near Highway 58. Water temperatures averaged 48.2^{o}F during the 1990 surveys recorded 11 stream miles upstream near Cow Camp (RM 91).

Riparian vegetation transitions from the willow and sitka sedge community to the bog blueberry and sitka sedge community more common at higher elevations. In the willow and sitka sedge vegetative community, the common riparian species include sedge grasses, willow, bog birch, and mountain alder with lodgepole pine above the floodplain. Moving upstream, sitka sedge, willow, alder, bog blueberry, lodgepole pine, and Engelmann spruce are the common riparian species.

Little Deschutes Tributaries (excluding Crescent and Big Marsh Creeks)

The three main tributaries entering the upper portion of the Little Deschutes River are Burn, Clover, and Hemlock creeks. Habitat summaries are based on USFS stream surveys completed in 1989 and 1990. Surveys were not done on Burn Creek.

Clover Creek originates on Miller Mountain and flows north approximately 3 river miles to its confluence with the Little Deschutes River near its headwaters. Many small spring fed tributaries enter Clover Creek from both banks. Stream surveyors classified 2.4 stream miles with a habitat distribution of 10% riffle, 86% glide, and <1% pool area. Gradient averages between 1 and 2% in the lower sections with alternating low gradient meadow and hillside constrained areas. The upper portion of the stream turns to cascades and falls with a high impassable waterfall at the end of the survey area. Discharge at the Little Deschutes confluence was measured at 8 cfs with a temperature of 41^{o}F. Substrate was dominated by sand with gravel secondary. Riparian vegetation is the Engelmann spruce, bog blueberry and forb association. Clover Creek is wholly within the Mt. Thielson Wilderness Area and is part of the Little Deschutes River cattle allotment that is being reviewed for termination by the USFS.

Hemlock Creek originates on Burn Butte and flows approximately 6 river miles entering the Little Deschutes near Mowich. Tributaries of Hemlock Creek include Spruce and Basin creeks. Spruce and Basin creeks are approximately 4 and 6 river miles in length, respectively. Discharge measured in Hemlock Creek was 18 cfs near the Little Deschutes confluence with Spruce Creek providing approximately 5 cfs and Basin Creek 0.5 cfs. Daily temperatures measured in Hemlock Creek ranged from 46.4 to 68.9^{o}F. The higher temperatures were noted just upstream from Basin Creek in an area of several small beaver dams. Hemlock Creek gradient was generally less than 1% with higher gradients of 2-4% in the upper sections. Habitat distribution was predominantly riffle in high gradient sections and glide in low gradient areas. Pool habitat as formed mainly by log dams and beaver dams. Dominant substrate is sand with gravel subdominant. Cover for fish is provided by aquatic and overhanging vegetation and wood material. Riparian vegetation transitions from willow and sedge in the lower sections to lodgepole pine, mountain alder, and bog birch in the upper sections.

Crescent Creek

Crescent Creek originates at Crescent Lake and travels approximately 30 miles to its confluence with the Little Deschutes River at RM 57.3. The drainage area is approximately 150 square miles. Big Marsh Creek is its largest tributary and enters at RM 19.0. Stream gauges are located at RM 19 just below the mouth of Big Marsh Creek and RM 29.9 below Crescent Lake dam.

Historically, Crescent Creek was much larger than today and drained a melting glacier at the present site of Crescent Lake. Crescent Lake formed behind moraines left by the glacier approximately 13,000 years ago. Big Marsh Creek has a similar history and originated from a glacier near it headwaters during the same time period. In addition, the Black Rock lava flow erupted and forced Crescent Creek around the south end of the flow approximately 4,000 years ago.

Habitat surveys were completed by ODFW and the Crescent Ranger District of the Deschutes National Forest in 1989 and 1990. Crescent Creek can be broken into three main sections based on topography; (1) the lower section from the Little Deschutes River confluence to Forest Road 61, (2) Forest Road 61 upstream to Highway 58, and (3) Highway 58 to Crescent Lake Dam.

Section 1 is comprised of the river section from the confluence of the Little Deschutes River (RM 57.3) and extends upstream 18.5 stream miles to Forest Road 61. Land ownership is approximately 95% private and 5% USFS. Land use is a mixture of grazing (71%), timber management (18%), and semi-natural (11%). Grazing by livestock is intense on the lower 9.5 stream miles. Surveyor notes indicated substantial sloughing of streambanks and severe erosion in this area.

Habitat distribution through the section is glide (52%), pool (34%), and riffle (11%) with side channels and cascades making up the other habitat types. Streambed substrate is comprised of gravel at 61% followed by sand at 29%. Numerous good spawning areas exist in pool tailout areas and on riffles with the abundance of good gravel increasing in the upstream areas. Fish hiding cover averaged 7% in the section with undercut banks being most common at 37.1% of the total followed by aquatic vegetation at 19.3%. Other cover types classified were wood and hanging vegetation at 16.2 and 14.5%, respectively. Wood material was lacking throughout the section with a total of 923 pieces classified and included only 55 designated as large. Wood averaged 45 pieces per mile total with large wood material making up 2.7 pieces per mile. Riparian habitat is primarily sedge and willow with lodgepole pine on upper terraces.

Section 2 extends 4 river miles, from Forest Road 61 upstream to Highway 58. Stream survey summaries by the USFS are qualitative and provide the following information. The section is broken from the prior by an increase in gradient to an average of 3% and lies within a steep canyon with sides averaging between 30 and 60%. Streambed substrate is dominated by small boulders, with cobble and large boulder substrates subdominant. Streambanks are armored by rock. Riparian habitat is in good condition and dominated by alder. Willow and wild rose are the subdominant riparian species. Instream cover is primarily from large and small boulders. Wood is prevalent throughout the section and is secondary as cover. The entire section is within National Forest land and remains in a natural condition.

Upstream of Section 2 the gradient decreases and the valley widens to start Section 3. Section 3 extends from Highway 58 upstream to Crescent Lake Dam, 7.5 river miles. Gradient through the section averages between 1 and 2%. Numerous backwater and side channel areas exist through the section. Habitat distribution has a fairly even balance between pools, riffles, and glides. Instream cover ranged up to 30% and is provided by undercut streambanks, wood material, and turbulence. Streambed substrate is comprised of sand, gravel, and cobble and transitions from sand dominance in downstream areas to cobble near Crescent Lake. Areas of good spawning gravel exist throughout the section. Riparian vegetation is dominated by willows and alders with small lodgepole pine behind the riparian area. Big Marsh Creek enters this river section at RM 19.0. Land ownership is predominantly USFS with 3.11 stream miles of private lands. In general, fish habitat in this river section is in good condition with some disturbance within a livestock grazing allotment just upstream of the confluence of Big Marsh Creek. Fish habitat conditions through private lands has not been evaluated.

Hydrologically, Crescent Creek is a low velocity stream through most of its length with an average drop of less than 45 feet per mile. Flow is regulated at Crescent Lake for irrigation use by Tumalo Irrigation District that delivers water to lands north of Bend. Low flows are prevalent between September and April during reservoir storage months and high during the rest of the year. The lowest flows occur in November and averaged 13 cfs between 1928 and 1987 with highest flows occurring in July which averaged 165 cfs during the same years as measured below Crescent Lake Dam. Flow fluctuations are moderated by Big Marsh Creek. ODFW thermographs placed in Crescent Creek recorded water temperature near USFS Road 62. Average temperatures of 58.1°F and maximum and minimum temperatures of 75.4 and 35°F were recorded between April and October 1995. Some habitat degradation is occurring due to regulated river flows, primarily by streambank erosion.

Big Marsh Creek

Big Marsh Creek originates from snow melt on Tolo Mountain, near the north boundary of the Mt. Thielsen Wilderness Area boundary, and travels north approximately 15 miles to its confluence with Crescent Creek. The drainage area of the subbasin is approximately 48 square miles. The stream flows through USFS lands with the except for approximately 3.5 stream miles of private lands. Big Marsh itself was privately owned from approximately 1916-1982 when it was purchased by the USFS from Diamond International.

The creek was formed by a series of glaciers which eroded a deep canyon. The last major glacier melted approximately 13,000 years ago. As it melted, the glacier left moraine deposits that formed a large lake about 4 miles long and 1 mile wide. Over time the lake filled with sediment and created what is now Big Marsh. Approximately 7000 years ago when Mt. Mazama erupted, the entire area was covered with about 5 feet of ash and pumice.

Big Marsh Creek headwaters have had little human impact with the exception of livestock grazing. In 1946, the stream was diverted into two ditches along the east and west sides of Big Marsh to drain the marsh and create a pasture for livestock grazing. In recent years, cattle grazing has been discontinued. In 1989, the stream was restored to the original channel through a cooperative ODFW and USFS project in an attempt to re-establish and revitalize the marsh and enhance fish and wildlife values and watershed health. Monitoring of the project is ongoing.

Stream surveys were conducted on Big Marsh Creek by ODFW in 1966 and by the Forest Service in 1989 and 1990. USFS surveys divided the creek into an upper and lower section. The lower section (Section 1) encompassed the stream section from the Crescent Creek confluence upstream to where the east and west canals converge at the north end of Big Marsh. The upper section (Section 2) extends from the canal convergence upstream to the headwaters. Habitat information is taken predominantly from the USFS surveys with some information from the ODFW surveys.

Section 1 was surveyed in 1989 covering 8.06 river miles. Habitat distribution is fairly even in the downstream portion of the section with 23 pools, 25 riffles, and 27 glides classified. Upstream of the railroad crossing, the habitat changes to alternating glides and riffles. Gravel is the dominate substrate through most of the section with sand becoming dominant in the uppermost portion. Cobble substrate was subdominant and occasionally gravel. Areas of gravel suitable for spawning are prevalent through downstream areas and decreased moving upstream. Cover was rated as poor overall and averaged between 5 and 20%. Aquatic vegetation was the dominant cover type observed. Wood cover is lacking throughout the section. Riparian vegetation is primarily sedge (80%) with willows and birch subdominant. Lodgepole pine becomes part of the riparian vegetation when hillslopes are adjacent to the river. Livestock grazing allotments have been discontinued on USFS lands, but continue on private lands. Deteriorated streambanks and poor stability are prevalent in those areas currently being grazed. Refrigerator Creek is the only tributary entering Big Marsh Creek in this section.

Section 2 extends from the confluence of the east and west canals upstream 7.15 stream miles. Approximately 2.5 miles of the survey were within the marsh. The marsh section surveyed was the original channel and not the canals. Numbers gathered will be used to gauge development of the original channel over time following diversion of the stream. Gradient throughout the section was less than 1%. Stream width averaged 22.3 feet with depths averaging 3.5 to 5.8 feet. Habitat distribution through the marsh was 85% glide and 14% side channel. In the balance of the section, habitat distribution was classified as 89% glide and 10% pool. Effective cover was lacking at near 0% in the marsh and 2% in the remainder of the section. Depth and aquatic vegetation provided the cover classified. Wood material upstream of the marsh totaled 42 pieces with only 2 large pieces counted. No wood was counted within the marsh. Substrate was dominated by sand through the section with gravel subdominant. Riparian vegetation through the marsh consisted of *Carex* grasses and willow less than 3 ft. tall. Upstream of the marsh, grasses and forbs were dominate along the stream margins with lodgepole and spruce behind. Otter Creek is the only tributary entering this river section.

Water quality in Big Marsh Creek is good. Near the confluence of Crescent Creek, average daily low temperatures were 55.8^{o}F and highs averaged 67.1^{o}F. Thermograph data collected in 1989 (USFS) show substantial water temperature increases occurring as water passes through the marsh, however temperatures do not rise to levels of concerns. Through the month of July (8th-23rd), daily low temperatures averaged 38.2^{o}F upstream of Big Marsh and 51.9^{o}F downstream a 13.7 degree increase. Average daily high temperatures were 47.2^{o}F upstream and 61.2^{o}F downstream of the marsh, a 14 degree rise. The Big Marsh Creek hydrograph shows April, May, and June as the peak runoff months with an average peak flow in May of 182 cfs between 1924 and 1987. Flows through the remaining months averaged less than 71 cfs with minimum flows occurring in November that averaged 13 cfs.

Habitat Limitations

Little Deschutes River

Section 1 -- Deschutes River confluence to Gilchrist Mill Pond

Physical habitat limitations or deficiencies in this river section are flows and cover. The combination of a man-altered flow regime, historic grazing practices, and more recently residential development of the river corridor has had the greatest impact on habitat conditions. Residential development in the downstream portion of the section increases the potential for water quality degradation in the future, however, problems have not been documented at this time.

Flow monitoring in the Little Deschutes River recorded an all time low of 5.5 cfs in 1994. This compounded temperature problems in the lower sections of the river. A thermograph placed near RM 2 recorded a peak temperature of 84.2^{o}F in early August of 1994. Thermographs were not placed until late August so summer long averages and peaks were not obtained. A thermograph placed in the same location in 1995 recorded a maximum temperature of 75.4^{o}F and an average temperature of 60.6^{o}F between April 6 and October 4. For one 10-day period in early August 1995 temperatures ranged from a minimum of 68^{o}F to a maximum of 75.2^{o}F. Water temperatures decreased steadily moving upstream.

Trout cover is lacking in this section of the Little Deschutes River. The combination of low flows, erosion, and degraded riparian conditions have eliminated or substantially reduced those features that would normally provide cover in this riparian association. In areas of good habitat, the sitka sedge and willow roots provide excellent bank stabilization and provide shade and cover for trout in the form of undercut banks. Additionally, lodgepole pine provides added bank stability and structural diversity. A good example of this is exhibited in a short section in the upstream portion of the section. In this area, riparian condition is excellent and effective cover jumps to near 20% with overhanging vegetation providing 13% and wood material providing 3%. A healthy riparian zone such as this would be extremely beneficial in reducing high water temperature downstream. In degraded areas, the sitka sedge will rapidly reestablish itself with rest or riparian protection.

Section 2 -- Gilchrist Mill Pond to Highway 58

Habitat limitations in this section of the Little Deschutes River are largely unknown because physical stream surveys have not been completed. One obvious deficiency is degraded riparian habitat from livestock grazing in the stream section immediately upstream of Forest Road 61.

Section 3 -- Highway 58 to Headwaters

Low water temperature and riparian vegetation destruction from excessive cattle grazing are the primary habitat limiting factors in this river section. The abundance of seeps and springs in the upper subsections, along with the aspect and elevation, prevent water temperatures from attaining the optimum range for fish growth.

Excessive grazing by livestock is the greatest habitat limitation that is treatable. The current USFS grazing allotment allows cattle use from July through October. The stream survey crew noted they revisited the survey area following the 1990 grazing season and found streambank vegetation to be cropped or trampled to the ground in many areas. Other damage noted included slumping and deteriorated streambanks and loss of undercut bank cover. This allotment is currently under review for possible cancellation. Should the allotment not be canceled, the permit should be altered regarding timing and number of animals to reduce negative impacts.

Little Deschutes Tributaries (excluding Crescent Creek)

Surveys indicate excessive grazing by livestock is having the greatest negative effect on riparian habitat of Little Deschutes tributaries, however, impacts were less than observed on the Little Deschutes River mainstem. All tributaries noted above are in the Highway 58 to Headwater section and subject to the same review by the USFS for possible cancellation of grazing allotments.

Crescent Creek

Flow fluctuations caused by irrigation demands are the greatest fish habitat limiting factor for Crescent Creek especially upstream of its confluence with Big Marsh Creek. In the 1994-95 water year, flows fluctuated from a 1 cfs daily average on January 11 to 127 cfs daily average on August 10. Stream survey results did not provide adequate information to determine changes in spatial habitat, but it is believed to be substantial. Monthly mean average flows for November and December 1994 were 3.6 and 2.7 cfs. Low flows not only concentrate fish, but increase their vulnerability to predators, severely reduce aquatic insect production, and potentially risk freezing of the entire water column. High flows are acting to increase the channel capacity and meander sequence of the creek to accommodate flows above the historical average.

Secondary to flows, cover becomes the limiting factor. Cover loss is especially noticeable in areas with ongoing livestock grazing. Excessive livestock use in riparian areas has reduced the sedge and willow components which are the basis for protection against bank erosion. In areas of good habitat, the sitka sedge and willow roots provide excellent bank stabilization and provide shade and cover for trout in the form of undercut banks. As noted earlier, areas in a semi-natural condition provided up to 30% cover.

Big Marsh Creek

Instream trout cover is the greatest limiting factor in Big Marsh Creek. Throughout the surveyed area, total effective cover was rated low. Very little wood material was noted and areas of sloughing and erosion reduced undercut streambanks through the entire stream. Lack of cover was especially prevalent through private lands where cattle grazing is ongoing. Stream surveyors recommended habitat enhancement projects to increase the amount of wood material in the stream. Elimination of livestock grazing on all federal lands will allow riparian habitat and stream channel areas to recover, over time, increasing the cover component. The short growing season in the area will slow vegetation recovery in the short term.

Fish Stocking History

Little Deschutes River

Current stocking records date back to 1945 when 52,000 fingerling rainbow of unknown stock were planted in the Little Deschutes River. Legal-size rainbow were first stocked in 1948, origin unknown. Other historical stockings are listed below:

Year	Species	Number	Size
1950	brook trout	26,240	fingerlings
1954	brook trout	1,000	legal-size
1969	kokanee	25,600	fry
1970	brown trout	462	legal-size
1974	brown trout	13,327	legal-size

Legal-size rainbow trout were stocked each year from 1954-1975 and from 1977-1978. There has been no stocking since 1978. Numbers ranged from 800-14,000 rainbow trout annually.

Crescent and Big Marsh Creeks

Current stocking records show Crescent Creek was stocked only once in 1950 with 4-6" rainbow trout, stock unknown. Brown trout in Crescent Creek most likely moved downstream from Crescent Lake or upstream from the Little Deschutes River.

Current records show Big Marsh Creek was stocked in 1968-69 with 4-500 legal-size rainbow trout, reared at Klamath hatchery. Brown trout in Big Marsh likely migrated from Crescent Creek. The origin of brook trout in Big Marsh Creek is unknown.

Angling Regulations

The Little Deschutes River is lightly fished compared to brown trout streams elsewhere in the subbasin. Reasons include: lack of public access, difficult to fish from the bank due to willow cover, the overall size of the fish found in the Little Deschutes are relatively small, and the Department no longer stocks the river.

Since the river is extremely low in nutrients, it will not produce "trophy" size fish, but the area is capable of producing a high-quality recreational opportunity which include large populations of small wild trout and minimal inter-angler contact in an aesthetically pleasing area.

The Little Deschutes River has not had the need for special angling regulations as have other waters within the basin. The few changes are listed below.

1935 Crescent Creek and tributaries closed to angling.

1936 Crescent Creek and its tributaries from its confluence with Big Marsh Creek to its source closed to angling.

1937 Big Marsh Creek open to angling from April 15 - September 20.

1942 All tributaries of Big Marsh Creek (name change) closed to angling.

1977 Special closure from April 23 - May 31 from Gilchrist Mill Pond dam to Highway 58 cutoff road.

General angling regulations for the Central Zone are in effect on the Little Deschutes River. The season opens in late April and closes at the end of October. The area from Gilchrist Mill Pond dam to the Highway 58 cutoff road has a special season of June 1 - October 31 to protect nesting waterfowl. The daily bag limit for trout is 5 per day, not more than 1 fish over 20 inches. There are no gear restrictions.

Fish Management

Indigenous fish species known to have existed in the Little Deschutes system include redband trout, bull trout, mountain whitefish, and reticulate sculpin. One document (Gray 1986) makes reference to bull trout occurring in Crescent Creek. These fish would have had unrestricted movement into Crescent Lake prior to the dam being built, however, no other documentation can be found of their presence in other areas of the Little Deschutes basin. Bull trout may have been in Big Marsh Creek, and the Little Deschutes River since there are headwater spring areas in both streams which could have provided suitable spawning sites.

It is unknown precisely when brown and brook trout were introduced into the Little Deschutes River system, but timing was most likely similar to the Deschutes River, prior to 1920.

Brown trout generally out compete rainbow in this system as they occupy the best habitat and are a longer-lived fish. The river is characterized as slow moving and highly meandering, associated with undercut and overhanging banks and is generally better habitat for brown trout than rainbow trout.

A 1974 ODFW research study on brown trout found the following species and their relative abundance in the Little Deschutes (including its tributaries):

Species	Relative abundance
brown trout	abundant
mountain whitefish	abundant
brown bullhead	abundant
tui chub	abundant
brook trout	common
reticulate sculpin	common
rainbow trout	scarce

Brown trout growth was found to be slow with rates from one to two inches per year, a result of low amounts of nutrients in the water and high trout density. High survival led to high densities of brown trout mostly under the length of six inches. The majority of the fish mature at three years of age and are 6.3 inches in length. Few fish survive after spawning due to subsequent loss of body condition and harsh winter conditions that follow (Lorz 1974).

Lorz found that brown trout spawning usually commences in mid-September and was completed by mid-November. The early spawning is uncharacteristic of brown trout in other areas of the Deschutes basin which generally begin spawning in October.

Study sites in the natural, free-flowing stream channel with adequately vegetated banks had greater trout populations than areas heavily grazed (Lorz 1974.) Cover was found to be the most important physical parameter governing the number of brown trout. The study found a large number of brown trout were lost annually because of entry into unscreened or improperly screened irrigation canals in the main Deschutes River in the vicinity of Bend. The same situation occurs in the Little Deschutes River today.

In 1990 and 1992, fish inventory was undertaken throughout the Little Deschutes River basin. Fish populations were sampled using a backpack electrofisher and by snorkeling. A drift boat mounted electrofisher was used in portions of Crescent Creek and the Little Deschutes River where water volume was too great for the backpack unit. Samplers collected relative abundance and species information using single pass electrofishing. It should be noted that 1992 was an extreme low water year.

In the Little Deschutes River, seven sites were inventoried (Figure 16) representative of the entire river length. Rainbow trout were scarce. Only 10 rainbow were captured with only 1 found upstream of LaPine. Rainbow ranged from 3 to 9 inches in length. Brook trout were fairly abundant in the uppermost (above Mowich) stream section sampled, and represented 62% of all trout sampled at that site. Brook trout numbers dropped to zero a short distance downstream of Highway 58. Brook trout captured were up to 7 inches in length. Brown trout were the most abundant trout species sampled. Brown trout numbers increased moving from the headwaters downstream to Highway 58 where 138 were captured in 570 feet of stream and then declined toward the Deschutes River confluence. Only 9 brown trout were captured in the three sites (approximately 4200 feet of total stream) downstream of Gilchrist Mill Pond. The size range of brown trout captured was 2 to 19 inches. Whitefish were the only species to increase in numbers moving downstream toward the Deschutes River confluence.

Nematodes were found in most brown trout from the first section sampled downstream of Gilchrist Mill Pond. Two of the brown trout were infested with several nematodes.

Overall, the trout population is fair upstream of Gilchrist, but poor downstream. Although rainbow were the dominant species historically, habitat conditions have allowed brown and brook trout to out compete them.

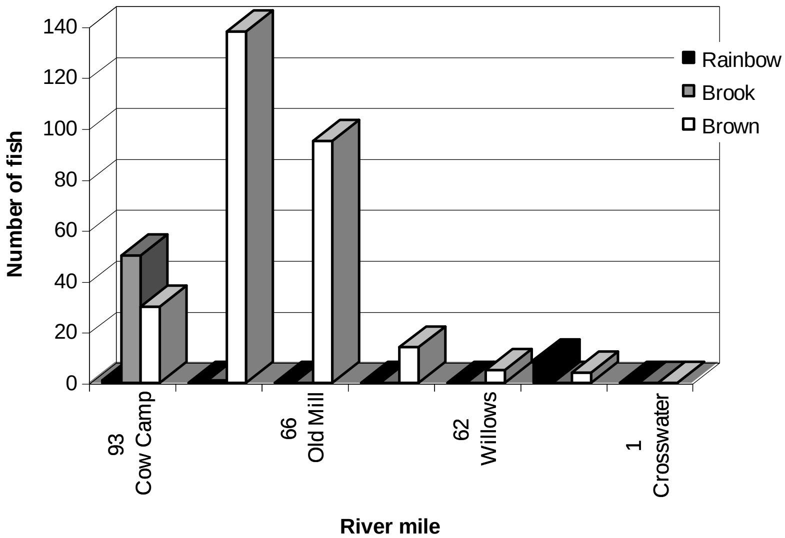


Figure 16. Little Deschutes River trout inventory at 7 sites, 1992.

Big Marsh Creek inventory was conducted in the vicinity of Big Marsh. Species composition was found to be 2.2% brown trout, 92.3% brook trout, and 5.5% whitefish with a few tui chub and sculpins. No rainbow trout were captured during the 1992 inventory effort, but 2 were caught in 1990 while sampling the same survey sections. Both rainbow captured were in the 6-8 inch size category. Size ranges for brown trout, brook trout, and whitefish were 2 to 18 inches, 2 to 12 inches, and 2 to 14 inches, respectively. The largest fish were captured in the mainstem immediately above and below the marsh. Sampling has not been done in areas further downstream of Big Marsh, however, we assume fish species composition transitions to predominantly brown trout as water temperatures increase toward the Crescent Creek confluence. Fish population surveys need to be conducted in representative areas downstream of the marsh. In general, the fish population appears healthy in terms of numbers for the areas surveyed. Rainbow trout were notably absent, however, habitat conditions and competition from other fish species may account for their low numbers.

Rainbow trout were the most abundant trout species captured in Crescent Creek. Three sections were surveyed in 1992, all downstream of Highway 58. In the canyon section below Highway 58, only 9 rainbow and no brown trout were captured in approximately 980 feet of stream. Sculpins were also in the section, but not captured or quantified. Nematodes were identified in several of the rainbow trout, but not at the level seen in brown trout below Gilchrist Mill Pond. Downstream of Forest Road 61, ODFW snorkelers identified 26 rainbow, 94 whitefish, over 50 sculpins, and 10 roach in approximately 1/2 mile of stream. The section furthest downstream was surveyed with a drift boat electrofisher. The section was approximately 2.5 river miles in length and included areas heavily grazed by livestock. Through the entire section, only 5 rainbow trout, 4 brown trout, and 41 whitefish were captured. Sculpins were observed, but not captured. Both brown and rainbow trout ranged from 3 to 10 inches in length. The high proportion of rainbow trout in the samples is explained by stream gradient. As gradient decreased moving downstream, the number of brown trout increased. Crescent Creek's low fish density is a mystery. In spite of some habitat deficiencies, Crescent Creek should be capable of supporting fish populations much higher than encountered.

There is no current angler creel census records for the Little Deschutes River or tributaries. Due to the lack of public access (both boat and bank) and heavy willow cover in many areas, the stream is lightly fished compared to other Central Oregon streams.

Parasites and Diseases

In recent years, a nematode parasite, *Eustrongylides sp.*, has been identified in brown trout from the Little Deschutes River system. The decline in the brown trout population has been substantial from the 1960-1970 period to present and the causes are unknown. This parasite could be partly or wholly responsible for the decline. It is unknown at what intensity of infection these nematodes could constitute a problem resulting in disease or mortality of brown trout. Reduced growth, damage to internal organs and sterility have been reported to be caused by this parasite. Department surveys have confirmed the presence of this nematode in brown trout from Crescent Creek and the Little Deschutes River downstream of Gilchrist Mill Pond. The total distribution of the parasite in the Little Deschutes basin in unknown and deserves further investigation. Additional surveys of brown trout and other fish species in the watershed will be required to determine the extent and impact of infestation.

Another parasite, the myxosporidean, *Ceratomyxa shasta*, was found in the Little Deschutes River basin in Crescent Lake and Crescent Creek (Bartholomew et al. 1989). This is a common parasite in the Deschutes River drainage and is especially lethal to non-resistant rainbow trout. *C. shasta* was not found in the Little Deschutes River, however it is highly likely it is present at least up to Gilchrist Mill Pond. Additional testing for this parasite in the mainstem Little Deschutes River and headwater tributaries is warranted.

Management Issues

1. Introduced brown and brook trout have extirpated native rainbow and bull trout from much of the upper Little Deschutes; bull trout have been completely eliminated, and rainbow trout are found only in a small proportion of their former range.
2. Reintroduction of bull trout and expansion of rainbow to their former range is technically infeasible at this time.
3. None of the irrigation diversions in the Little Deschutes River basin are screened. The most significant unscreened diversion is the Walker basin canal (37 cfs). The extent of trout loss in these diversions is unknown.

4. Fluctuations in stream flow in Crescent Creek and the Little Deschutes downstream from Crescent Creek due to irrigation withdrawals from Crescent Lake impact survival (abundance and distribution) of trout in those streams.
5. Much of the Little Deschutes River system is in private ownership, and not accessible to the public.

MANAGEMENT DIRECTION

LITTLE DESCHUTES RIVER AND TRIBUTARIES

POLICIES

Policy 1. Mountain whitefish and redband trout will be managed for natural production under the Wild Fish Management Alternative for trout (ODFW 1987)

Policy 2. Brown and brook trout will be managed for natural production under the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 3. Hatchery trout will not be stocked in the Little Deschutes River and tributaries.

OBJECTIVES

Objective 1. Maintain the genetic diversity, adaptiveness, and abundance of redband trout, mountain whitefish and introduced brown and brook trout in the Little Deschutes River drainage.

Assumptions and Rationale

1. Little Deschutes River redband trout have been identified as sensitive species.

2. This subbasin supports redband trout and mountain whitefish and naturally-reproducing brown and brook trout.
3. Monitoring the distribution, size, age-class, structure and abundance of populations of mountain whitefish and redband, brown and brook trout will provide an indication of their health and adaptiveness.

4. Releases of hatchery trout near areas where spawning of wild trout occurs may decrease the genetic fitness of wild trout populations.

ACTIONS

Action 1.1 Establish trout population trends, distribution and abundance in selected index sections of the Little Deschutes River and tributaries.

Action 1.2 Verify and document distribution and upper limits of redband, brown, and brook trout and mountain whitefish in the Little Deschutes River and tributaries.

Action 1.3 Assess the status of sensitive redband trout in the Little Deschutes River and tributaries.

Action 1.4 Establish baseline data on the genetic characteristics of redband trout with the use of biochemical and phenotypic parameters.

Objective 2. Provide diverse angling opportunities for wild trout and whitefish in the Little Deschutes River and tributaries.

Assumptions and Rationale

1. Management under this alternative seeks to provide a diversity of angling opportunities including nonconsumptive as well as consumptive use of wild trout and whitefish.

2. These waters are managed to use their natural productivity to grow trout and whitefish to a harvestable size. Most of the trout available to the angler are either from natural production or from drift of hatchery rainbow from releases made upstream in Crescent Lake.

3. The fisheries on these waters are of a general, consumptive nature.

4. Special regulations may be necessary to protect stock fitness and life history characteristics and to maintain healthy trout populations with multiple age classes.

6. The whitefish population is abundant but the fish do not reach a desirable size to be of much interest to Oregon's anglers.

ACTIONS

Action 2.1 Evaluate angling pressure and harvest rates of wild trout through creel surveys on key stream sections to determine consumptive use and impacts on wild populations.

Action 2.2 Determine the need for additional or modified angling regulations to protect populations of wild trout by monitoring the production, harvest, and catch rate of wild trout and to provide non-consumptive angling opportunities.

Objective 3. Protect, restore and enhance wild trout and whitefish habitat in the Little Deschutes River and tributaries.

Assumptions and Rationale

1. Protection and enhancement of trout and whitefish populations can be achieved principally through habitat protection and improvement.

2. Habitat management is the basis of wild fish management. Management objectives for natural fish production cannot be obtained without all the elements of habitat to support fish production. Habitat protection is more effective than restoration or enhancement, but habitats that have been degraded should be restored to return fish production to optimum levels. Habitat restoration and enhancement can increase natural production, but should not be considered a substitute for habitat protection.

ACTIONS

Action 3.1 Support enforcement of existing laws and regulations concerning habitat protection by agencies with enforcement authority such as USFS, ODWR, DOF, DEQ, and Klamath and Deschutes counties.

Action 3.2 Coordinate and provide technical input in management of all riparian areas along the Little Deschutes River and tributaries to achieve vegetative potential to optimize fish production.

Action 3.3 Identify habitat deficiencies and sites for habitat improvement projects.

Action 3.4 Develop a habitat improvement plan for the Little Deschutes River and tributaries.

Action 3.5 Work with volunteers, sporting clubs, landowners and agencies to implement habitat improvement projects.

Action 3.6 Implement habitat protection actions outlined in this document.

Objective 4. Maintain or improve flow for fish production in the Little Deschutes River and tributaries.

Assumptions and Rationale

1. Water quantity is as important as water quality for fish production. Fish production is limited by low streamflow in some sections of the Little Deschutes River and tributaries. Restoration of optimum streamflows will increase the fish production capacity in the drainage.

2. Flow diversions during summer months and water storage in Crescent Lake in winter months impacts spawning and rearing habitat in the Little Deschutes River and tributaries.

ACTIONS

Action 4.1 Identify stream sections that would benefit from instream water rights and apply to Oregon Department of Water Resources for designations.

Action 4.2 Encourage irrigators (through education and financial assistance where available) to improve water distribution and application techniques in an effort to use less water more efficiently.

Action 4.3 Encourage the Water Resources Department to require legal flow measuring devices on diversions and improved supervision and enforcement.

Objective 5. Improve the water quality of the Little Deschutes River and tributaries.

Assumptions and Rationale

1. High quality aquatic habitat is necessary for optimum fish production. The aquatic environment must provide the requirements for every life history phase of fish. Adequate amounts of clean, cool water, food organisms, cover, and spawning areas for salmonids are components of high quality habitat.

2. Land uses in the watershed can adversely affect water quality. Agriculture, livestock grazing, urban development and timber harvest practices have the potential to degrade watershed conditions and decrease water quality.

ACTIONS

Action 5.1 Coordinate with state and county agencies to improve monitoring and enforcement of water quality standards.

a. Urge the Department of Environmental Quality to increase water quality monitoring especially in important fish production areas.

b. In joint responsibility with the Department of Environmental Quality, determine point and non-point pollution sources.

c. Develop an action plan to address point and non-point source pollution in cooperation with state and federal agencies.

Action 5.2 Promote riparian zone protection as a means maintaining and/or improving water quality for the future.

a. Coordinate with county and state agencies and actively pursue regulations for the establishment and maintenance of quality riparian zones in agricultural and urban lands.

b. Investigate opportunities for purchase or lease of riparian areas.

Objective 6. Prevent fish losses at unscreened diversions in the Little Deschutes River and tributaries.

Assumptions and Rationale

1. Unscreened irrigation diversions in the Little Deschutes River and tributaries kill trout and whitefish.

ACTIONS

Action 6.1 Inventory irrigation and other water diversions to determine screening needs to protect trout and whitefish in the Little Deschutes River and tributaries.

Action 6.2 Prioritize unscreened diversions for installation of screens and coordinate this with the screening program with the Habitat Conservation Division, ODFW. Diversions affecting sensitive wild trout will have highest priority.

Action 6.3 Install screens in priority order.

Objective 7. Provide adequate upstream and downstream passage for fish at dams, road culverts, and other artificial obstructions.

Assumptions and Rationale

1. Adequate fish passage at obstructions and diversions is necessary to prevent injury delay or loss of fish as a result of any water development project.

2. Adequate fish passage is necessary at road crossings to provide access to upstream spawning and rearing areas.

ACTIONS

Action 7.1 Evaluate newly constructed fish ladder at Gilchrist Mill Pond dam for adequate fish passage.

Action 7.2 Inventory culverts for fish passage problems. Make recommendations to the USFS or appropriate landowner to improve upstream passage at culverts.

Action 7.3 Work with the ODFW Fish Passage Coordinator to establish and implementation schedule for installation of fishways on private lands.

Objective 8. Provide additional public boat and bank access from Highway 58 downstream to the mouth.

Assumptions and Rationale

1. Approximately 83% of land adjacent to the Little Deschutes is in private ownership.

2. Sections of the river are driftable by small boat below Highway 58.

ACTIONS

Action 8.1 Analyze current ownership patterns including conservation and access easements.

Action 8.2 Encourage Deschutes County to continue pursuing conservation easements and Klamath County to adopt ordinances pursuing conservation easements with public access on all land use actions.

Action 8.3 Develop a boat and bank access plan, prioritize the list of desired sites and aggressively pursue acquisition of key areas.

Action 8.4 Develop site criteria for boat and bank access.

Action 8.5 Work with counties to develop and maintain small boat access at existing and future road crossings.

Objective 9. Determine if it is feasible to restore bull trout in the Little Deschutes River and tributaries.

Assumptions and Rationale

1. Bull trout were historically distributed throughout the upper Deschutes River.

2. Restoring bull trout will eliminate some fisheries and create a new fishery with subsequent economic losses and benefits.

3. Restoration of upstream and downstream fish passage for adult and juvenile fish will be integral to bull trout restoration (Crescent Lake Reservoir).

4. More stability will be needed in the Crescent Lake pool to maintain quality bull trout habitat.

5. Adequate flow must be maintained in the river to provide the habitat conditions needed by bull trout.

6. Water temperatures will have to be regulated at Crescent Lake to maintain habitat conditions for bull trout in Crescent Creek.

7. Fish screening will be necessary to reduce mortality and loss of bull trout to dam facilities.

8. The range of bull trout will be expanded which will ease Endangered Species Act constraints.

9. Restoration would be compatible with Wild and Scenic River designation.

10. Bull trout may be an effective predator on introduced tui chub.

11. Suitable stock from the Metolius River are available in adequate numbers for reintroduction.

12. The population may need to be started and possibly maintained by hatchery methods if habitat constraints could not be overcome.

13. Their may be undesirable movements of introduced species with the construction of fish passage facilities.

14. Upper basin brook trout populations would probably hybridize and compete with bull trout.

15. It would be difficult to eliminate competition between bull trout and brown trout.

16. Bull trout are very susceptible to predation and poaching.

ACTIONS

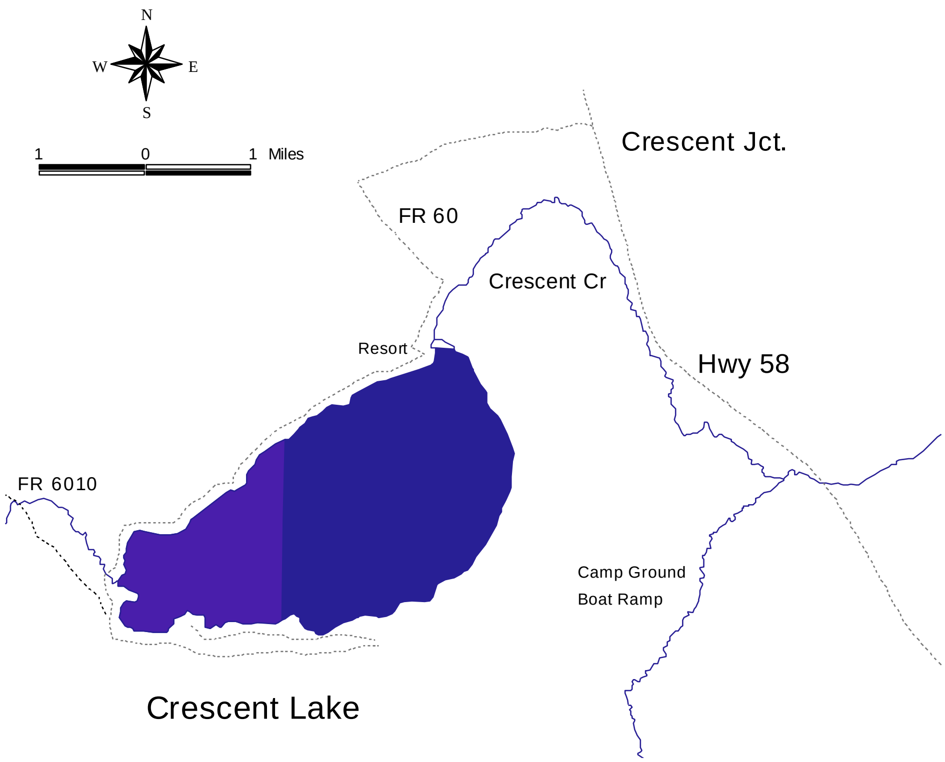
Action 9.1 A feasibility study will be conducted to determine if the reintroduction is technically possible and what biological, social, and economic factors would be involved.

CRESCENT LAKE

Location and Ownership

Crescent Lake lies just east of the summit of the Cascade Mountain Range in Northern Klamath County. It is about 3 miles south of Hwy 58 via Deschutes National Forest Road 60 from Crescent Lake Junction. Access to lake shore areas and facilities is off Forest Road 60 and 6015.

Crescent Lake is entirely within the Deschutes National Forest. Developments on the lake include a resort at the outlet that provides lodging, food, tackle, boat rentals and moorage. The Deschutes NF has four campgrounds on the lake: Crescent Lake CG, at the outlet; Spring CG, at the southwest end; Contorta Point CG, on the south shore; and Simax CG, on the east end. There are three developed day-use areas, a Boy Scout camp and a number of private homes along



the shoreline. There are three boat ramps on Crescent Lake. Only two of the ramps, one each at Crescent Lake CG and Spring CG, are serviceable at higher water levels. Drawdown to lower water levels exposes the third ramp, located at Crescent Lake CG; this is the only ramp that is functional at lower water levels. Some boats are launched off exposed beach areas when the lake level is drawn down.

In addition to angling, this lake is popular for boating, sailing, water skiing and swimming.

Habitat and Habitat Limitations

Crescent Lake lies in a naturally glaciated basin behind a moraine dam. In 1922, a small earth and wooden dam was built across the outlet to store water for irrigation in the Bend area via Crescent Creek, Little Deschutes and Deschutes rivers The Bureau of Reclamation constructed a 40 foot-high earth and concrete structure in 1956 bringing the lake's surface elevation at full pool to 4,847 feet where it has a surface area of 4,008 acres. There is 86,860 acre-feet of usable storage under permit to Tumalo Irrigation District and about 500,000 acre-feet of volume in the natural lake basin. At minimum pool, elevation 4,823, the surface area is 3,470 acres. Average monthly flow is shown in Figure 17, data for flow prior to construction of Crescent Dam is not available. Maximum depth is 280 feet. Shoal areas, less than 25 feet deep, make up only 5% of the area while 60% is over 100 feet deep. Bottom materials are mainly fine sediments predominated by pumice. Much of the sand, gravel and rock in the shallow areas are exposed at low water levels.

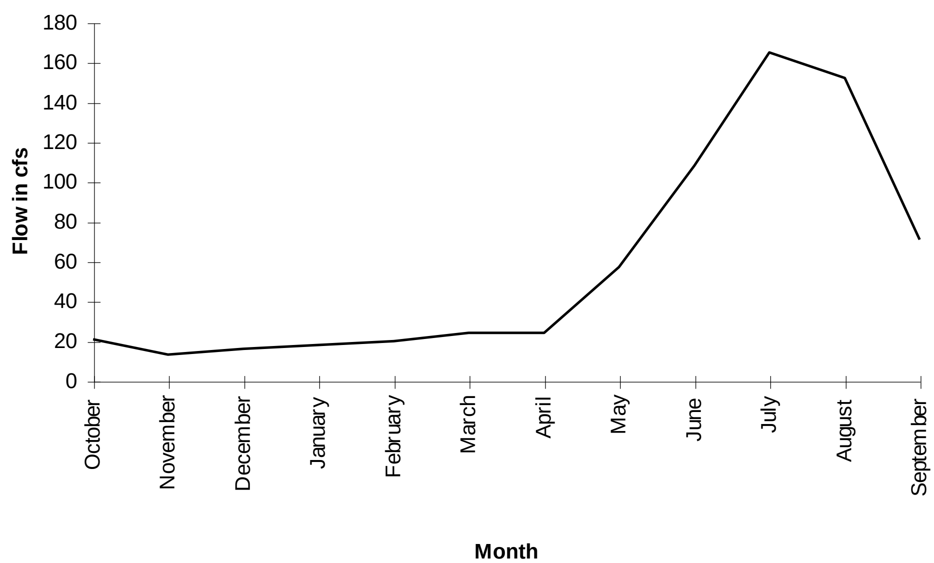


Figure 17. Average monthly flow from Crescent Lake, 1928-1987.

The lake's drainage basin covers 60.7 square miles and is largely dominated by coniferous forest of pine, fir and hemlock. The primary inflow tributary is Whitefish Creek headed in the Diamond Peak Wilderness Area and Summit Lake; however, its flow drops below 0.5 cfs by late summer and may even go sub-surface. Windy and Cowhorn creeks are important tributaries during spring runoff. Many submerged springs near Spring Camp and Contorta Point are also significant sources of inflow.

The lake is oligotrophic with water transparency from the surface down to about 20 feet throughout the year. Water temperatures are cool with surface waters rarely exceeding 68^{o}F. A thermocline normally develops at 30-50 feet by late June or early July. Dissolved oxygen levels are typically high and pH is near neutral. Water surface elevation drops each year in late summer because of irrigation draw-down but because of the great depth, it has little effect on water quality.

The lake has low productivity in terms of Total Dissolved Solids (TDS) and zooplankton abundance. TDS averages about 15.5 according to measurements made in 1975. For comparison, the TDS was 20 in Odell Lake and 395 in Paulina Lake. In 1975, numbers of zooplankters averaged 2,690 per cubic meter during early June to late July but increased to 13,735 in late July and August. *Cyclops* made up 95% of the population and *Daphnia* were the remaining 5%. There is very little growth of macrophytes (aquatic vegetation) because of the lack of shoal area, lack of suitable substrate and the annual drawdown.

The outlet structure on Crescent Lake dam is screened to prevent fish from passing down into Crescent Creek. There are no provisions for upstream passage over the dam.

Habitat limitations in Crescent Lake are:

1. Natural low level of productivity.
2. Annual draw-down exposes shoal areas thereby eliminating the most productive food producing and rearing areas.
3. At lower pool levels, some kokanee spawning habitat is denied by exposure of spring areas and blockage of the entrance to Whitefish Creek by a pumice delta. Spawning habitat for lake trout is also reduced by exposure of rock and gravel areas along the shoreline.
4. Poor quality gravel in Whitefish Creek and the spring areas probably limits success even when these areas are available to spawning kokanee.

Fish Stocking History

Bull trout, redband rainbow trout and mountain whitefish were indigenous fish species to Crescent Lake. Bull trout have been extirpated. Fish species now present are: rainbow, brown and lake trout, mountain whitefish, kokanee, Tui chub and reticulate sculpin. The sculpin is probably also native, but early reports did not document them in the lake; they were found in Crescent Creek in 1958. Tui chubs were introduced sometime before 1940 when they were reportedly abundant (Newcomb 1941). Brook trout may be present rarely when they drop down from the tributaries.

Brook trout were the first species to be stocked in Crescent Lake when 400 were released in October of 1915 (History of Early Northern Klamath County, Oregon). In 1928, another 25,000 were stocked and between that time and 1939 up to 335,000 brook trout were stocked annually. No more were released into the lake after 1939.

An article in the *Bend Bulletin*, July 26, 1917, reported that lake trout "indigenous to eastern lakes" were stocked in Crescent Lake, among others, but no specific numbers were given. Only one other release of lake trout was made; that was in 1957 when 74,650 (Odell Lake egg-take) were stocked.

Brown trout (origin unknown) were first stocked in 1925 when 367,500 were released. Those fish established a small naturally reproducing population. In the early 1980's, it was decided to augment the natural production with hatchery fish. Between 1982 and 1990, 10,000-20,000 fingerlings (Wickiup egg-take) were stocked in several years. Since 1991, the allocation has been for 12,000 yearling brown trout per year.

A historical account of the creation and operation of the Odell Lake Fish Hatchery, on Odell Creek in 1913 and 1914 described fish being spawned at Gold, Davis and Crescent lakes. Those eggs were then hatched and the fish reared at the Odell Hatchery. Those fish were reportedly stocked in Odell, Gold, Crescent, and Davis lakes (Gray). The next known record of rainbow trout being stocked in Crescent Lake was in 1928 when 75,000 (origin unknown) were released. Between then and 1940, several plantings of up to a million rainbows of unknown origin were made. Between 1945 and 1976, an average of 157,000 rainbows were stocked each year; those fish included fall spawners from Oak Springs and Roaring River stocks and spring spawning "Kamloops" from Diamond Lake. Beginning in 1947, and through 1958, an average of 22,000 rainbows (mainly Oak Springs stock) over 6 inches in length were released along with the fingerlings. Stocking of rainbow trout was discontinued after 1976 as a result of poor survival caused by mortality from *Ceratomyxa shasta*. Stocking was resumed in 1987 with *C. shasta* resistant Deschutes rainbows, Lot 66. Since then, between 20,000 and 68,000 at 37 to 68/lb. have been released annually. The present yearly allocation is for 65,000 at 50/lb.

In 1954, 513,000 kokanee fry were introduced to Crescent Lake as the initial release of this species. Between 1954 and 1961, an average of 405,000 fry were stocked annually. Beginning in 1962, and to present, all kokanee stocked have been fingerling-sized. Between 1962 and 1974, an average of 185,000 fingerlings were released; 1975-1983, the average release was 90,000 fish at 95/lb.; 1984-1994, the average release was 134,000 fish at 79/lb. The current allocation of kokanee is 150,000 fish at 75/lb. stocked in late July or early August.

Angling Regulations

Angling regulations were found dating back to 1938. There was a 6-inch minimum size limit, a bag limit of 15 pounds of fish plus one fish but not to exceed 20 fish per day, the season in Crescent Lake was April 15 - November 20. Other major changes are listed below:

1942 Season changed to May 1 - October 31

1945 Game fish $\geq$ 6" bag limit changed to regular trout bag limit and fish $\geq$ 10" bag limit was 3 fish per day, Crescent Lake open from May 12 to October 31

1948 Bag limit lowered to 10 fish per day not to exceed 15 lbs plus one fish, no length limit on brook trout

1949 Regulations based on state-wide zones rather than by county

1952 No bag or length limit for Dolly Varden (bull trout)

1953 Bag limit lowered to 10 fish per day, not more than 5 > 12"

1954 Special season for waters within national forest boundaries instituted, trout season open May 29 to October 31

1962 Trout bag limit changed to only 2 fish greater than 20"

1967 Crescent Lake open to angling entire year

1974 Special national forest opener removed

1981 Open season April 25-October 31, bag limit 10 trout per day over 6 inches, but not more than 5 over 12 inches nor more than 2 over 20 inches

1992 Bag limit reduced to 5 trout over 6 inches per day, but not more than one over 20 inches (to protect large lake trout from excessive harvest)

The current regulations are the same as those adopted in 1992.

Fish Management

In October 1986, the Oregon Fish and Wildlife Commission adopted the Crescent Lake Fish Management Plan, a so-called mini-plan. That plan directed management to be for wild and hatchery fish and has been the guide for fish management at Crescent Lake since that time. This plan supersedes the 1986 plan.

Kokanee

Since 1954, when they were first introduced, kokanee have reproduced naturally in Crescent Lake. But natural recruitment of kokanee has apparently been limited by a shortage of spawning areas. They have been know to spawn in Whitefish Creek and in the upwelling spring areas in the lake. In many of the years since 1978, drought and low water conditions have denied them access to the mouth of Whitefish Creek. At the same time, the creek has been dry or nearly so and many of the spring areas have been exposed and dry and unavailable to spawning kokanee.

Kokanee have been stocked annually since they were first introduced but natural production still provides the majority of fish observed in the angler catch, at least until the last decade of drought conditions. In 1980-82, catch estimates showed that hatchery fish contributed and average of 37% of the kokanee catch; during that period, the return to the angler of stocked kokanee was 4.1%.

Hatchery reared kokanee have provided an important segment of the catch and are needed to augment natural production to meet acceptable angler success rates. The survival of stocked kokanee is probably keyed to the availability of enough food at the time of stocking. The food supply, mainly zooplankton, is dependent on the primary productivity of the lake in a given year and the time of year. Good numbers of zooplankton are not present until July at the earliest. In recent years, the Department has been stocking kokanee from middle to late July with larger sized fish (average about 78 per pound). Later stocking of hatchery fish should also improve survival of naturally produced kokanee because hatchery fish are not competing with the wild fry when they begin foraging in the lake. Populations of both naturally produced and hatchery kokanee will continue to vary in response to the productivity of the lake. Stocking at higher rates cannot fully overcome poor conditions in the lake. Poor conditions are a combination of reduced primary productivity due to low water levels and due to the natural oligotrophic nature of the lake.

There is an inverse correlation between the length of maturing kokanee and the total amount of water inflow into the lake in the three years prior to maturity (Figure 18). More water flowing into the lake carries more nutrients and raises the lake elevation which provides more food and rearing area for juvenile kokanee. The greater flow of water may also increase spawning and hatching success. Better survival of juvenile fish causes greater competition for the available food in successive years. That situation produces more but smaller fish, usually resulting in better catch rates for the angler.

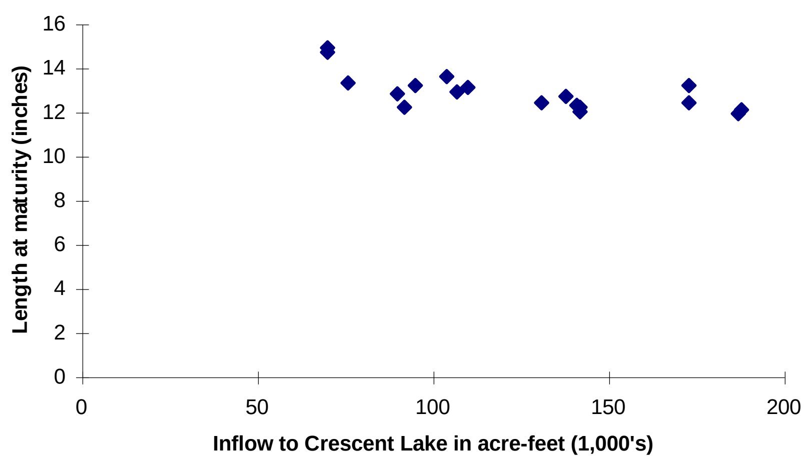


Figure 18. Kokanee length at maturity and inflow to Crescent Lake, 1965-1983.

In the past 31 years, the average length at maturity of female kokanee has been 13.9 inches fork length, ranging between 11.9 and 16.4 inches. Within the past decade, the average fork length of maturing females has been 14.7 inches.

Kokanee provide the main fishery at Crescent Lake. Angler success is generally good early in the season when the fish are near the surface but the fishery has a history of declining significantly after early July when the kokanee seek cooler waters below the thermocline. Between 1964 and 1986, catch rates for kokanee ranged from a low of 0.1 fish/hour in 1977 to 0.7 fish/hour in 1975 and averaged 0.4 fish/hour during that period. In 1980-82 and in 1990 statistical creel surveys were conducted. The following estimates were made:

Year	Anglers	Kokanee caught
1980	11,300	16,500
1981	9,500	8,730
1982	9,300	8,360
1990	4,890	1,970

The downward trend in kokanee catch from 1980 to 1990 is likely a reflection of the dominance of drought conditions within that period resulting in poorer survival of kokanee. As discussed above, those conditions result in fewer, although larger, kokanee in the population which leads to decreased angler success. The average length of maturity of kokanee during 1980-82 was 13.7 inches and was 16.4 inches in 1990; maturing kokanee in 1990 were the largest ever seen in Crescent Lake.

Lake trout

Natural production of lake trout has sustained the fishery for that species since it was first introduced in 1917. Only in 1957, was there another group of hatchery-reared lake trout stocked in Crescent Lake.

Lake trout draw the second most amount of angler interest at Crescent Lake. In 1981, angler effort for lake trout increased to 1,500 angler days from 700 angler days the previous year. Effort rose further in 1982 to 2,100 angler days. Estimated angler effort targeting on lake trout in 1990 was 616 angler days. Catch rose from 110 lake trout in 1980 to 800 in 1981 but fell to 690 in 1982 and only 213 in 1990. Part of the total catch was taken incidental to other fisheries; in 1990, kokanee anglers caught 40% of the lake trout. Catch rates for anglers seeking lake trout were 0.02, 0.1, 0.1 and 0.05 fish per hour for 1980, 1981, 1982 and 1990 respectively.

Lengths of lake trout caught have been between 15 and 38 inches. Average sizes of lake trout in the angler catches were 25.4 inches in 1981 and 29.3 inches in 1982. A 35-pound fish was landed in 1993.

Redband trout

Redband trout were indigenous to Crescent Lake where they most likely spawned in the spring-fed streams and in the outlet, Crescent Creek. Those historic spawning areas have since been inundated or blocked off by the dam construction.

Rainbow trout were stocked periodically from 1928 through 1976. Stocking was discontinued after 1976 because of poor returns caused by mortality from *Ceratomyxa shasta*. Since 1987, Deschutes rainbow trout have been stocked. The Deschutes stock is resistant to *C. shasta* and has been entering the fishery in recent years at 16-20 inch lengths. These fish add to the diversity of the fishery.

There has been some natural production in recent years as evidenced by a few naturally produced rainbows in angler catches and in trapnet samples. These trout are apparently resistant to *C. shasta* but their numbers are limited by a lack of good spawning habitat. Since there is virtually no spawning habitat in the lake's tributaries, there would be no advantage to providing passage over the dam. Screening of the outlet keeps the stocked trout in the lake and prevents them from impacting redband trout spawning in Crescent Creek.

<u>Brown trout</u>

Brown trout were stocked in 1925. Natural production has maintained modest numbers of these fish since that time but is limited by lack of suitable spawning habitat. In the early 1980's, the Department began to augment that natural production with hatchery reared brown trout, first with fingerlings and more recently with yearling-aged fish. Brown trout abundance has increased in the catch and has attracted a target fishery on this "trophy" species. A brown trout male nearly 30 inches in length was caught in the trapnet sample in fall of 1994. It is a species that should be available to the angler throughout the angling season. Brown trout may compete for food with rainbow and lake trout to some degree but they are most likely to forage on chubs.

<u>Brook trout</u>

The rare brook trout that may be found in Crescent Lake are strays that have traveled down from tributary headwaters. They are susceptible to *C. shasta* and make virtually no contribution to the fishery.

<u>Bull trout</u>

Bull trout were indigenous to Crescent Lake and Crescent Creek. Historical accounts from the early 1900's describe Indians catching Dolly Varden (bull trout) from Crescent Creek during the summer, and in the fall, told of large Dolly Varden in Crescent Creek that could run in and out of Crescent Lake at will prior to the dam being built (Gray 1989). The life history of those bull trout is not clear but there were one of few lake rearing populations in the state. Current understanding of bull trout requirements are that they need stream environments with stable, cold flows in the fall and winter for spawning and rearing to occur and be successful. That type of environment was most likely provided by spring fed streams in the vicinity of Spring Camp. Those spring areas were all inundated with the addition of the dam and, presently, habitat to support bull trout does not exist in Crescent Lake.

<u>Mountain whitefish</u>

Mountain whitefish are indigenous to Crescent Lake, maintain fairly stable numbers and make up a substantial portion of the lake's total fish population. This species could sustain a much higher level of harvest but there is little interest in seeking them out at this time. Most whitefish are taken incidentally to other fisheries, particularly by anglers jigging for kokanee; the majority of those fish are released back into the lake. Whitefish are important as forage for lake trout.

Non-game fish

Tui chubs and reticulate sculpin are the only non-game fish present in Crescent Lake. Tui chubs are quite numerous at times in shoal areas. Although there are often many chubs caught in net-sets, their numbers are probably out of proportion to other species because they inhabit the shallow waters where nets are set. They compete for food with other species but they, in turn, are forage for lake, brown and rainbow trout. Attempts to control the number of chubs are probably not feasible or necessary.

The abundance of sculpins is unknown. They are found, rarely, in trapnet sets but are probably not very susceptible to nets and are not caught by anglers. Their habitat requirements are also unknown but are apparently being provided to some degree based on their continued presence in Crescent Lake. They are also candidates as trout forage.

Management Issues

1. Irrigation withdrawals leading to low water elevations cause reduced productivity.
2. No bull trout habitat exists within the lake basin under present conditions.
3. *Ceratomyxa shasta* is present in the lake and affects brook trout and non-resistant stocks of rainbow trout.
4. Increased effort and exploitation of lake trout threatens viability of natural production.
5. Only one boat ramp is serviceable at low water levels.
6. There has been no assessment of angler use and fish catch, including hatchery contribution, in more than a decade.

MANAGEMENT DIRECTION

CRESCENT LAKE

POLICIES

Policy 1. Mountain whitefish will be managed for natural production; introduced kokanee salmon, rainbow and brown trout will be managed for natural and hatchery production. All of these species will be managed consistent with the Basic Yield Management Alternative for trout (ODFW 1987). No hatchery reared whitefish will be stocked.

Policy 2. Introduced lake trout will be managed for natural production consistent with Natural Production Policy under the Trophy Fish Management Alternative for trout (ODFW 1987). No hatchery reared lake trout will be stocked.

OBJECTIVES

Objective 1. Maintain genetic diversity, adaptiveness and abundance of wild mountain whitefish in Crescent Lake.

Assumptions and Rationale

1. Crescent Lake supports an abundant and healthy population of wild mountain whitefish.

2. Monitoring abundance, size, age-class structure, and distribution of mountain whitefish in Crescent Lake will provide and indication of their health and adaptiveness.

3. Releases of hatchery trout will not decrease the genetic fitness of the mountain whitefish population.

ACTIONS

Action 1.1 Establish population trends of mountain whitefish in Crescent Lake during annual inventory activities.

Objective 2. Provide a consumptive fishery on naturally and hatchery-produced kokanee, brown and rainbow trout, and mountain whitefish.

Assumptions and Rationale

1. These fisheries will be of a general consumptive nature.

2. Natural production of rainbow and brown trout and kokanee is limited by lack of suitable spawning and early rearing habitat.

3. Year-class abundance of kokanee varies with the amount of water inflow to the lake. In years of high inflow, juvenile kokanee survival is enhanced and that year-class is more abundant than in years when inflow is low.

4. Stocking of kokanee should be done in late July or early August coinciding with peak zooplankton densities for best survival of hatchery fish and least competition with natural production.

5. Population levels of mountain whitefish are adequate to support an increased sport fishery.

ACTIONS

Action 2.1 Annually stock up to 150,000 hatchery reared kokanee fingerlings at 70/lb. in late July.

Action 2.2 Annually stock up to 65,000 hatchery reared rainbow trout fingerlings at 50/lb. of Deschutes stock (Lot 66, *C. shasta* resistant).

Action 2.3 Annually stock up to 12,000 hatchery brown trout yearlings (Wickiup egg-take) at 7/lb. in July.

Action 2.4 Monitor relative abundance and length distribution of trout in Crescent Lake by conducting periodic creel surveys and through netting inventories.

Action 2.5 Publicize information on distinguishing characteristics of mountain whitefish and angling opportunities for that species.

Objective 3. Provide a trophy fishery for naturally-produced lake trout.

Assumptions and Rationale

1. Crescent Lake historically has produced large, trophy-sized lake trout.

2. There is strong public interest in angling for these large, trophy-sized lake trout.

3. Lake trout mature at age 6 or 7 years at approximately 22 inches in length.

4. Providing adequate spawning escapement through restrictive regulations is more practical than attempting to supplement natural production through hatchery releases.

5. Restricting harvest to fish greater than 30 inches in length will allow lake trout to spawn more than once prior to harvest and will increase the abundance of large fish in the population for a trophy fishery.

ACTIONS

Action 3.1 Monitor relative abundance and length distribution of mature lake trout through trapnet inventory.

Action 3.2 Verify size and age at maturity assumptions for lake trout to aid in determining angling regulations necessary to provide adequate spawning escapement and maintain a fishery for trophy-sized lake trout.

Action 3.3 Adopt special daily bag and length limits for lake trout specifying not more than one lake trout with a minimum length of 30 inches.

Action 3.4 Investigate the feasibility of inventorying lake trout population abundance through hydroacoustic sampling.

Objective 4. Prevent losses of fish at Crescent Lake outlet structure.

Assumptions and Rationale

1. Losses of trout out of Crescent Lake through the irrigation outlet structure on Crescent Creek impacts naturally-reproducing trout in Crescent Creek downstream and reduces the number of trout available for fisheries in the lake.

ACTIONS

Action 4.1 Coordinate with the irrigation district to assure the outlet screens are inspected frequently and cleaned and repaired as needed.

Objective 5. Provide additional boat access at Crescent Lake for use during low water conditions.

Assumptions and Rationale

1. The boat ramp at Spring Camp is unusable during low water conditions**.**

2. The lack of a developed boat ramp on the south and west sides of Crescent Lake that is serviceable during low water conditions reduces angler use from those areas and on the lake overall.

ACTIONS

Action 5.1 Coordinate with USFS to extend the boat ramp at Spring Camp.

Objective 6. Protect, restore, and enhance trout and whitefish habitat at Crescent Lake.

Assumptions and Rationale

1. Current annual lake drawdown for downstream irrigation uses reduces and restricts rearing and spawning areas for trout, kokanee and whitefish.

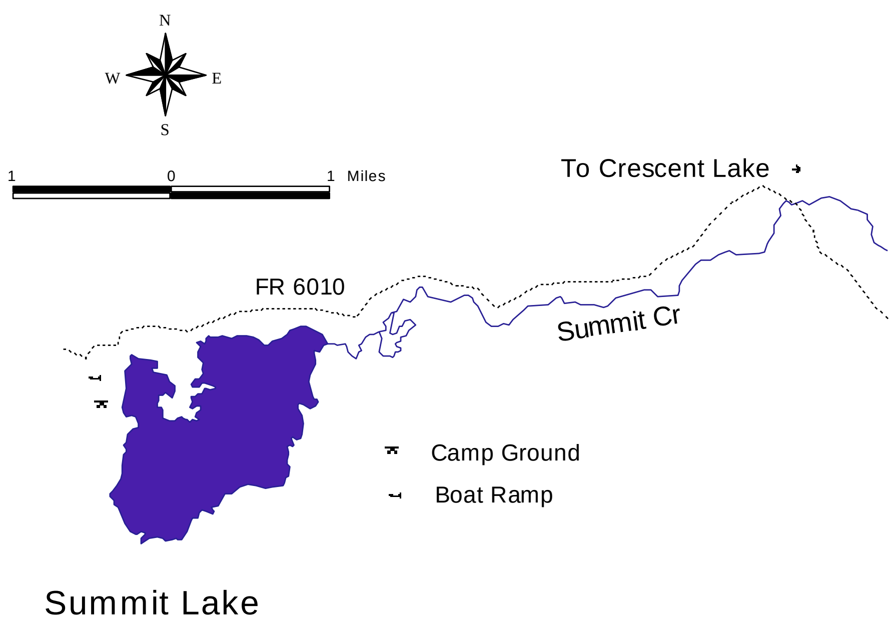
ACTIONS

Action 6.1 Communicate to the irrigators the impacts of drawdown (lower water levels) have on fish resources and encourage them to improve water distribution and application techniques in an effort to use less water more efficiently.

SUMMIT LAKE

Location and Ownership

As its name describes, Summit Lake lies very near the crest of the Cascades just east of the divide between the Deschutes River drainage and the Willamette River drainage to the west. Access to the lake is by Forest Road (FR) 6010, 7 miles from its intersection with FR 60 at the west end of Crescent Lake. FR 6010 is an unsurfaced pumice road that receives minimal maintenance. The lake may also be reached from the west side by following the Middle Fork Willamette River up FR 21; that road has a maintained gravel surface. The Pacific Crest Trail



also passes by the lake. Because of the lake's 5,553 foot elevation, access is typically blocked by snow except for about four months during the summer and early fall.

Summit Lake is within the Deschutes National Forest's Oregon Cascades Recreation Area, (OCRA). There is one small, primitive campground with an earthen boat-launch slot. Other camp sites are mainly at dispersed pack-in locations around the lake.

Habitat and Habitat Limitations

Summit Lake has a surface area of 482 acres and a maximum depth of 63 feet. Shoals comprise about 23% of the surface area. It has a small drainage basin of about 8 square miles. There are no perennial streams in the basin. Inflow is from snow melt, direct precipitation and sub-surface seepage. The lake's surface out-flow is into Summit Creek which flows into Whitefish Creek and then to Crescent Lake. Vegetation cover is typical high-elevation coniferous forest (Johnson et al. 1985). Surface soils in the drainage are dominated by pumice.

"The shape of the lake basin is rather complex with several deeper holes and some underwater ridges and hills. The shoreline is also highly indented, particularly along the northern shore, which is flanked by a relatively recent lava flow. Water in the lake is extremely low in concentrations of major ions, alkalinity and conductivity. Concentrations of phosphorus and chlorophyll are also very low. All indicators identify this lake as ultraoligotrophic. The water is very transparent giving the lake the lovely turquoise color characteristic of very pure water," (Johnson et al. 1985).

Habitat Limitations

1. Natural low productivity
2. No perennial tributaries to provide spawning habitat

Fish Stocking History

There are no records of indigenous fish in Summit Lake. Like most of the high Cascade lakes it was naturally fishless.

The earliest documentation of stocking is a personal report by a Bend resident who said he helped his father stock lake trout in Summit Lake in 1905. Those fish were reportedly brought to the Lewis and Clark Exposition by the U. S. Bureau of Commercial Fisheries (Gerlach). There are no other records of lake trout being released in this lake.

Rainbow trout, 28,000, were stocked in 1931 followed by 41,000 in 1946. Between 1968-1977, 1,000 to 4,000 legal sized rainbows were stocked each year. Since 1979, the allocation has been for 15,000 rainbow fingerlings per year.

Brook trout were first stocked in 1934 when 5,000 were released. A large liberation of 372,000 was made in 1939. In 1949-53, brook trout yearlings were stocked at rates of 5,000-10,000 per year. An average of 55,000 fingerlings were released per year between 1950 and 1967. Since 1978, the annual allocation of brook trout has been 15,000 fingerlings.

Kokanee were stocked in Summit Lake from 1953 to 1958 at rates averaging 20,000 fish per year. No kokanee have been released there since 1958.

Cutthroat trout have been stocked three times. In 1969, a release of 39,000 small fingerlings was made from a Utah source. In 1987 and 1990, there were, respectively, 9,650 and 15,000 large fingerling Twin Lakes (WA) cutthroat stocked.

Angling Regulations

The bag limit at Summit Lake in 1940 was the general limit for fish over 6 inches or larger. The daily limit was 15 pounds plus one fish. The limit for 7 consecutive days or in possession was 30 pounds plus one fish. The open season that year was May 20 through September 20.

Beginning in 1965 and currently, the daily bag limit for trout over 6 inches has been 10 fish per day but not more than 5 over 12 inches nor more than 2 over 20 inches. The open season runs from late April through October.

Fish Management

Since there were no fish native to Summit Lake, fish management there has consisted of periodic stocking of various species. The species currently present in the lake are: lake, brook and rainbow trout. Kokanee and cutthroat trout have been stocked in the past. After kokanee stocking was discontinued, presumably because of small length at maturity (about 9 inches), that species died out because of the lack of spawning habitat. For reasons unknown, the cutthroat disappeared soon after their releases.

Lake trout have persisted through natural reproduction since 1905, the only report of their introduction. Rocky substrate within the lake provides good spawning habitat for lake trout. Twenty-one lake trout have been measured in periodic inventories within the past 10 years; those fish had an average length of 23.3 inches, ranging between 19.0 and 25.2 inches. The condition of these fish has been generally good with the exception of a couple of "snakes". The diet of these fish is limited to insects and stocked trout; there are no other forage fish for them to feed upon.

Survival of stocked brook and rainbow trout fingerlings is apparently quite low. Anglers report low rates of catch. In the past 10 years, the catch per gill-net set has been less than two fish for each species. The low survival is probably largely due to predation by lake trout. Yet, despite the lake's low productivity, the surviving brook trout are usually in good condition and the rainbows are typically in excellent shape. In recent years, sampled brook and rainbow trout have had lengths of up to 17 and 20.5 inches, respectively. From informal inspection of stomach contents, these trout apparently subsist mainly on terrestrial insects.

Summit Lake adds to the state's diversity of angling opportunities by providing potentially large trout in an outstandingly esthetic setting.

There are a few anglers that are loyal to Summit Lake but, in general, angler effort is quite low, presumably because of the poor catch rate. The notoriously abundant mosquitoes may also influence angler use at this lake.

Management Issues

1. Lack of a forage fish species hampers the survival and growth of lake trout.
2. The mountain whitefish, indigenous to Crescent Lake, is the logical candidate for introduction as a forage fish, but transfer of whitefish from Crescent Lake would carry the risk of introducing *Ceratomyxa shasta* to Summit Lake.

MANAGEMENT DIRECTION

SUMMIT LAKE

POLICIES

Policy 1. Summit Lake will be managed for natural production of lake trout and mountain whitefish under the Basic Yield Management Alternative in the Trout Plan (1987).

Policy 2. Hatchery reared brook and rainbow trout will be stocked in Summit Lake and managed under the Basic Yield Management Alternative in the Trout Plan (1987).

Policy 3. Introduce mountain whitefish from Crescent Lake into Summit Lake.

OBJECTIVES

Objective 1. Provide consumptive angling opportunities for naturally-produced lake trout and mountain whitefish and stocked brook and rainbow trout.

Assumptions and Rationale

1. Introduced lake trout have maintained a population by natural production for many years and will continue to do so.

2. There is no spawning habitat for brook and rainbow trout and, therefore, no opportunity for their natural reproduction.

3. Brook and rainbow trout have been stocked in Summit Lake since the early 1930's and are also established in the drainage downstream from the lake.

4. Stocked trout fingerlings provide the only forage fish available to lake trout at the present time, so the survival of brook and rainbow trout is depressed by predation by lake trout.

5. The introduction of a forage fish species (whitefish) to Summit Lake would improve the survival and growth of lake trout if whitefish become established and abundant.

6. Mountain whitefish are indigenous to the basin and are the logical choice for a forage fish in Summit Lake.

7. Mountain whitefish can be captured in Crescent Lake and successfully transferred the short distance to Summit Lake.

8. Studies at Odell Lake show whitefish are the lake trout's most important forage species.

9. There are no tributaries to Summit Lake to provide spawning habitat for whitefish, so unless they may be able to spawn within the lake or in the outlet stream in good water years, they may not reproduce successfully.

10. *Ceratomyxa shasta* could, potentially, be introduced to Summit Lake with the transfer of whitefish from Crescent Lake.

11. The introduction of *C. shasta* to Summit Lake would preclude the survival of brook trout and non-resistant stocks of rainbow trout.

12. Whitefish would compete for food with trout to some degree but they would also provide an additional forage species for the trout.

ACTIONS

Action 1.1 Stock brook and rainbow trout fingerlings annually.

Action 1.2 Capture mountain whitefish from Crescent Lake and introduce them to Summit Lake.

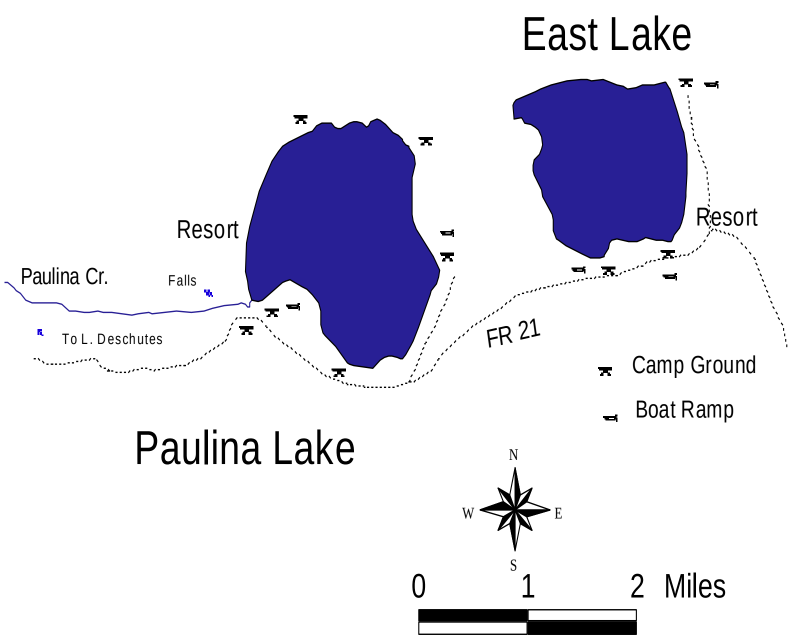
Action 1.3 Monitor relative abundance and length distribution of lake, brook and rainbow trout and mountain whitefish through annual inventory activities.

EAST LAKE, PAULINA LAKE and PAULINA CREEK

Overview

Hydrologically, East Lake, Paulina Lake, and Paulina Creek are part of the Little Deschutes subbasin. They are separated from the Little Deschutes River section of this basin plan because Paulina Creek no longer flows into the Little Deschutes River due to irrigation diversions.

East and Paulina lakes were originally devoid of fish and the Wild Fish Management Policy (ODFW 1992) is not applicable for these lakes. A "wild only" alternative is not required because the fisheries in both lakes are supported totally with hatchery fish. Fish cannot move upstream from Paulina Creek because of barriers. There are at least 18 impassable falls starting a short distance below Paulina Lake, the highest of which is Paulina Creek Falls. A rotary fish



screen was installed in 1946 on Paulina Creek at the location of the dam first established in 1899 (NNVMCMP 1993). The purpose of the screen was to minimize the loss of trout from Paulina Lake, especially during spring high water. The fish screen was replaced with a modern version in 1995. Some fish can still escape around the ends of the screen structure during spring high water. It is not known how many fish escape from Paulina Lake annually, but it is believed the number is small based on observations of fish numbers in Paulina Creek.

Water and fish samples taken by the Oregon Department of Environmental Quality indicated high levels of mercury in East Lake, but not in Paulina Lake. An advisory was issued to the public to limit their consumption of fish from East Lake in 1995. The high mercury levels are naturally occurring and the investigation is continuing.

Location and Ownership

East and Paulina lakes are located approximately 30 miles south of Bend in the Newberry Crater at the summit of the Paulina Mountains. Road access to Newberry Crater is primarily provided by US Highway 97 and Deschutes County Road 21 from the west. Access from the east is via Forest Road 18 and Forest Road 21 which is an extension of County Road 21. There are no access roads into Newberry Crater from the north or south.

The crater is a volcanic caldera nearly five miles in diameter and was formed by volcanism similar to that which created Crater Lake. The crater is estimated to be 20-25,000 years old. Lava flows on the outer slopes of Newberry volcano may be as recent as 1,000 years old. It is apparent the caldera was originally occupied by one large lake, but subsequent volcanic action built up a barrier of subsidiary cinder cones and lava flows, running north and south across the middle of the depression to form two lakes. By the time the recent eruptions within the crater had ceased, about 2,050 years ago, the two lakes were separated, and probably each was near its present water level.

After formation of the caldera, snow and ice associated with the most recent period of glaciation accumulated to depths of several hundred feet; flowing ice may have helped form Paulina Creek by scouring an outlet from Paulina Lake that cuts through the flank of the crater. The crater rim rises steeply above the lakes to a high point of 7,984 feet at Paulina Peak. Slopes, where not exposed by bare rock and lava flows, are covered by a forest cover typical of mountain terrain in regions of moderate precipitation- a lodgepole pine forest with ponderosa pine scattered throughout. There are also some hemlocks and alders. The physiographic setting is similar to that of Crater Lake.

East and Paulina lakes are entirely within the Deschutes National Forest except for a private pumice mining claim covering approximately 157 acres extending west from the southwest shore of East Lake. The Deschutes National Forest is attempting to purchase this property. In 1990, the US Congress declared the crater and vicinity a national monument. The Newberry Crater National Monument Management Plan, approved in 1994, supersedes the Deschutes National Forest Land Resource Management Plan (LRMP 1990).

Both lakes have privately owned resorts offering boat rentals, cabins, restaurants and stores. There is also an RV park operated by East Lake Resort. The Forest Service maintains 4 campgrounds and 4 boat ramps at East Lake. On Paulina Lake, the Forest Service has 2 campgrounds with road access and 2 walk-in camping areas. In addition, they maintain a horse camp and a group camping area at Paulina Lake. They also maintain three boat ramps. The Paulina Lake Resort has a private boat ramp and some boat moorage spaces.

Motor boats are permitted on both lakes and both have 10 mph boat speed restrictions.

EAST LAKE

Habitat and Habitat Limitations

East Lake lies at an elevation of 6,370 feet above sea level and covers 1,044 surface acres. The maximum depth of the lake is 180 feet with an average depth of 67 feet. Much of the northern half of the lake is deeper than 100 feet. In this century, the water level of East Lake has fluctuated between elevation 6,366 and 6,382 feet, but rarely fluctuates more than 2 feet per year. Several factors account for this minimal fluctuation; the lack of surface streams, a close balance between annual precipitation and evaporation, and an apparently low rate of seepage loss. At maximum pool, the lake contains a water volume of 69,600 acre-feet. About 12% of the lake is classified as shoal area. The shoreline is 5.9 miles in length. There is no surface inflow to the lake. Seasonal runoff from snowmelt provides water, but the major source is a number of small, mineralized hot springs near and below the lake surface on the southeast shore. Other springs probably exist at greater depths around the lake. There is no surface outlet from East Lake; water is lost by seepage and evaporation and since the water in the lake is fresh, the rate out must be at least as large as the rate of inflow to the lake from mineralized springs. The water retention time for East Lake is 18 years (Johnson et al. 1985).

The water chemistry of East Lake is influenced greatly by inflow from the mineralized hot springs. For example; the conductivity is unusually high at 310 umhos/cm, the alkalinity is unusually high at 103 ppm, and the sulfate levels are as much as 80 ppm, exceptionally high (Johnson et al. 1985).

East Lake rarely exceeds 67^{o}F and that maximum temperature generally occurs in late July or early August. East Lake develops a thermal stratification during the summer and freezes over in the winter. The bottom water temperature in summer is slightly warmer (41^{o}F) than expected in a lake 180 feet deep at an altitude over 6000 feet. The conductivity decreases with depth suggesting a complicated mixing zone involving both heat and salinity in the lake (Johnson et al. 1985). The thermocline will vary in depth from about 20-45 feet from June to September. The temperature at the lower depth of the June thermocline averages about 47^{o}F and will go as low as 39^{o}F at 170 feet. By September the upper warm layer of water will penetrate to 35 feet, but the thermocline temperature stays about the same as in June.

The amount of dissolved oxygen varies sharply between June and September. In June, sufficient oxygen is present at all depths. In September, sufficient oxygen is present only to about 50 feet. The pH alkalinity varies from about 7.9 to 8.1 in late summer (Johnson et al. 1985).

The lake bottom is composed of pumice, rock, some sediment and detritus. The shoreline is quite varied and includes lodgepole forest, sheer rock bluffs, pumice beach, talus rock slopes and lava formations.

Bottom samples and plankton sampling show that East Lake is very productive. There is abundant aquatic vegetation, primarily *Elodea canadensis*, which harbors an abundance of freshwater shrimp, the predominant aquatic food organisms. Good hatches of Diptera occur during the summer. Overall, East Lake is mesotrophic, but at the lower end of the scale (Johnson et al. 1985).

Mercury

Geothermal power development is occurring on the west flank of Newberry Crater. In association with the proposed development, the USGS sampled water in both East and Paulina Lakes to determine background levels of a variety of water borne chemicals. From that sampling, high mercury levels were detected in East Lake. Subsequently, fish were collected by ODFW from both lakes and tissues analyzed by a private laboratory under contract to the geothermal developer, CE Explorations. High mercury levels in East Lake fish were detected. Additional fish were collected by ODFW and analyzed by DEQ. Those tests showed high mercury levels in East Lake fish, especially brown trout, but no problems with fish from Paulina Lake. Fish from Paulina Lake are safe for unlimited human consumption.

Mercury (Hg) in East Lake is from naturally occurring cinnabar deposits and is assumed to enter the lake via subsurface hot springs. Bacteria in lake sediments transforms mercury into methyl mercury, a form easily assimilated by fish and toxic in high concentrations. Mercury in fish accumulates as it is not quickly excreted from the body. The Oregon Division of Health evaluates human health risk associated with consumption of fish with elevated mercury levels and develops consumption advisories. In general, mercury concentrations increase with increasing fish age and size and in those species in higher trophic levels.

East Lake fish were sampled in 1994 and 1995 to determine Hg concentration levels and corresponding consumption advisories were developed. Brown trout were found to have the highest mercury concentrations with levels ranging from 0.13 ppm in a 13.8 inch fish to 3.44 ppm in a 29.3 inch fish. The average concentration of 19 brown trout was 1.42 ppm. Mercury concentration in rainbow trout ranged from 0.34 to 0.92 ppm in fish from 7.9 to 12.8 inches, with an average concentration of 0.60 ppm for 7 fish. Kokanee mercury concentrations were 1.39 ppm for a composite sample of 11 fish. This was a surprise due to their zooplankton diet preference. Only three Atlantic salmon were sampled and mercury concentrations ranged from 0.28-0.29 ppm. The Oregon Health Division action level for mercury levels in fish is 0.6 ppm while the Federal Drug Administration level is 1.0 ppm. Corresponding health advisories were set by the Oregon Health Division in June 1994 at the following limits:

- Pregnant women, nursing mothers, infants, and children less than 6 years old should not eat more than two eight-ounce servings per year;
- Women of child-bearing age should not eat more than eight eight-ounce servings per year;
- The general population should not consume more than 55 eight-ounce servings per year;
- No one should consume brown trout measuring 16 inches or longer.

Fish Stocking History

Rainbow trout were first brought to Newberry Crater in 1912 after a group of men with the La Pine Community Club introduced the idea of stocking East and Paulina lakes with fish to state officials. In July 1912, the Oregon Game Commission shipped rainbow trout fingerling to Bend by train. A party consisting of the district game warden, superintendent of state fish hatcheries, other officials, and local fishermen were assembled to transport the fish. From Bend it took the party all night to reach Paulina Prairie as the road was merely two ruts with alternating chuck holes (King 1969). From Paulina Prairie, pack horses took the fish the remaining 14 miles to the Newberry Crater entrance. In order to keep the fish alive, party members had to climb into Paulina Creek canyon periodically to carry up buckets of fresh water. Half of the rainbow fingerlings were stocked into Paulina Lake and the other half into East Lake, numbers unknown.

Department hatchery diaries state that brook trout eggs were purchased from the Atlantic states and raised at Bonneville hatchery. These fish may have been stocked in East Lake as early as 1912, but records are not specific. The next record of stocking in East Lake was in 1916 when brook trout, rainbow trout, and/or steelhead were released into the lake, numbers and specific species unknown. Coho salmon were released sometime between 1931 and 1935. Brook trout were released in 1931, 1932, and 1936, but no numbers are listed. In November of 1925, brook trout were seined at East Lake for egg collections. This was likely the first establishment of the egg take station which operated for many years. The Department cabin on the southwest shore of East Lake was built that year. Brook trout egg collections occurred in 1926 and 1927. East Lake was stocked with brook trout during the years 1927-1931, unknown numbers. It is not known when brown trout were first planted in East Lake, however, they were stocked once between 1935-1940 (Newcomb 1941) and were maintained at low population levels by natural reproduction.

Modern stocking records began in 1945 when 600,210 brook trout fry were stocked into East Lake. Rainbow trout were stocked in 1946 with a release of 281,696 fry. Rainbow have been stocked every year since 1946 as fry, fingerlings, or legal-size fish. Numbers have varied from a high of 561,031 fingerlings in 1953 to a low of 115,000 fingerlings in 1995. Numbers of brook trout stocked have varied from a high of 583,138 in 1953 none in 1973-74. Brook trout stocking was discontinued after 1992.

The lake currently supports populations of rainbow trout, brook trout, brown trout, Atlantic salmon, kokanee and tui chub. Presently, 115,000 rainbow fingerlings, 10,000 brown trout yearlings, 25,000 kokanee fingerlings and 6,000 Atlantic salmon yearlings are stocked annually. There is no known reproduction by rainbow, but there may be some successful shoreline spawning by brook trout. Brook trout stocking was discontinued after 1992 because of poor returns to the anglers. Fishermen were able to catch them early and late in the season, but total contribution to the fishery was not enough to warrant continuation of the stocking program.

Angling Regulations

East Lake has had a variety of angling regulations over the years and appears frequently in the historical records. The lake usually had a different season than the general trout season. Highlights of the major changes are listed below:

1924 West side of East Lake closed all year.

1931 Bag limit in East Lake is lowered from the general bag limit to 10 lbs plus one fish not to exceed 20 fish per day.

1934 Bag limit changed to 15 lbs plus one fish not to exceed 20 fish.

1936 Bag limit changed to 15 fish or 15 lbs plus one fish per day.

1937 Bag limit changed to 10 fish or 15 lbs plus one fish per day.

1947 Bag limit in East Lake reduced to 5 fish not to exceed 15 lbs plus one fish per day.

1951 Bag limit reduced to 5 fish per day.

1955 Bag limit changed to regular trout bag.

1959 Closure on west side of East Lake removed.

1960 Season changed to regular trout season.

1961 May trout opener reinstated on East Lake.

1962 Season changed to regular trout season.

1974 Late opener reinstated.

1980 Bag limit 10 fish per day, not more than 5 over 12 inches nor more than 2 over 20 inches

1988 Bag limit reduced to 5 fish per day, not more than 1 over 20 inches

1995 Fish consumption advisory for mercury contaminated fish in East Lake.

Currently East Lake is open from May 18 to October 31. The trout bag limit is 5 fish per day, not more than 1 over 20 inches. The Department in 1996 recommended the season be changed to the general April-October period to become effective in 1997. A final decision will be made in Fall of 1996.

Fish Management

Since before 1920, East Lake has been regarded as one of Oregon's premier trout-producing waters. The variety of trout species, presence of trophy size fish, overall trout abundance and quality and lake setting have contributed to its popularity.

Currently, East Lake is managed primarily as a Basic Yield fishery for rainbow, large brown trout, and lesser numbers of brook trout, and experimental groups of kokanee and Atlantic salmon.

Rainbow trout

Rainbow trout were first stocked in 1912 and have been stocked every year from 1945 to the present. Rainbow trout do not reproduce in East Lake because there are no suitable spawning areas. Rainbow trout have provided the largest percentage of angler harvest and effort. Table 36 shows percent rainbow from creel checks in East Lake by decade for 1960-1990.

Table 36. Percent rainbow trout in the creel from random checks at East Lake by decade for 1960-1990.

Year	Percent rainbow
1960	92.6%
1970	92.2%
1980	85.0%
1990	94.5%

With the introduction of Atlantic salmon and kokanee in the early 1990's, the percent rainbow in the catch as observed during random creel checks declined from historical rates. In 1995, rainbow trout constituted 57.4% of the catch for 76 anglers. Atlantic salmon contributed 27.7%.

A major concern relative to rainbow trout in East Lake is a trend toward smaller fish as indicated by a growing percentage of yearling age rainbow in the creel Table 37.

Table 37. Percent of yearling rainbow trout in the spring creel census, 1975-1994.

Year	Percent rainbow
1975	62
1976	56
1977	67
1978	80
1979	87
1980	71
1982	85
1983	63
1984	71
1985	84

Table 37. Continued

1986	100
1987	100
1988	100
1989	100
1990	87
1994	91

Larger three year old fish are disappearing. Figure 19 shows length frequency for rainbow captured by a trapnet in June of 1995.

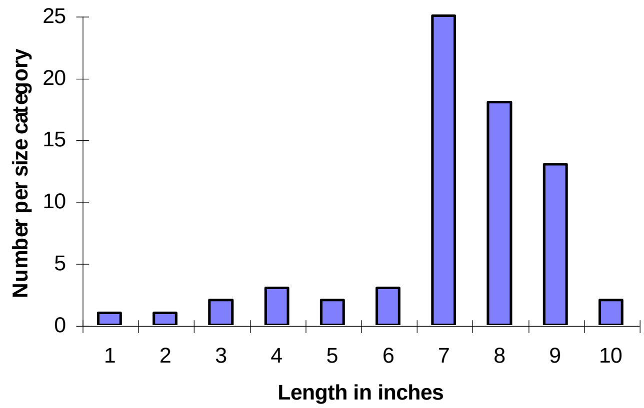


Figure 19. Length frequency of rainbow trout in a June 1995 trapnet sample in East Lake.

The average length of all rainbow trout in from that sample was only 9.08 inches fork length. The precise reasons for this decline are not known, but it is believed the Lot 53 rainbow (Oak Springs Hatchery domestic stock) have suffered genetically from many years of inbreeding, resulting in poorer growth rates, poorer survival and loss of ability to compete with chubs.

Brown trout

It is not known when brown trout were first stocked in East Lake. An Oregon Game Commission lake survey report (Newcomb 1941) reported brown trout were stocked during the period 1935-40. Current stocking records date to 1945 and show no brown trout stocking from 1945-1984. A relatively small brown trout population was obviously maintaining itself through natural reproduction, probably by beach spawning. The Department began a restocking program in 1985 with the release of 5,000 fingerling brown trout. Fingerlings were released annually through 1990 and again in 1992. In 1991, yearling age brown trout stocking began and continues to the present. The Department decided to stock larger brown trout in hopes the fish would move on to a fish (chub) diet in a shorter time. Stocking has varied from 6-10,000 fish annually. These brown trout are from Wickiup Reservoir wild stock and reared at Klamath Hatchery.

Brown trout in East Lake are managed for their large size and as a trout species which can successfully utilize the abundant chub population. The largest brown trout officially recorded in recent years was a 22 lb 6 oz fish caught in 1981. Oregon State Game Commission hatchery personnel captured a 30 lb brown trout during egg collections in 1952. East Lake today contains an abundance of large brown trout. For example, in a one night trapnet set in fall 1994, a total of 205 brown trout were captured with an average length of 20.1 inches. Those fish ranged in length from 8.7 - 31.5 inches (Figure 20).

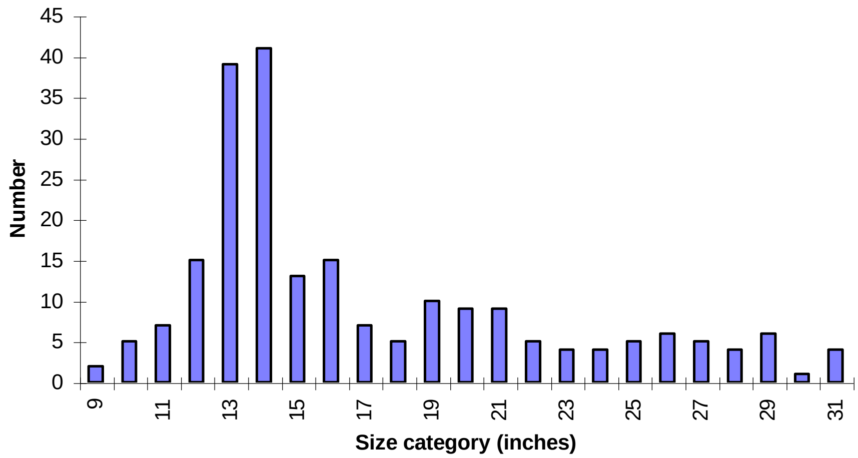


Figure 20. Brown trout size distribution from a East Lake trapnet, October 1994.

Brown trout have generally represented less than 1% of the total trout catch at East Lake. However, since restocking began in 1985, more brown trout have been observed during random creel checks. In 1995, 10.6% of the total catch by 76 anglers was brown trout. Brown trout are generally caught by a select group of anglers targeting those fish.

Brook trout

The first record of brook trout stocking in East Lake was reported in the Oregon Sportsman 1916. A lake survey report by the Oregon Game Commission (Newcomb 1941) said over 5 million brook trout were stocked in East Lake between 1935-40. The report also mentioned brook trout were very abundant! Current stocking records show brook trout were stocked annually from 1945-1992. Brook trout grew well in East Lake until the late 1970's when the average size began to decline as shown in Table 38. They were quite abundant for many years and contributed up to 20% of angler harvest until about 1970. Since that time, they have not contributed more than 10% of the catch. The precise reasons for the decline in performance are not known, however they may have experienced a decline in genetic vigor due to years of inbreeding. They were discontinued after 1992 because of low contribution to the East Lake fisheries. In 1995, no brook trout were seen in creel checks of 76 anglers. Brook trout were popular even with the low catch rates and many questions are received each year about their demise in East Lake.

Table 38. East Lake brook trout population trends as shown by fall trapnet catches during the years 1970-1995.

Year	Number fish	Average length (inches)	Stocking rates
1970	842	13.5	100,254
1971	285	13.6	99,980
1972	296	13.4	100,093
1973	458	9.9	*none
1974	505	12.3	*none
1975	698	13.7	100,130
1976	73	12.3	99,948
1977	238	12.4	100,050
1978	600	10.4	100,178
1986	54	11.0	**50,007
1990	82	11.2	50,014
1991	2	n/a	67,825
1992	53	9.1	51,250
1993	10	10.3	***discontinued
1994	6	10.6	discontinued
1995	3	11.8	discontinued

* An outbreak of IPN virus at Fall River hatchery resulted in two years of no brook trout production.
** Stocking of brook trout reduced by 50% because of poor return to the creel.
*** Brook trout program discontinued.

Atlantic salmon

Atlantic salmon were first introduced to East Lake in 1974. These fish were an anadromous stock from Gaspe Bay, Quebec, the same stock used in Hosmer Lake. They were only released that one year and did not produce a fishery. They were never observed in subsequent years in creel checks or inventory nets. In 1990, a land-locked Atlantic salmon stock from Maine was introduced with the anticipation these fish would utilize the tui chubs, grow large, and provide a featured species fishery. They were stocked through 1995 with an annual allocation of 6,000 yearling-age fish. Creel checks and inventory nets have shown these Atlantic salmon survived and generated a popular sport fishery, but have not utilized the tui chubs as expected. A trapnet set in the fall of 1995 captured 16 Atlantic salmon ranging in fork length from 8.1-14.2 inches with an average fork length of 11.6 inches. Since 1990, no Atlantic salmon over 20 inches have been seen in angler catches or inventory nets. Only a few Atlantic salmon were tested for mercury concentrations and they had levels well below the 0.6 ppm Oregon Health Department action level. The Department plans to continue the Atlantic salmon program because they provide a popular open water fishery and are easily caught.

Kokanee

Kokanee were first stocked into East Lake in 1993 on an experimental basis. They were stocked through 1995 as 100/lb fingerling with an annual allocation of 25,000 fish.

The rationale for introducing kokanee to East Lake was as follows:

1. Kokanee are a popular gamefish.
2. Previous sampling showed East Lake to have an abundant zooplankton supply, the primary food of kokanee.
3. The potential for natural reproduction was minimal.

4. Kokanee would occupy a large area of this deep lake and provide mid-summer angling opportunities when fishing for other trout species was slow.
5. A good kokanee fishery would help offset the declining rainbow and brook trout fisheries.

Kokanee generally reach sexual maturity at three years of age, then die in the fall. Age three is when they reach maximum size and are most prevalent in angler creels. The first group of kokanee reached sexual maturity in 1995. Fall inventory with a trapnet showed mature fish had grown to an acceptable size averaging 13.3 inches in fork length with a range of 12.2-14.6 inches fork length. Only 2 kokanee were checked during random creel checks, both over 14 inches in length. Few anglers were aware of their presence in the lake, however their popularity is expected to increase.

Kokanee sampled for mercury concentrations in 1995 showed high levels with a composite sample from 11 fish averaging 1.39 ppm, well above the 0.6 ppm action level. This was surprising because kokanee forage on zooplankton which are near the bottom of the food chain. The Department plans to continue stocking kokanee because of their good growth and high popularity with anglers.

Non-game fish

The lake contains an abundant population of tui chub, *Gila* (Siphateles) *bicolor* (Girard), most likely introduced in the 1920's by anglers fishing for large trout (Bird 1975). The tui chub is endemic to the Klamath River basin (Bird 1975). It is unknown exactly when chubs first appeared, but they were reported by Game Commission biologists in 1940 to be overpopulating the lake. They are found throughout the shoreline areas and are especially abundant in the southeast corner of the lake (near the hot springs) where they spawn in the prolific weed beds. These chubs provide forage for large trout, but do reduce the total number of pounds of trout which could be produced in the lake by competing for the same food supply and habitat space.

Partial chub control at East Lake by Department biologists began as early as 1941. In 1947, an estimated 940,000 chubs were removed by seines and shoreline spot treatments with rotenone. Chub control continued annually until the 1980's when it was terminated due to environmental concerns, lack of manpower, and high cost of rotenone. Millions of chubs were removed in some years, but the actual benefit to trout populations in East Lake is unknown. However, there has been a decline in rainbow trout growth rates and average size in East Lake during the last 20 years. Research is needed to determine effective, safe and efficient control techniques and competitive interaction between rainbow trout and tui chubs.

In 1967, a 9-inch goldfish was found dead on the shore of East Lake. A 12-inch goldfish was caught by an angler the same year. Goldfish have not been seen since 1967.

Parasites and diseases

Parasites and diseases are not considered to be a serious problem at East Lake. Yearling age rainbow trout (10-13 inches) will in some years, usually in late summer, be affected by strawberry disease which causes unpleasant appearing red lesion(s) on their sides. This disease does not kill the fish and most often disappears after several weeks, but appearance makes the fish undesirable to consume. There have also been periodic small losses of rainbow and brook trout from parasitic tapeworms.

Harvest and Angler Use

Virtually all types of trout angling take place and produce results depending on time of year and species being fished. Historically, East Lake anglers predominantly still-fished with bait or trolled with flashers and bait. Fish were seldom released. Fly fishing has gained in popularity during the last 10 years and has been responsible for some of the trophy catches. More fish are being released today, but there is still a strong demand for trout consumption. About 85 to 90% of the catch is rainbow followed by brook trout and brown trout. Brown trout reach the largest size with fish close to twenty pounds being caught nearly every year. Rainbow trout in excess of 10 pounds were caught nearly every year in the past, but are rare today.

There are no recent statistically valid estimates of total angler use and catch for East Lake. The last study completed was in 1981 and results are summarized in Table 39.

Table 39. A summary of total angler use, harvest by species and catch rates for East Lake during the 1981 season.

Anglers	46,532
Hours	190,781
Rainbow trout kept	24,890
Brook trout kept	5,459
Brown trout kept	59
Rainbow trout released	3,803
Brook trout released	771
Total fish	**34,982**
Fish per angler	**0.75**
Fish per hour	**0.18**

The impact on angler use from the high mercury levels and fish consumption advisory at East Lake has been dramatic. In 1995, general observations by Department personnel and reports from the resort operator showed a severe decline in angler use at East Lake. However, anglers who did fish experienced good catch rates for rainbow trout and Atlantic salmon. More positive information and education regarding fish which can be safely consumed and emphasis on trophy fish opportunities will help bring anglers back to East Lake.

The Department would like to initiate the use of legal-size rainbow beginning in 1996 to give anglers an opportunity to catch and consume a mercury-free trout. These fish would be fin-clipped for identification purposes and periodically sampled to determine rates of mercury accumulation.

Another concept to generate a new fishery at East Lake would be the use of tiger trout. Tiger trout are a sterile hybrid brown and brook trout cross. They currently are being used successfully in Nevada to utilize undesirable fish species and produce trophy trout fisheries. The Department has experimentally raised tiger trout in hatcheries for display purposes, but have not used them to produce a fishery. They are very piscivorous, reach large size, and are striking in coloration. Potentially, they could produce a unique featured species fishery in East Lake. There are other potential rainbow trout stocks such as Klamath Lake, Crane Prairie, and Eagle Lake (California) which could also produce featured species fisheries in East Lake.

Management Issues

1. The discovery of naturally-occurring mercury at high levels in fish at East Lake has seriously reduced angler use and impacted current fish management strategies.
2. The abundant tui chub population limits the carrying capacity for trout in East Lake and restricts management options to those fish species able to successfully interact.
3. Partial control of chub populations in the past may have helped sustain the rainbow trout fishery. Chub control by the Department is no longer done at East Lake due to a lack of manpower, funding, and environmental concerns.
4. There is strong evidence that Lot 53 rainbow from Oak Springs hatchery are not surviving in East Lake past yearling age. The historic rainbow trout fishery which made East Lake so popular has declined.
5. Although the brown population is abundant, especially large-size fish, there is relatively light harvest, usually by anglers specializing in brown trout fishing.
6. There is very limited opportunity for natural reproduction (beach spawning) for salmonids in East Lake and the fishery must be maintained with hatchery fish.

MANAGEMENT DIRECTION

EAST LAKE

POLICIES

Policy 1. East Lake brown trout will be managed for hatchery production consistent with the Trophy Fish Management Alternative for trout (ODFW 1987).

Policy 2. Hatchery brook trout will no longer be stocked in East Lake.

Policy 3. Rainbow trout, kokanee and Atlantic salmon will be managed for hatchery production consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 4. Investigate the feasibility of stocking tiger trout in East Lake.

OBJECTIVES

Objective 1. Maintain the genetic diversity, adaptiveness, and abundance of rainbow and brown trout, kokanee and Atlantic salmon in East Lake.

Assumptions and Rationale

1. Monitoring the distribution, size, age-class, structure and abundance of populations of rainbow trout and brown trout, kokanee and Atlantic salmon will provide an indication of their health and adaptiveness.

2. There are periodic losses of game fish from the parasitic tapeworm *Protocephalus salmonidicola*.

3. Fish losses significantly affect the numbers and quality of fish available to the fishery.

4. Tui chub are extremely productive in East Lake. They compete with game fish for food and space and negatively affect the fishery when populations are high.

5. Tui chub are a food resource for piscivorous trout species.

6. There is no recreational or commercial use for tui chub at the present time and they are not limited in population throughout their range.

7. The current stock of rainbow trout (53's) have been performing poorly in recent years and it is believed to be related to genetic problems.

ACTIONS

Action 1.1 Establish trout population trends, distribution and abundance in East Lake.

Action 1.2 Study and implement methods of controlling tui chubs to minimize negative interactions with game fish. Encourage the Department's Research Division to lead this action.

Action 1.3 Investigate methods of reducing fish losses to the parasitic tapeworm *Protocephalus salmonidicola.*

Action 1.4 Investigate a new stock of rainbow trout to be used in the hatchery program.

Objective 2. Provide diverse angling opportunities for selected fish species in East Lake.

Assumptions and Rationale

1. East Lake was originally fishless.

2. There is a high level of public interest in retaining these fisheries as shown by angler use and catch surveys.

3. East Lake has been stocked with hatchery fish since the 1910's.

4. Adequate spawning habitat does not exist in this lake and periodic stocking is required to maintain the current fishery. There is little or no opportunity to improve spawning habitat.

5. These angling opportunities depend on land management that maintains the natural productive capacity of East Lake.

6. A statistical creel survey is needed at East Lake.

7. Brook trout did not make a large contribution to the creel or provide significant control on tui chub.

ACTIONS

Action 2.1 Annually stock East Lake with up to 10,000 hatchery brown trout yearlings, and up to 30,000 legal-size 72 stock rainbow trout, 20,000 fingerling kokanee and up to 10,000 Atlantic salmon yearlings.

Action 2.2 Discontinue stocking fingerling-size rainbow of Oak Springs domestic stock (53's).

Action 2.3 Inventory fish populations for size, growth, condition factor, and species composition.

Action 2.4 Monitor angler effort and catch through a creel survey.

Action 2.5 Continue to adjust the stocking program and to meet the lakes natural productivity and angler use.

Action 2.6 Continue to examine angling regulations for their adequacy in maintaining the fishery.

Objective 3. Protect and enhance trout rearing and spawning habitat in East Lake.

Assumptions and Rationale

1. Habitat is good at the present time, but can be improved through habitat enhancement.

2. Fish production is limited by spawning habitat.

3. Habitat enhancement will increase the abundance of trout.

4. Natural productivity in East Lake is closely related to geothermal vents in the lake bottom.

5. Proposed geothermal power generation may affect the function of these vents.

ACTIONS

Action 3.1 Use USFS, ODFW, and other available surveys to determine the most effective area and type of enhancement.

Action 3.2 Implementation of habitat projects will be done through the Mitigation and Enhancement Committee, USFS, and other interested groups.

Action 3.3 Continue working with the USFS to maintain productivity of East Lake.

Action 3.4 Implement habitat enhancement projects.

Objective 4. Investigate the feasibility of stocking tiger trout in East Lake.

Assumptions and Rationale

1. Tiger trout are a sterile hybrid between brown trout and brook trout.

2. Tiger trout may be an effective predator on tui chub.

3. Tiger trout are very aggressive feeders and should provide an exciting sport fishery.

ACTIONS

Action 4.1 Conduct a feasibility study on the ability of tiger trout to control tui chub and provide a Featured Species fishery.

PAULINA LAKE

Habitat and Habitat Limitations

Paulina Lake is relatively large and one of the deeper lakes in Oregon. The lake lies at an elevation of 6,331 feet above sea level and covers 1,531 surface acres area with a maximum depth of 250 feet and an average depth of 163 feet. Only 3% of lake bottom is classified as shoal area (less than 10 feet in depth) and the shoal is a very narrow strip around the shore. The shoreline is 6.7 miles in length. At full pool, the lake contains a water volume of 249,800 acre-feet (Johnson et al. 1985). Bottom composition of Paulina Lake is primarily volcanic rock and muck with a few shoreline areas of pumice. Macrophyte growth is limited by the small amount of shoal area. Common macrophytes are Myriophyllum and Elodea.

The lake has a very small watershed area of only 8 square miles. Steep slopes surrounding the lake have sparse forests consisting of lodgepole pine, ponderosa pine, hemlock, and alder. Much of the ground is bare volcanic rock. Fifty-five percent of the watershed is forest and 18.9% rock (Johnson et al. 1985).

Paulina Lake develops a distinct thermal stratification in the summer, with a thermocline at 50 to 60 feet. Deep water (below 200 feet) remains very cold at 39^{o} F all year and each winter the surface ices over. Because of the high elevation and large volume, surface water also remains cool during the summer. The maximum summer water temperature at the surface is about 64^{o} F (Johnson et al. 1985).

The water chemistry of Paulina Lake is unusual. The lake has a high concentration of major ions and a higher concentration and conductivity than East Lake. Alkalinity is 340 ppm and conductivity 560 umhos/cm but the concentration of sulfate is lower than in East Lake. The lake is strongly influenced by underwater hot springs of 96-113^{o} F (Johnson et al. 1985). It is nearly saturated with oxygen at all but the lowest depths where it decreases slighty (ODEQ 1990).

Paulina Lake is a biologically productive lake. The concentration of phosphorus is sometimes rather high, contributing to overall mesotrophic conditions. Chlorophyll concentrations are variable, due to the occasional algal blooms. Zooplankton are very abundant in Paulina Lake, also an indication of a productive food chain. In summary, the lake is mesotrophic in ecological character (Johnson et al. 1985). Aquatic insects in the families Diptera, Annelida, Amphipoda, Gastropoda, and Pelecypoda are important food sources for trout in Paulina Lake. Results of 1963 surveys by Putnam (1963) indicate the rainbow trout were eating mostly Diptera, scuds, vegetation, and other fish.

Paulina Creek is the only outlet to the lake. Paulina Creek usually seeps into the ground before reaching the Little Deschutes River. There are no perennial inlet streams, but their is considerable runoff during the snowmelt season and water seeps underground from East Lake (Johnson et al. 1985).

Water levels in the lake are controlled by a dam first established in 1899 to supply irrigation water to downstream users. The dam was rebuilt in 1945, storing four feet of additional water in Paulina Lake. By agreement between the Department and the Kellems ranch, 2.75 feet of water (3,780 acre-ft.) was allotted to the Kellems for agricultural irrigation; water rights for this use were established in 1899 and 1909, respectively (NNVMCMP 1993). The Department was allocated the remaining 1.25 feet for fish propagation or instream flows. The dam is operated cooperatively with the irrigators. The Department built rotary drum screens just upstream of the dam in 1945 to hold game fish within Paulina Lake. New screens were built and installed by the Department in 1995. Virtually all of Paulina Creek outflow is used for irrigation or stock water purposes prior to reaching the Little Deschutes River.

Fish Stocking History

Rainbow trout were first brought to Newberry Crater in 1912 after a group of men with the La Pine Community Club introduced the idea of stocking East and Paulina lakes with fish to state officials. In July 1912, the Oregon Game Commission shipped rainbow trout fingerling to Bend by train. A party consisting of the district game warden, superintendent of state fish hatcheries, other officials, and local fishermen were assembled to transport the fish. From Bend it took the party all night to reach Paulina Prairie as the road was merely two ruts with alternating chuck holes (King 1969). From Paulina Prairie, pack horses took the fish the remaining 14 miles to the Newberry Crater entrance. In order to keep the fish alive, party members had to climb into Paulina Creek canyon periodically to carry up buckets of fresh water. Half of the rainbow fingerlings were stocked into Paulina Lake and the other half into East Lake, numbers unknown.

Large numbers of rainbow trout were stocked during the years 1935-40. Newcomb (1941) reported an average of 455,764 rainbow trout released annually. ODFW stocking records date to 1945 and show rainbow trout fry, fingerling, and legal-size fish have been stocked annually to the present. Numbers stocked ranged from a high of 391,081 in 1954 to a low of 66,125 in 1989. Rainbow for Paulina Lake have been reared at Fall River, Wizard Falls, Klamath, Oak Springs, Willamette, and Roaring River Hatcheries. The current annual allocation is 75,000 Lot 53 (Oak Springs domestic stock) fingerling at a size of 40 per pound reared at Wizard Falls Hatchery.

Records are not available to show when the first brown trout were stocked in Paulina Lake. However, Newcomb (1941) reported 349,995 brown trout were stocked in the lake during the years 1935-40. In the late 1940's, biologists considered brown trout to be a major threat to the success of the rainbow trout fishery in Paulina Lake because of their piscivorous nature. Brown trout were not stocked again until 1981. Since then, from 5,000-10,000 yearling-age brown trout have been released annually. This brown trout stock is from Wickiup Reservoir wild fish and are reared at Klamath Hatchery.

Brook trout may have been stocked in Paulina Lake as early as 1915. The Oregon Sportsman (1916) reported brook and rainbow trout, and steelhead were stocked in many Central Oregon waters including East and Paulina lakes. It is not known which species or numbers were specifically stocked in each lake. Diaries kept by the Fall River hatchery manager show brook trout stocking in Paulina Lake in 1927-28. Newcomb (1941) reported an average of 566,772 brook trout stocked in Paulina Lake annually during the years 1935-40. Brook trout were stocked each year through 1955. They were discontinued because of poor returns to the anglers and have not been stocked again.

The kokanee stocking program began in 1973 and continues to the present. The annual allocation has been 20,000-25,000 fingerlings at 100 per pound in size. These are kokanee stock taken from Paulina Lake fish and reared at Wizard Falls Hatchery.

Angling Regulations

Paulina Lake has had a variety of angling regulations over the years. The lake has had a later season opening than the general trout season because of ice cover and lack of access into Newberry Crater. Highlights of the major changes are listed below:

1931 Paulina Lake closed around the outlet at Paulina Creek. Bag limit is lowered from the general bag limit to 10 lbs plus one fish not to exceed 20 fish per day.

1934 Bag limit changed to 15 lbs plus one fish not to exceed 20 fish.

1942 Special bag limit of 10 fish not to exceed 15 lbs plus one fish.

1947 Bag limit reduced to 5 fish not to exceed 15 lbs plus one fish per day.

1954 Bag limit of 5 fish per day.

1955 Special bag limit removed from Paulina Lake.

1962 Special season removed from Paulina Lake.

1968 Special closed area on Paulina Lake reopened.

1974 Late opener reinstated.

1980 Bag limit 10 fish per day, not more than 5 over 12 inches nor more than 2 over 20 inches.

1988 Bag limit reduced to 5 trout per day, not more than 1 over 20 inches.

Currently Paulina Lake is open from May 18 to October 31. The trout bag limit is 5 fish per day, not more than 1 over 20 inches. There are no special gear restrictions.

Fish Management

Since before 1920, Paulina Lake as been regarded as one of Oregon's most popular trout-producing waters. Historically, it was a premier producer of excellent quality rainbow trout. It has always been popular as a family fishing destination because of excellent fishing, good campgrounds, resort accommodations, and aesthetics. It recent years, new fisheries for trophy-size brown trout and kokanee have kept angler interest high.

A management plan for Paulina Lake adopted by the Oregon Fish and Wildlife Commission in 1980 is superseded by this basin plan.

Currently, Paulina Lake is managed with hatchery fish as a Basic Yield fishery for rainbow trout, large brown trout, and large kokanee.

Rainbow trout

Rainbow trout were first stocked in 1912 and have been stocked every year from 1945 to the present. Rainbow trout do not reproduce in Paulina Lake because there are no suitable spawning areas. Rainbow trout have always provided the largest percentage of angler harvest and effort. However, with the introduction of kokanee in 1973, and the reintroduction of brown trout, the percentage of rainbow in the creel is steadily declining. In 1995 random creel checks, kokanee constituted 72.5% of the catch, rainbow trout 25.5%, and brown trout 2%. Table 40 shows the percent rainbow trout in the catch from random creel checks by decade for 1960-1990.

Table 40. Percent rainbow trout in the catch from random creel checks at Paulina Lake by decade for the period 1960-1990.

Year	Percent rainbow
1960	99.6%
1970	100.0%
1980	86.2%
1990	75.0%

A concern relative to rainbow trout in Paulina Lake is a trend toward smaller fish as indicated by a steady high percentage of yearling age rainbow trout in the creel Figure 21.

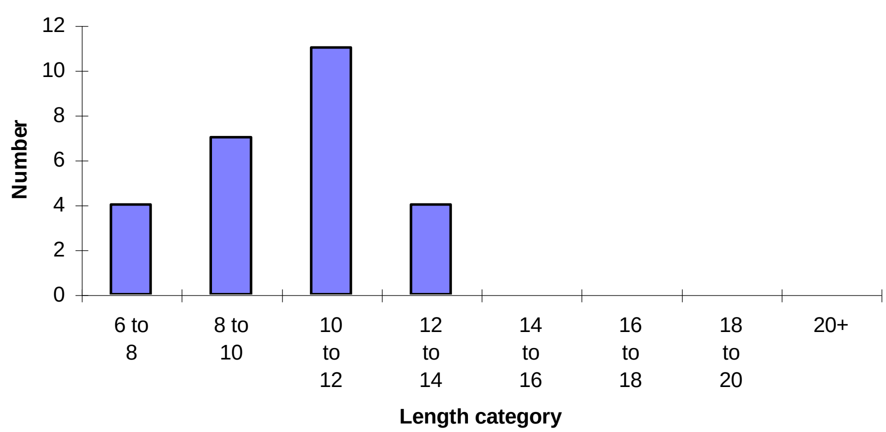


Figure 21. Size distribution of rainbow trout in random creel surveys at Paulina Lake, 1995.

A trapnet set in September 1995 captured only 7 rainbow trout ranging in length from 5-14.5 inches with an average of only 8.5 inches. As in East Lake, the precise reasons for this decline are not known, but it is believed the Lot 53 rainbow (Oak Springs Hatchery domestic stock) have suffered genetically from many years of inbreeding resulting in poorer growth rates, low survival, and loss of ability to compete with chubs.

Brown trout

Records are not available to show when brown trout were first introduced into Paulina Lake. An Oregon Game Commission lake survey report (Newcomb 1941) reported 349,995 brown trout were released into Paulina Lake during the period 1935-40. They were not popular with biologists in the early years. In 1946, Oregon Game Commission biologist Borovicka reported the most serious threat to the rainbow trout sport fishery in Paulina Lake is the presence of a large population of cannibalistic brown trout. During 1946, 300 brown trout were removed by seines. Removal of brown trout continued for several years until their population was depleted.

They were not stocked again until 1981 when the Department released 5,000 fingerling-size brown trout. Fingerling and yearling-age brown trout have been released annually since 1981 with the current allocation of 10,000 yearling-age brown at a size of 6.0 per lb.

Brown trout in Paulina Lake are managed with the objective of providing large fish which also utilize the abundant chub population. The current official Oregon State Record brown trout was taken at Paulina Lake in 1993 weighing 27 lbs. 12 ounces. One year later, a specimen weighing 23 lbs. 6 ounces was taken from the lake. In 1965, a 35 lb. 8 ounce brown trout was taken from the lake, but it was not caught by hook and line, so it was not an official record. Obviously, some of the largest brown trout in North America are being produced in Paulina Lake.

Today, Paulina Lake contains an abundance of large brown trout. For example, in a one-night trapnet set in September of 1995, 39 brown trout were captured ranging in length from 9-30 inches with an average of 21.5 inches.

Brown trout comprise a small percentage of the catch at Paulina Lake. Random creel census in 1995 showed only 2% of the catch was brown trout. As is the case at East Lake, brown trout in Paulina Lake are generally caught by a select group of anglers fishing specifically for brown trout. In recent years, the largest brown trout have been taken the first few weeks of the season.

Kokanee

Following several years of zooplankton sampling to determine abundance, and species composition kokanee were introduced into Paulina Lake in 1973 with a release of 20,000 fingerlings at a size of 100 per pound. The management objective for kokanee was to produce a large size kokanee, and diversify the fishery by using a gamefish adapted to living in the large deepwater pelagic area of Paulina Lake. The kokanee program has been highly successful in meeting management objectives, and in addition, has provided an annual source of high quality eggs for the Oregon kokanee program since 1978. Other states such as Idaho and Washington have also used eggs from Paulina Lake kokanee. Table 42 summarizes the kokanee egg collections at Paulina Lake for the years 1991-95.

Table 42. A summary of kokanee egg collections at Paulina Lake for the years 1991-95.

Year	Number females	Number eggs	Eggs/female
1991	594	689,440	1,161
1992	1,333	1,423,000	1,068
1993	1,026	1,132,536	1,104
1994	1,045	1,295,000	1,239
1995	549	838,000	1,526

Since the program started, kokanee at Paulina Lake have maintained a large size at maturity and are among the largest found in Oregon. The current Oregon State record kokanee was taken at Paulina Lake in 1990 and weighed 4 lbs. 2 ounces. The stocking rate of 20-25,000 fingerling annually appears to be compatible with the zooplankton supply, the primary forage for kokanee. A trapnet set in September of 1995 captured 34 kokanee with a length range of 12-17 inches and an average of 13.9 inches. Each year, fish over 20 inches are observed in angler catches and during egg collections.

Angler interest in the kokanee fishery is very high because of the fish size, quality, and edibility. Random creel checks in 1995 showed 72.5% of the catch was comprised of kokanee.

Crayfish

Crayfish are abundant and of high quality (large size) in Paulina Lake. A commercial fishery has existed in some years, generally by one fisherman, operating under a special use permit by the Deschutes National Forest. The last reported commercial crayfish landings at Paulina Lake was 3,638 pounds in 1991. There have been numerous conflicts reported between commercial crayfishing operations and sport fishing, primarily abandoned gear and entanglement of lines and anchors. The Newberry National Volcanic Monument Comprehensive Management Plan (Deschutes National Forest) calls for the elimination of commercial crayfishing. The Department has no objection.

Sport fishing for crayfish is popular at Paulina Lake because of their abundance, large size, and good eating qualities. There are no estimates of angler effort or catch.

Their have been no biological investigations of the crayfish population. Little is known of their life histories, reproductive rates, growth rates, or contribution to trout as forage.

Non-game fish

Paulina Lake is inhabited by one non-game fish species, the blue chub, *Gila* (Gila) *coerulea* (Girard). The blue chub is endemic to the Klamath River system of California and Oregon and probably were introduced into Paulina Lake in the 1920's (Bird 1975).

The blue chub population in Paulina Lake apparently did not grow as quickly as the tui chub population in East Lake. Newcomb (1941) reported the chub population was beginning to appear in 1940. They are found throughout the shoreline areas depending on life stage. Spawning is keyed to shallow areas with vegetation. As with tui chub in East Lake, the hot springs area in Paulina Lake is inhabited by large concentrations of chubs throughout the year.

Partial chub control began at Paulina Lake in the 1940's. Borovicka (1949) reported 10,000 chubs weighing 1,100 pounds were removed from Paulina Lake using poison, gillnets, and seines. Chub control continued annually until the 1980's when it was terminated due to environmental concerns, and lack of manpower. Millions of blue chubs were eliminated in some years, but the actual benefit to rainbow trout populations in Paulina Lake is unknown. However, there has been a decline in rainbow trout growth rates and average size during the last 20 years. Research is needed to determine effective, safe and efficient control techniques and the nature of the competitive interaction between rainbow trout, kokanee, brown trout, and blue chubs.

Parasites and diseases

Currently, parasites and diseases are not considered to be a serious problem at Paulina Lake. However, in past years, a parasitic tapeworm, (*Proteocephalus salmonidicola*), was reported by Putnam (1963) to cause the loss of many rainbow trout annually and reduced the body condition of trout at times. Tapeworms can still occasionally be found in rainbow trout and blue chubs, but not at levels high enough to cause mortality or serious loss of body condition. Lower stocking densities of rainbow trout have likely lessened the threat of tapeworm epidemics.

Harvest and angler use

Since stocking began in the early 1900's, fisheries have existed for rainbow, brook, and brown trout, and since the late 1970's, kokanee. Through the years, rainbow trout have dominated the catch, however, kokanee have become increasingly popular and dominated the catch in 1995, based on random creel checks. A fishery for trophy-size brown trout has also developed since the restocking program began in 1981. Brook trout are no longer stocked because of poor returns to the anglers and that fishery is gone.

Most angling at Paulina Lake takes place from boats. Early in the season when rainbow trout are in shallow water, bank anglers have success along the east shoreline. As the water warms and fish seek deeper water, this bank fishery ends. Boat anglers primarily troll for kokanee, brown trout, and some rainbow trout. They also still fish with bait in shallower water for rainbow trout, primarily early and late in the season. In recent years, drifting and jigging lures for kokanee from a boat in the deep water portion of the lake has become popular.

The first total catch estimates were in 1939 when 1,600 anglers caught 21,000 trout. A statistical sampling program in 1967 showed 24,000 anglers with a catch of 49,000 trout. The most recent estimate was completed in 1981 and is summarized in Table 43.

Table 43. A summary of total angler use, harvest by species and catch rates for Paulina Lake during the 1981 season.

Anglers	48,408
Hours	212,343
Rainbow trout kept	41,677

Table 43. Continued

Kokanee kept	8,740
Rainbow trout released	5,812
Kokanee released	416
Total fish	**56,645**
Fish per angler	**1.17**
Fish per hour	**0.27**

Note: no brown trout in catch. they were reintroduced beginning the year of this study, 1981.

Management Issues

1. The abundant blue chub population limits the carrying capacity for trout in Paulina Lake and limits management options to those fish species able to successfully compete for space and food.
2. Partial control of chub populations in past years may have helped sustain the rainbow trout fishery. Chub control by the Department is no longer done at Paulina Lake due to a lack of manpower, funding, and environmental concerns.
3. There is strong evidence that Lot 53 rainbow trout from Oak Springs Hatchery are not surviving in Paulina Lake past yearling age. The historic rainbow trout fishery which made Paulina Lake so popular has declined, replaced in part by a growing kokanee fishery.
4. Although the brown trout population is abundant, especially larger size fish, there is relatively light harvest, usually by anglers specializing in brown trout fishing.
5. There is virtually no spawning area available for trout in Paulina Lake and the fishery must be maintained with hatchery fish.
6. Little is known of the biology of crayfish in Paulina Lake or their value as fish forage. They appear to be abundant and are of high quality. The impact of sport or commercial harvest is unknown.

MANAGEMENT DIRECTION

PAULINA LAKE

POLICIES

Policy 1. Brown trout and kokanee will be managed for hatchery production consistent with the Trophy Fish Management Alternative for trout (ODFW 1987).

Policy 2. Rainbow trout will be managed for hatchery production consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 3. Crayfish will be managed as a recreational fishery for natural production. The commercial crayfish fishery will be discontinued.

OBJECTIVES

Objective 1. Maintain the genetic diversity, adaptiveness, and abundance of rainbow trout, brown trout and kokanee in Paulina Lake.

Assumptions and Rationale

1. Monitoring the distribution, size, age-class, structure and abundance of populations of rainbow trout, brown trout and kokanee will provide an indication of their health and adaptiveness.

2. There are periodic losses of rainbow trout from the parasitic tapeworm *Protocephalus salmonidicola.*

3. Fish losses to the tapeworm can reduce the numbers and quality of fish available to the fishery.

4. Kokanee in Paulina Lake are an important source of eggs for Oregon, Washington and Idaho.

5. Blue chub are extremely productive in Paulina Lake. They compete with game fish for food and space and negatively affect the fishery when populations are high.

6. Blue chub are a food resource for piscivorous trout species.

7. There is no recreational or commercial use for blue chub at the present time and they are not limited in population throughout their range.

8. The current stock of rainbow trout (53's) have been performing poorly in recent years and it is believed to be related to genetic problems.

ACTIONS

Action 1.1 Establish trout population trends, distribution and abundance in Paulina Lake.

Action 1.2 Study and implement methods of controlling blue chubs to minimize negative interactions with game fish.

Action 1.3 Investigate methods of reducing fish losses to the parasitic tapeworm *Protocephalus salmonidicola*.

Action 1.4 Investigate a new stock of rainbow trout to be used in the hatchery program.

Objective 2. Provide diverse angling opportunities for selected trout species in Paulina Lake.

Assumptions and Rationale

1. Paulina Lake was originally fishless.

2. There is a high level of public interest in retaining these fisheries as shown by the 56,645 angler-trips found in the 1981 creel survey.

3. Paulina Lake has been stocked with hatchery fish since the 1910's.

4. Adequate spawning habitat does not exist in of this lake and periodic stocking is required to maintain a fishery. There is little or no opportunity to improve spawning habitat.

5. These angling opportunities depend on land management that maintains the natural productive capacity of Paulina Lake.

6. A statistical creel survey is needed at Paulina Lake.

7. Some fish in Paulina Lake can escape downstream around the rotary fish screen.

8. There are no listed provisional wild fish populations downstream in Paulina Creek, but wild populations may exist.

ACTIONS

Action 2.1 Annually stock Paulina Lake with up to 10,000 hatchery brown trout yearlings, 75,000 rainbow trout fingerlings and 20,000 kokanee fingerlings.

Action 2.2 Inventory trout populations for size, growth, condition factor, and species composition.

Action 2.3 Monitor angler effort and catch through a creel survey.

Action 2.4 Continue to adjust the stocking program to meet its productivity and angler use.

Action 2.5 Continue to adjust Paulina Lake angling regulations to meet its fishery.

Objective 3. Protect and enhance trout habitat in Paulina Lake.

Assumptions and Rationale

1. Rearing habitat is good at the present time but spawning habitat may be improved through habitat enhancement.

2. Habitat enhancement will increase the natural production of trout.

3. Natural productivity in Paulina Lake is closely related to geothermal vents in the lake bottom.

4. Proposed geothermal power generation may affect the function of these vents.

5. Natural fish production is limited by lack of spawning habitat.

ACTIONS

Action 3.1 Use USFS surveys to determine the most effective area and type of enhancement.

Action 3.2 Implementation of habitat projects will be done through the Mitigation and Enhancement Committee, USFS, and other interested groups.

Action 3.3 Continue working with the USFS to maintain the productivity of Paulina Lake.

Action 3.4 Implement habitat improvement projects.

Objective 4. Provide a recreational fishery for crayfish in Paulina Lake.

Assumptions and Rationale

1. It is not known if crayfish are indigenous to Paulina Lake.

2. Little is known about interspecific relationships, life history and abundance of crayfish in Paulina Lake. Harvest may limit crayfish abundance and subsequently affect forage abundance for game fish.

3. These shellfish are an important food source for game fish.

4. There is a high public interest in maintaining the fishery.

5. There is no written crayfish management plan, crayfish are managed by Oregon Administrative Rules (OAR) 635-05-070 through 635-05-085.

6. There is sport and commercial crayfish harvest throughout the state. Paulina Lake and Lake Billy Chinook have supported both commercial and recreational harvest.

7. In 1995, Scott Lewis an Oregon State University masters candidate, began a crayfish life history study in Lake Billy Chinook. Some of the information gathered may apply to Paulina Lake.

8. There have been numerous conflicts in the past between commercial crayfishermen and recreational anglers.

ACTIONS

Action 4.1 Establish crayfish population trends, distribution, abundance and size in Paulina Lake.

Action 4.2 Monitor recreational effort and catch through a statistical creel survey.

Action 4.3 Continue to adjust crayfishing regulations to protect the crayfish fishery.

PAULINA CREEK

Location and Ownership

Paulina Creek originates at Paulina Lake and flows due west approximately 13.5 river miles to its confluence with the Little Deschutes River, however, no recent record exists of Paulina Creek reaching the Little Deschutes. Land ownership is approximately 63% federal (Deschutes National Forest), and 27% private land. The upstream 1.75 river miles are within the Newberry National Volcanic Monument administered by the Deschutes National Forest. Primary land uses along the stream include recreation, timber management, farming, and residential. Paulina Creek has no significant tributaries. Access along Paulina Creek is good within National Forest lands via FR 21 that essentially parallels the creek upstream to Paulina Lake. Other roads in close proximity to the stream include FR 2120 from the FR 21 bridge crossing upstream to McKay Crossing Campground, and FR 500 to Paulina Lake. Public access to Paulina Creek through private lands is lacking.

Habitat and Habitat Limitations

Fish habitat in Paulina Creek is marginal at best. Numerous water falls, water withdrawal for irrigation use, and long term isolation from the Little Deschutes River all limit fish production in the creek.

Several irrigation diversions exist on private land and use most water coming down the stream. Irrigation rights exist for 3,780 acre feet of storage in Paulina Lake with a delivery rate totaling 7.2 cfs for application to 503.5 acres of land (DNF Special Use permit). The lower two miles of Paulina Creek is comprised of portions of the historic stream channel. In most years, water does not reach this area because it is either diverted from the channel or spreads out over pastureland and diffuses into the ground. No records could be found showing a surface flow connection with the Little Deschutes River. The exact number of irrigation diversions is unknown and none are screened to our knowledge.

The average monthly flow in Paulina Creek is shown in Figure 22. Data were not available to show natural stream flow and the period of record is small.

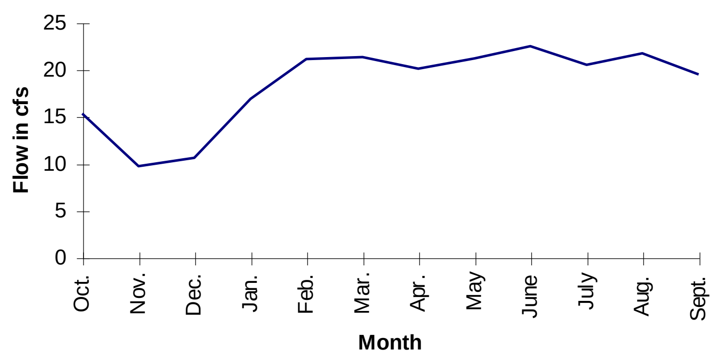


Figure 22. Average monthly flow in Paulina Creek, 1983-1994. Note that irrigation releases are added to natural stream flow so natural stream flow is not shown.

The entire length of Paulina Creek was surveyed in 1968 by ODFW personnel. Surveyors classified 1,020 square yards of spawning gravel, 208 of which was rated as "good" quality.

The USFS surveyed 8.5 river miles of Paulina Creek on their lands in 1989. Surveyors divided the creek into 6 sections based on gradient, canyon shape, and location. Section 1 begins at the downstream forest boundary and Section 6 ends at Paulina Lake. In general, gradient increases moving upstream. Gradient in Section 1 averaged 1% and increased to 6.8% in Section 5 and 5.7% in Section 6. Pool habitat throughout the creek was low and ranged from 2 to 12% per section. Riffle habitat was the dominant habitat type and ranged from 36 to 81% with 4 sections averaging over 70%. Glide habitat was the second most prevalent habitat type. Cover was rated as poor (0-5%) or fair (6-20%) for all sections. Hanging vegetation, water turbulence, and substrate were the most common features providing cover. Surveyors classified 51 falls through the entire survey section, 23 of which occurred in the upper 2.8 stream miles. The Forest Service protocol classifies falls as those greater than 6.6 feet in height. Falls less than 6.6 feet are not documented as "special cases". Surveyors noted an abundance of aquatic insects (macroinvertebrates) throughout the surveyed sections including the orders Trichoptera, Plecoptera, Ephemeroptera, and Diptera.

Habitat Limitations

Habitat limitations in Paulina Creek include:

1. At least 51 natural falls creating upstream fish passage barriers.
2. Diversion of water for irrigation use.
3. Unscreened irrigation diversions.
4. Shortage of good spawning gravel and stream cover for trout.
5. Lack of connection with the Little Deschutes River.

Fish Stocking History

The first fish introductions in Paulina Creek may have been incidental, resulting from escapement following stocking of Paulina Lake as early as 1912. The Department's first record of fish stocking in Paulina Creek is 1972 when 747 fingerling rainbow trout were released. These fish were reared at Fall River Hatchery. Subsequent rainbow trout releases occurred through 1981, except for 1979. Numbers of fish released ranged from 240-540 fingerlings, except 240 legal-sized rainbow in 1978. Origin of the fish were Fall River, Oak Springs, and Wizard Falls hatcheries.

Current records show only one release of 250 brook trout fingerlings into Paulina Creek in 1978.

Angling Regulations

The general trout regulation has always applied in Paulina Creek except for 1924 when the section between Big Paulina Falls and Paulina Lake was closed to angling. Paulina Creek is currently open from April 27 through October 31. The bag limit is 5 fish per day over 6 inches, one of which can be greater than 20 inches. There are no gear restrictions.

Fish Management

Paulina Creek is managed as a Basic Yield fishery for hatchery rainbow trout with the potential for a few naturally produced brook trout, however no fish are stocked at this time.

The existence of indigenous fish species is unknown. Historically, redband trout, mountain whitefish, bull trout, and reticulated sculpin may have been able to access Paulina Creek from the Little Deschutes River prior to irrigation diversions. Upstream areas are blocked by impassable waterfalls which explains why Paulina Lake was originally fishless.

Recent inventory and creel information for Paulina Creek does not exist. Fish species potentially inhabiting Paulina Creek include hatchery rainbow and brown trout, and kokanee which can escape from Paulina Lake during the spring when water overflows the dam. Some resident brook trout have been reported by anglers. A small brook trout population could be naturally reproducing as a result of early plantings in Paulina Lake and Paulina Creek. Based on angler reports, early stocking efforts resulted in good rainbow trout growth. However, these trout were subjected to high harvest rates following completion of access trails along Paulina Creek.

In the future, fish inventory work should be conducted to determine the extent of fish emigration from Paulina Lake, their relative abundance by species, and growth rates. Information could be used to assess the potential for developing a put and take fishery using catchable trout or fingerlings.

Management Issues

1. Numerous impassable falls prevent upstream fish movement and tend to isolate fish populations between the barriers. The genetic interchange of any naturally producing stocks would be severely limited by these barriers.
2. Water is diverted for irrigation use.
3. A lack of pool habitat reduces the carrying capacity for trout and concentrates fish in a few well known pools where they are vulnerable to excessive harvest rates.
4. In the past, stocked rainbow trout fingerlings exhibited good growth, but were quickly harvested. There is a potential to generate a put-and-take legal rainbow fishery in Paulina Creek, however, it would be limited by the number of pools available to spread out harvest by area and time.

MANAGEMENT DIRECTION

PAULINA CREEK

POLICIES

Policy 1. Paulina Creek will be managed with hatchery rainbow and brown trout which emigrate from Paulina Lake and a naturally-reproducing brook trout population consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

OBJECTIVES

Objective 1. Provide angling opportunities for a variety of trout species in Paulina Creek.

Assumptions and Rationale

1. There is public interest in retaining these fisheries.

2. Hatchery fish have been present in Paulina Creek since the early 1900's when Paulina Lake was first stocked.

3. These angling opportunities depend on maintaining or improving pool habitat in Paulina Creek.

ACTIONS

Action 1.1 Inventory trout populations in Paulina Creek for size-class distribution, condition factor, and species composition.

Action 1.2 Monitor angler effort and catch rates through random creel checks.

Action 1.3 Adjust Paulina Creek angling regulations to meet the objective.

Objective 2. Protect and enhance fish habitat in Paulina Creek.

Assumptions and Rationale

1. Fish habitat surveys were completed in 1968 and 1989.

2. Habitat maintenance or enhancement will be required to maintain or increase trout production.

3. The natural flow regime of Paulina Creek has been altered by irrigation releases from Paulina Lake. The impacts to fish habitat from this altered flow regime are not fully understood.

4. Paulina Creek is no longer connected with the Little Deschutes because of irrigation diversions.

ACTIONS

Action 2.1 Use habitat surveys to determine deficiencies by type and area.

Action 2.2 Implementation of habitat projects will be done through the Mitigation and Enhancement Committee, USFS, and other interested groups.

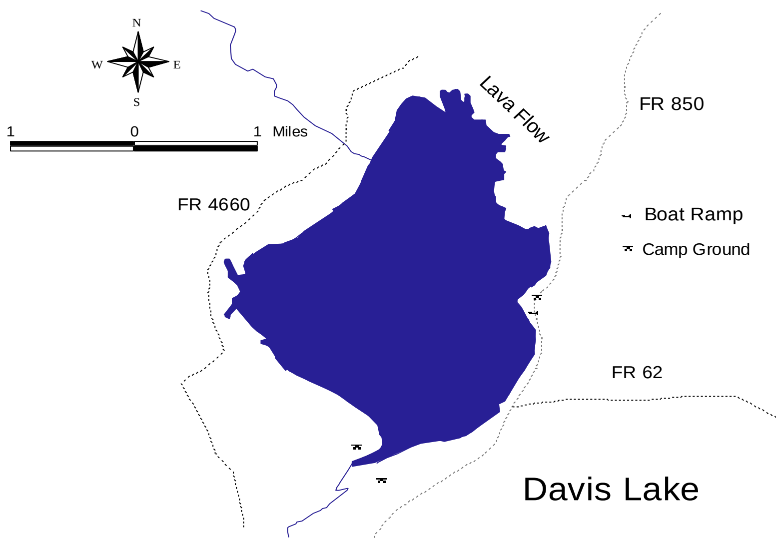
DAVIS AND ODELL LAKES; ODELL CREEK

DAVIS LAKE

Overview

The name Davis is taken from "Button" Davis, a nineteenth century stockman from the Prineville area who ran cattle in the vicinity of the lake (Johnson et al. 1985).

Davis Lake is a dramatic product of the recent geologic history of the Central Oregon Cascades, an area of widespread volcanic activity. Odell Creek incised a channel into the surface of a high lava plateau and was later filled by a lava flow several hundred feet thick that impounded the creek, forming Davis Lake.



Although the date of this flow has not been determined precisely, it is certainly one of the youngest in the Cascades and may be as recent as 1,000 years old. Certainly, it is less than 6,600 years old, because the flow is not covered by the regional blanket of pumice from Mt. Mazama (Johnson et al. 1985).

Prior to this volcanic eruption, Odell Creek was likely directly connected to the upper Deschutes River basin as evidenced by the common indigenous fish species; redband trout, mountain whitefish, and bull trout. These three species were endemic to Odell Lake and tributaries, Odell Creek, and Davis Lake as well as the upper Deschutes River subbasin. Due to extensive stocking of hatchery trout and past chemical treatment projects, it is unknown if any of the indigenous redband trout or bull trout remain.

Location and Ownership

Davis Lake lies at an elevation of 4,386 feet and straddles the Deschutes-Klamath County line approximately 41 air miles southwest of Bend in the Deschutes National Forest.

Primary road access to Davis Lake is provided by Highway 58 on the south, Highway 97 on the east, and Highway 46 (Century Drive) to the north. Secondary road access is provided by Forest Service roads 850, 855, 4660, 600, and 4669. The US Forest Service manages the surrounding land and maintains two functional campgrounds; East and West Davis Campgrounds located at the south end of Davis Lake. A third campground, Lava Flow Campground on the northeast shore has recently been closed.

There is an unimproved boat access area at West Davis Campground. This access is only useable when lake water levels are high. In very high water years, anglers will launch small boats into Odell Creek channel at East Davis Campground. The only improved boat ramp is located at Lava Flow Campground on the northeast shore. However, due to concerns about bald eagle nesting, the Forest Service has closed public access to this ramp for most of the summer the last two years. Limited boat access to Davis Lake is a major concern of the Department. A new improved boat ramp, accessible at most water levels, is sorely needed at Davis Lake.

Habitat and Habitat Limitations

Water for Davis Lake is supplied via spring snowmelt and the tributaries of Odell, Ranger and Moore creeks. Moore Creek, the outlet of Bobby Lake, supplies water to the lake only during spring runoff while Ranger Creek is a spring-generated tributary. Odell Creek is the primary water supply and is responsible for maintaining suitable trout habitat in the summer months. Odell Creek flows eight miles from Odell Lake to Davis Lake. Flows range from 73 cfs to 106 cfs with a maximum temperature of 59^{o}F.

Davis Lake is a large, shallow body of water varying from approximately 1,000 to 3,906 acres in size. In the drought year of 1994, the lake receded leaving only 200-300 surface acres of water. At full pool, the maximum depth is 20 feet and the average depth is 9 feet. At maximum water level, the lake contains a water volume of 35,940 acre-feet. The lake has 13.5 miles of shoreline with a maximum width of 1.2 miles. Shallow depths and high summer water loss makes Davis Lake particularly vulnerable during poor water years. Water levels fluctuate a great deal annually due to losses from evaporation and seepage through fissures in the lava flows at the north end of the lake.

Davis Lake is productive due to its shallow depth. However, the lake's large size is deceptive because habitable trout water (around the mouths of Odell and Ranger creeks and in the deeper portion along the lava flow) during a warm summer with low water may only be 10%

of the total acreage. Surface water temperatures as high as 84°F have been recorded. When water temperatures climb in late June, trout move into the cooler waters of the Odell Creek channel and off the lava flows at the north end of the lake.

Much of the ecological character of Davis Lake is determined by its shallow morphometry and fluctuating water level. It is constantly mixed from top to bottom and does not develop any stable thermal stratification. Dissolved oxygen is always plentiful throughout the water column. The concentrations of chlorophyll and phosphorus and the water transparency suggest mesotrophic conditions. Nutrients are readily recycled from the rich organic sediments and stimulate the growth of planktonic algae, also a consequence of the continual mixing of the water column. Additional nutrients are added by migrating water birds. Davis Lake water is alkaline with pH ranging from 7.6-8.7 (Johnson et al. 1985).

Davis Lake is rich biologically; the bottom material has a high organic content and the production of insects, crustaceans, and other fish food is high (Johnson et al. 1985). Sampling of the lake bottom by the Department has produced readings as high as 173 pounds per acre of aquatic organisms. Aquatic vegetation, both emergent and submergent, harbors many aquatic insects, but lowers the lake's dissolved oxygen content when it decomposes under ice and snow. Grasses, reeds and willows surround the lake, providing nesting and rearing habitat for waterfowl and marsh dependent birds. This vegetation also harbors abundant aquatic insect populations and provides excellent rearing habitat for juvenile fish.

Large amounts of water are lost through holes in the lake bottom and in the lava flows. Klamath and Deschutes counties and ODFW combined efforts to seal several sumps along the east side of the lake to reduce water loss. Five holes were plugged in the fall of 1967, severing a flow of 11 cfs. An additional 16 water loss areas have been identified along the lava at the east end of the lake.

In years of both high and low precipitation, water loss is excessive and the lake levels can fluctuate greatly. The extreme fluctuations cause the following effects on the lake environment: destroys fish food organisms in the dewatered areas; reduces living space for fish, shallow lake depth increases the proportion of lake volume and area subject to extremes in water temperatures, warmer in summer and colder in winter; and low water levels make boat access more difficult and detract from the lake's aesthetic values. Also, low water increases competition between tui chub and trout, increases incidence of parasites and diseases, and makes fish more vulnerable to predation.

Habitat limitations in Davis Lake are:

1. Widely fluctuating water levels drastically affect the sustainability of the lake's fish production capability from year to year.
2. Warm water temperatures in summer months concentrate salmonids in relatively small refuge areas of cool water.
3. Large volumes of water are lost annually in sink holes and through porous basalt in the north end of lake thus reducing the ability to maintain a minimum pool in Davis Lake for aquatic life.

Fish Stocking History

Diaries from Fall River Hatchery show rainbow trout were stocked in Davis Lake as early as 1936, origin and numbers unknown. Newcomb (1941) reported 31,698 rainbow trout stocked in 1940. Current records show rainbow trout were stocked annually until the drought years in the late 1980's and early 1990's when low water levels resulted in no fish being stocked in a few years. Rainbow from Klamath, Oak Springs, Wizard Falls, Roaring River, Willamette, and Fall River hatcheries were stocked in Davis Lake. The first disease (*Ceratomyxa shasta*) resistant rainbow from Oak Springs Hatchery (Lot 66) were stocked during the period 1972-74. From 1976 to 1981, no resistant rainbow were available for stocking. This disease resistant rainbow stock was periodically stocked from 1982 to 1991. A new rainbow stock (Lot 28), indigenous to Klamath Lake, *Ceratomyxa shasta* resistant, and reared at Klamath Hatchery were first stocked in 1990. They have been stocked annually through 1995 except in 1992, a severe drought year. The current allocation calls for 35,000 Klamath rainbow annually at a size of 20-30 per pound.

Kokanee were stocked in Davis Lake from 1962-64. Coho salmon were stocked from 1965-1971, however they were not resistant to *C. shasta* and the program was terminated. Disease resistant Columbia River fall chinook salmon were stocked as an experiment from 1980-82, but failed to survive or generate a fishery. Atlantic salmon were first stocked in 1952 and again in 1962. These were the anadromous Gaspe Bay stock used in Hosmer Lake. They were not disease resistant and failed to generate a fishery. In 1989, Atlantic salmon stock from Grand Lakes, Maine, were first released in Davis Lake. They were subsequently stocked as fingerling and yearling size fish in 1990, 1993, and 1994. Shortages of fish at the hatchery and low lake water levels altered stocking plans in some years. All Atlantic salmon are reared at Wizard Falls Hatchery. No Atlantic salmon are allocated for Davis Lake in 1996.

Angling Regulations

The Davis Lake fishery has been governed by a variety of angling regulations over the years including fly angling only restrictions. Listed below are major changes:

1937- Flyfishing only.

1939- Closed by the legislature to all but fly-angling.

1945- Bag limit lowered to 5 fish not to exceed 15 lbs plus one fish per day.

1951- Bag limit lowered 5 fish per day.

1953- Davis Lake closed to operation of boat in excess of 10 miles per hour during days and hours of legal fishing.

1954- Davis Lake closed to angling from a boat while motor is operating.

1955- Bag limit the same as general trout regulations.

1957- Angling from a boat while under power allowed.

1959- The 1939 fly angling statute was repealed, but the Oregon Game Commission retained the restriction by regulation.

1960- The fly angling restriction was removed because of chemical treatment planned for 1961.

1962- Closed to angling.

1963- Reopened to angling. Bait allowed.

1965- Fly angling only on the southern 4,000 ft. of the lake.

1967- Fly angling only on the entire lake and bag limit of 2 trout per day over 6 inches. Ten mph speed limit removed.

1969- Fly angling only entire lake. Special bag limit removed, statewide bag limit for lakes and reservoirs applies.

1974- No angling from a motor-propelled craft.

1986- Bag limit reduced to 2 trout per day, 6 inch minimum.

Current regulations for Davis Lake are fly angling only on the entire lake with no angling allowed from motor-propelled craft while the motor is operating. Bag limit is two trout per day, 6-inch minimum, general trout season from late April through October. In addition, regulations provide restrictions to protect spawning rainbow trout. Odell Creek opens June 1 compared to the lake which opens in late April and closes at the end of October. Boundary markers separating Davis Lake from Odell Creek are posted on both sides of Odell Creek to protect fish that accumulate to take advantage of cool inflow into the lake.

Fish Management

A management plan for Davis Lake was adopted by the Oregon Fish and Wildlife Commission in 1980. This basin plan supersedes that plan.

Bull trout, redband trout, and mountain whitefish were the indigenous fish species in Davis Lake. Introduced fish species are rainbow trout, brook trout, coho salmon, fall chinook salmon, Atlantic salmon, kokanee, tui chub, and largemouth bass. Presently, Davis Lake and its tributaries are known to have rainbow trout, mountain whitefish, Atlantic salmon, brook trout, tui chub, and largemouth bass.

The first biological investigation of Davis Lake occurred in 1932 by Oregon State biologists. That survey was not detailed, but did report the presence of rainbow trout and bull trout. A more extensive biological survey was done in 1940 by Oregon State Game Commission biologists who reported tui chub and rainbow trout were common. It is unknown when tui chub, native to the Klamath basin, were first introduced to Davis or Odell lakes.

Two of the more significant circumstances which have influenced fish management in Davis Lake are the tui chub population and *C. shasta*. Tui chubs have been known to be present since the first biological investigations in 1940. They compete with trout species for food and living space in the lake. Tui chub thrive in warm water, spawning on submerged vegetation, are long-lived, and have tremendous reproductive capabilities.

Partial chub control work began as early at 1949 by the Oregon State Game Commission. Intensive work to control tui chub in the early 1950's proved ineffective and the lake was chemically treated in 1961 with toxaphene in an attempt to eliminate the population. However, tui chub were present in Odell Lake and were able to move downstream to reinfest Davis Lake. By 1979, chub again made up most of the fish population in spite of some control work carried out since 1968. A major tui chub die-off occurred in 1969, but the cause was not determined. The Department terminated partial chub control efforts at Davis Lake in the 1980's due to a shortage of manpower, lack of funding, and environmental concerns.

C. shasta was discovered at Davis Lake in 1966 by Oregon State University pathologists. Coho salmon were especially susceptible to this disease resulting in a termination of the stocking program after 1971. The rainbow trout stocks being used in Davis Lake prior to 1966 were non-resistant. In addition to *C. shasta*, rainbow trout sampled in 1979 were heavily infested with tapeworms and copepods. Presently, there are infestations of both found in some rainbow trout from Davis Lake. Although not well documented, it seems likely that losses from tapeworms and copepods occur in some years.

Bull trout in Davis Lake were reported as early as 1932 and again by Borovicka (1950). It is believed they were temporarily eliminated from Odell Creek and Davis Lake by the 1961 chemical treatment project, however, they existed in Odell Lake and could easily repopulate downstream areas. Bull trout reappeared in Davis Lake in 1966 when a 10-inch specimen was captured in a trapnet set by the Oregon State Game Commission. No bull trout have been reported in Davis Lake since 1977 when two 7-inch specimens were captured in gillnets by ODFW.

Redband trout were indigenous to Davis Lake and reported to be common in the earliest biological surveys. One of the earliest records of rainbow trout was in the Oregon Sportsman (1914) which reported rainbow trout eggs were collected at Davis Lake in 1913.

Rainbow trout have always been the primary species producing the fishery and a variety of stocks have been used in Davis Lake since the 1930's. Chemical treatment of Davis Lake and Odell Creek in 1961 most likely extirpated the indigenous redband trout stock. Since the discovery of *C. shasta* in 1966, the Department has tried to find a disease-resistant rainbow trout stock for Davis Lake which would provide a fishery for large trout under a fly angling only regulation, forage on the abundant tui chub population, survive parasites such as tapeworm and copepod, and spawn successfully in Odell Creek.

The Deschutes strain of redband trout (Lot 66), reared at Oak Springs Hatchery, were the first known *C. shasta* resistant rainbow released into the lake. They did survive, but failed to produce consistent results in the fishery and did not utilize the chub population. This stock was endemic to the Lower Deschutes River and did not adapt well to the rather harsh habitat of Davis Lake.

In the last few years a second *C. shasta* resistant rainbow stock (Lot 28), endemic to Klamath Lake and reared at Klamath Hatchery, has been stocked. Unfortunately, these fish have been exposed to very severe drought conditions, but are showing some promise. Klamath rainbow trout released in 1993 as holdover fingerlings and sampled by trapnet in April of 1994 ranged in length from 11.6-14.2 inches and comprised 16% of all rainbow captured. In addition, several of these fish had small chubs in their stomachs and were not infested with parasites.

Davis Lake suffered a severe drought in 1994 and had receded to an estimated 200-300 surface acres of water by October. A trapnet set in April of 1995 captured a total of 85 rainbow trout, but only one was a fin-clipped Klamath rainbow trout. Water conditions improved in 1995 and 1996 will be an excellent water year. The Department stocked fin-clipped Klamath rainbow in 1995 and plans to release another marked group in 1996. Lake habitat conditions should be ideal for these fish to survive and grow.

Even though Davis Lake has suffered greatly during the last 10 years or so of low water conditions, there remains a small, naturally-reproducing rainbow trout population. It is unknown precisely what these fish are genetically. They may be a "Davis Lake" rainbow stock which have evolved and adapted to a harsh environment. Samples of these rainbow were collected in Odell Creek in 1994 for genetic analysis and results are pending.

Davis Lake adult rainbow trout spawn in Odell Creek in the spring (March to May). The Department has conducted annual spawning ground surveys in Odell Creek since 1988. Since 1988, the number of rainbow trout redds observed has declined sharply from a high of 721 in 1988 to lows of 48 in 1990 and 51 in 1994 (see Odell Creek section below). It is believed the drought period which began in the late 1980's and extended to 1995 was directly responsible for the depressed rainbow trout population in Davis Lake and corresponding spawning population.

Kokanee can migrate from Odell Lake to Davis Lake via Odell Creek. An excellent population of land-locked blueback salmon (kokanee) was reported to exist in Davis Lake as early as 1950 (Borovicka 1950). Borovicka also reported kokanee were not taken by anglers because of the fly fishing only regulation. Kokanee were first stocked in Davis Lake in 1962, but made no significant contribution to the fishery. In high water years, kokanee have grown and survived in Davis Lake, but have not been seen in annual net inventories since 1979. A series of low water years began in the late 1980's and extended to 1995 causing the lake habitat to be unsuitable for kokanee growth or survival.

Brook trout are self-sustaining in the cold waters of spring-fed Ranger Creek. In high water years when the mouth of Ranger Creek is accessible by boat, anglers target on brook trout in the channel where fish up to 14 inches long have been caught. Warm lake water temperatures prevent them from expanding their distribution.

Atlantic salmon have not survived in sufficient numbers to produce fisheries or utilize the abundant chub population. Low water conditions, predation, and parasites are suspected to contribute to their poor survival.

Coho salmon were introduced to Davis Lake in 1965. Growth and survival was good, but coho were extremely susceptible to *C. shasta* and the program was terminated after 1971. There was no evidence that coho spawned successfully in Odell Creek and none are found today.

Both coho salmon and rainbow trout grew well in Davis Lake, but coho did not contribute as well as rainbow to the sport catch under a fly-fishing-only regulation.

C. shasta resistant fall chinook salmon from the Columbia River were stocked as an experiment in 1980-82. It was believed they would utilize the abundant chub population, reach large size, and be able to withstand the harsh habitat conditions including high water temperatures. They failed to survive in any appreciable numbers, did not utilize the chub population, and did not generate a fishery. The reasons for their demise is unknown.

Largemouth bass have been illegally introduced into Davis Lake and their presence confirmed by the Department in 1995. The Department had received several unconfirmed reports of bass from trout anglers. Department personnel found bass in the 6-inch size range, but anglers report bass up to 14 inches long which would indicate they were probably introduced in 1994 or earlier. An examination of scales from the 6-inch bass by the warmwater biologist showed the fish was age 0, phenomenal growth for largemouth bass in Oregon.

The Department plans extensive electrofishing in the spring of 1996 to determine bass distribution, relative abundance, and size class distribution. It is believed largemouth bass will thrive in Davis Lake and grow to large sizes based on high water levels in 1996, an abundant food supply for all ages of bass (insects, tui chubs), and abundant spawning and rearing habitat. Since bass were just discovered in 1995, their potential impact on the trout population is unknown.

In general, angling pressure at Davis Lake is very light, especially since the mid-1980's due to a poor fishery and poor access caused by low water levels. The highest recorded boat count on Davis Lake was 310 boats on opening morning 1963, and that count fell to 40 boats the following morning. The reason for this high count was the lake was chemically treated in 1961, closed in 1962, reopened in 1963, and the fly angling only restriction had been removed. On opening day mid-morning of 1995, no boats were seen on the lake.

Early in the season when water temperatures are cool, angling takes place throughout the lake because the trout are scattered As the water warms, most of the activity is centered off the mouth of Odell Creek and adjacent to the lava flow at the north end of the lake, and during low water years, many anglers fish the lake in chest waders or float tubes.

With so few anglers, the Department has relied on voluntary creel data for angler success information. Voluntary data for 1978 (36 anglers) show 1.0 fish per angler and 0.3 fish per hour caught while Department sampling for the same time period (25 anglers) indicates 1.2 fish per angler and 0.3 fish per hour. In 1981 an Oregon State Police creel check included 23 anglers with 0.65 fish per angler and 0.17 fish per hour. Virtually no creel census has been collected in recent years and a statistically designed study to estimate total catch and effort has never been done.

The best fishery probably existed in Davis Lake in 1965; toxaphene residues from lake treatment had decomposed, tui chub populations were low, and two high water years had maintained suitable habitat for trout. Rainbow trout up to 13 pounds were caught.

Davis Lake is a highly productive body of water capable (in good water years) of raising large salmonids. The lake has the size and campgrounds to accommodate many more anglers than presently use the lake. Presently, boat access is limited with the seasonal closure of the Lava Flow Campground boat ramp. A new boat ramp is sorely needed.

Management Issues

1. The presence of the parasite *C. shasta* has limited management options in terms of fish species to generate a sustainable fishery for large size salmonids.
2. The abundant tui chub population limits the salmonid production capability of Davis Lake by competing for food and space. However, tui chubs provide forage for large piscivorous salmonids and largemouth bass.
3. In some years, parasitic tapeworm and copepod infestations are heavy, especially in rainbow trout and may cause losses, extent unknown.
4. Boat access to the lake has been limited in recent years by the seasonal closure of the Lava Flow Campground boat ramp to protect nesting bald eagles. A new boat ramp is sorely needed.
5. Davis Lake water levels fluctuate greatly depending on water years. Large volumes of water are lost through sink holes in the bottom of the lake and the porous lava flow at the north end of the lake. Wet or drought condition cycles can last for several years at a time increasing or decreasing fish production and the subsequent fishery. Low and warm water concentrate salmonids in small refuges of cool water by mid-summer in most years.
6. A naturally producing rainbow trout population exists in Davis Lake and spawns in Odell Creek. The genetic characteristics of this population is unknown.
7. Bull trout were endemic to Davis Lake and Odell Creek, but are rarely found today although they can move downstream from Odell Lake. The reasons for bull trout not repopulating Odell Creek and Davis Lake are unknown.
8. Angler use of Davis Lake is minimal because of poor fishing, limited boat access, and restrictive angling regulations. The lake has the size to accommodate more fishing pressure.

9. Illegally introduced largemouth bass were identified in Davis Lake by the Department in 1995. They are expected to thrive and the impact on the trout fishery is yet to be determined. Davis Lake is restricted to fly angling only.

MANAGEMENT DIRECTION

DAVIS LAKE

POLICIES

Policy 1. Davis Lake shall be managed for natural and hatchery production of rainbow trout consistent with the Trophy Fish Management Alternative for trout (ODFW 1987).

Policy 2. Atlantic salmon will no longer be stocked in Davis Lake.

OBJECTIVES

Objective 1. Maintain genetic diversity, adaptiveness, and abundance of rainbow trout and mountain whitefish.

Assumptions and Rationale

1. It is not known if a self-sustaining population of redband trout exists in Davis Lake.

2. A self-sustaining population of mountain whitefish exists in Davis Lake.

3. Redband trout and mountain whitefish indigenous to Davis Lake and tributaries have been identified as provisional wild fish populations.

4. Extensive numbers of non-native rainbow hatchery stocks were introduced into Davis Lake beginning in 1936.

5. Electrophoresis will be used to determine if hatchery rainbow have interbred with the redband trout population.

6. Special regulations will be needed to protect stock fitness, life history characteristics, and population health of redband trout (if they exist) and mountain whitefish.

7. Monitoring of fish populations in Davis Lake will provide an indication of their stock fitness and population level.

8. Tui chubs compete with trout for food and space and reduce the trout production capability of Davis Lake.

ACTIONS

Action 1.1 Verify, document, and establish fish population trends in Davis Lake. Population trends will be determined by netting, creel surveys, electrofishing, and spawning ground surveys.

Action 1.2 Determine the need for additional or modified angling regulations to protect populations of redband trout (if they exist) and mountain whitefish by monitoring the production, harvest, and catch rate.

Action 1.3 Investigate methods of controlling tui chubs to minimize their negative interactions with trout.

Objective 2. Provide a trophy fishery for rainbow trout at Davis Lake.

Assumptions and Rationale

1. An adequate catch rate has not been determined at this time. Statistical creel sampling over a number of years would be necessary to establish this rate for Davis Lake.

2. Davis Lake is capable of growing large, trophy-size rainbow trout.

3. The Department desires to maintain the high quality rainbow trout fishery by minimizing the effects of largemouth bass on that population.

4. The fly fishing only regulation will be maintained.

5. The best fish growing conditions for rainbow trout occur after a series of good water years.

ACTIONS

Action 2.1 Monitor abundance, size, age-class structure, and distribution of trout by conducting periodic netting, creel and spawning ground surveys, and electrofishing.

Objective 3. Provide a fishery on mountain whitefish.

Assumptions and Rationale

1. Many people are unaware of the excellent sporting and eating qualities of mountain whitefish. Whitefish are generally underutilized and could sustain additional harvest.

ACTIONS

Action 3.1 Publicize information on the desirable attributes of whitefish and angling opportunities.

Objective 4. Protect fish rearing and spawning habitat in Davis Lake.

Assumptions and Rationale

1. Spawning and rearing habitat for trout, whitefish, and bass is adequate to sustain the present fishery.

2. Good quality habitat will benefit all aquatic species.

3. Maintaining a large game fish population depends on a series of good water years and/or establishing a higher minimum pool.

ACTIONS

Action 4.1 Work with the Crescent Ranger District, Klamath County and private landowners to maintain the present good quality fish habitat and minimize possible damage to the area from the impact of recreation development.

Action 4.2 Continue to work with Crescent Ranger District to establish a higher minimum pool in Davis Lake.

Objective 5. Improve access to Davis Lake.

Assumptions and Rationale

1. The Lava Flow boat ramp has been closed to public use during the bald eagle nesting season. This ramp is critical to low water access during the summer and is the only improved boat ramp on Davis Lake.

2. Development of a boat ramp that is useable at all water levels is needed at Davis Lake.

ACTIONS

Action 5.1 Continue to work with Crescent Ranger District to open Lava Flow boat ramp when eagles are not successfully nesting.

Action 5.2 Encourage Crescent RD to search for a season-long available boat ramp.

Objective 6. Restore a resident population of bull trout in Davis Lake.

Assumptions and Rationale

1. Restoring this stock would improve the diversity of the fish community in Davis Lake.

2. Bull trout were historically found in Davis Lake.

3. These fish will change the ecological relationships in the existing fish community.

4. Population levels may be reached which would sustain a consumptive or non-consumptive fishery.

5. Restoration will occur through restoration of the population in Odell Lake as fish migrate downstream through Odell Creek.

ACTIONS

6.1 Monitor presence of bull trout through annual inventory and creel surveys.

ODELL, RANGER AND MAKLAKS CREEKS

Location and Ownership

Odell Creek originates as the lake outlet of Odell Lake and flows approximately 7.5 river miles in a northeast direction to Davis Lake. Land ownership along the creek is entirely U.S. Forest Service. Watershed area for Odell Creek is approximately 43,000 acres. Maklaks Creek is the only tributary to Odell Creek.

Access to Odell Creek is good. The section downstream of FR 4660 is paralleled by FR 600 that lies within 1/8 mile for the entire section. Upstream of FR 4660, FR 4668 parallels the creek within 1/2 mile. Several spur roads exist along FR 4668 that allow closer access. The upstream area of Odell Creek is readily accessible via Highway 58 and FR 680 that goes to Odell Lake Resort.

Habitat and Habitat Limitations

Odell Creek has been surveyed on at least 3 different occasions. ODFW surveyed the entire creek in 1964 and the USFS did complete surveys in 1979 and 1990.

ODFW surveys in 1994 calculated a pool-to-riffle ratio of 36:64. Gradient was 1.77%. Vegetation was noted as Englemann spruce and lodgepole pine. No natural passage barriers were noted by the surveys.

The Crescent Ranger District of the Deschutes National Forest surveyed Odell Creek in 1990. Two sections were identified in the survey summary. Section 1 extends from Odell Creek entry into Davis Lake upstream 2.94 river miles to an old wooden bridge site accessed via FR 280. Section 2 begin at the wooden bridge and ends at Odell Lake Resort, a distance of 4.11 river miles.

Section 1 habitat distribution was classified as 14% pool, 51% riffle, and 25% glide. Side channel habitat comprised the habitat area balance. Average depth in riffle areas was approximately 24 inches and 46 inches in pool areas. Pool density was 4.3 pools per mile. Stream width averaged 24 feet with a width-to-depth ratio of 20.7. Cover through the section averaged 3% with wood and undercut streambank being the dominant and subdominant cover types. Wood material classified totaled of 120 pieces, including 3 large pieces. The inner riparian area was dominated by grasses and forbs, with alder secondary. Lodgepole pine and Englemann spruce dominated in the outer riparian area. Streambed substrate was predominantly sand with gravel subdominant. Percentages of substrates were not given in the survey summary. Gradient averaged 2% for the section. The only special case identified were the culverts at FR 4660 crossing. These culverts may delay upstream migration but are not a barrier.

Habitat distribution in section 2 was 10% pool, 74% riffle, and 7% glide as a percentage of total stream area. Side channels made up the remaining 9%. The pool-to-riffle ratio was 1:2.3

by length for the section. Depth averaged 39 inches in pool areas and 21 inches through riffles. Stream width averaged 20 feet. The width-to depth-ratio calculated at 20.7. Cover was low at 2% and provided by wood, hanging vegetation, and undercut streambanks in order of abundance. Wood material through the section totaled 117 pieces, 2 of which were classified as large. Gradient averaged 2%. Surveyors noted that high velocities were encountered in riffle areas. The inner riparian area was dominated by grasses and forbs with alders being subdominant. Englemann spruce and lodgepole pine dominated the outer riparian area. Streambed substrate was mostly sand followed by cobbles and gravels.

In general, physical habitat is good except lack of cover and pools in some areas. There are some long riffle areas that would benefit from addition of wood to reduce velocities and create pocket water for fish. Some material may have recruited to the stream since completion of the survey due to an abundance of beetle killed trees in the area and several large storms.

Thermographs placed in Odell Creek near East Davis Creek campground recorded a maximum temperature of 75^{o}F in July 1994. Water temperatures were above 68^{o}F on three days and above 63^{o}F for 7 days (all within the same week) for the time period of July 15 to November 11, 1994 (DNF 1994).

Minimum flows in Odell Creek typically occur in September with maximums in June. Flows were measured at the stream gauge near FR 4660. Mean monthly flows measured between 1970 and 1992 were 158 cfs for June and 79 cfs for September (Kyle Gorman, Oregon Department of Water Resources, personal communication, 1996). Average flows by month are in Figure 23.

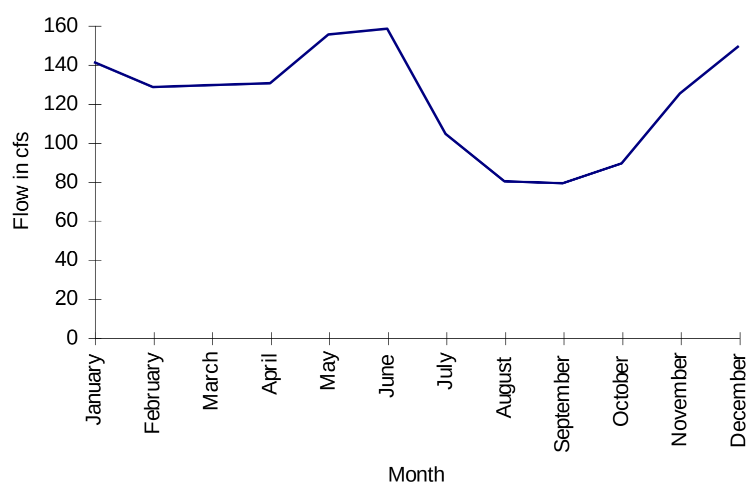


Figure 23. Average monthly flows in Odell Creek.

Aquatic insect samples from Odell Creek were collected and analyzed in 1991. The sample site was located a short distance downstream of the Odell Lake outlet. Samples were collected by Deschutes Forest personnel and analyzed by Bob Wissman, Aquatic Biology Associates. Analysis indicated moderate impairment. Insect species and abundance were characteristic of locations with reduced habitat complexity and moderate to high embededness. This would apply to Odell Creek as substrate near the sample site is composed of small material. Species richness (number of taxa) and abundance of aquatic insects in the sample was low. General comments by Wissman were that invertebrate communities in lake outlet streams may be low in abundance in locations where the lake is oligotrophic such as Odell Lake. A breakdown of insect orders present and their relative contribution included Ephemeroptera (26.1%), Plecoptera (5.6%), Coleoptera (40.9%), Diptera (1.7%), Chironomidae (13%), and misc. taxa (12.5%).

Maklaks Creek is the only tributary to Odell Creek, and enters Odell Creek approximately 2.5 river miles downstream of Odell Lake. Maklaks Creek originates as several springs and seeps on Maklaks Mountain and flows east 0.43 miles to Odell Creek. Maklaks Creek was surveyed by Deschutes National Forest personnel in 1990. Gradient was found to range from 3% near the Odell Creek confluence and 6% near the headwaters. Habitat type distribution was 4% pool, 91% riffle, and 3% glide by total area. Only 2 pools were classified for the entire length. Cover was rated as low and provided by undercut and hanging vegetation, however, wood material was not quantified or included as a cover component. ODFW personnel conducting fish inventory along Maklaks Creek indicated wood material was relatively abundant. Riparian vegetation was predominantly grasses and forbs with some alder present. Water quality appears suitable for bull trout ranging from 40.1^{o}F at the source to 41.9^{o}F at the Odell Creek confluence during the survey. A season long temperature profile has not been recorded.

Habitat limitations for Odell Creek are:

1. A low abundance of pool habitat and cover.
2. Low natural productivity.

Fish Stocking History

According to ODFW records, Odell Creek has never been stocked with any fish. Fish stocked in Davis Lake have free access to Odell Creek and commonly move into it when Davis Lake becomes too warm for salmonid fishes.

Angling Regulations

Odell Creek was closed to angling in the past but reopened in 1959 and currently is opened to angling from June 1 to October 31, 5 trout per day, only 1 over 20 inches, all bull trout must be released. The angling regulations history is listed below.

1931 Odell Creek closed to angling.

1932 Odell Lake and Odell Creek to one-half mile downstream from the lake open after April 14, 1942; rest of Odell Creek closed from September 16 - May 30 each year until 1942.

1935 Odell Creek from its outlet in Odell Lake to the Willamette highway bridge, closed to angling. Open season for angling in that part of Odell creek otherwise May 5 to October 31.

1936 Odell Creek closed to angling.

1945 Odell Creek closed from outlet to telephone line near forestry camp at Davis Lake.

1947 Closed to angling.

1959 Odell Creek open to angling, general trout regulations.

1992 Odell Creek closed to angling for bull trout.

Fish Management

Odell Creek is managed as a Basic Yield fishery for naturally reproducing rainbow trout. No hatchery fish are stocked.

Fish believed indigenous to Odell Creek include bull and redband trout and whitefish. In October 1961, Odell and Maklaks Creeks were rotenoned in conjunction with a treatment project at Davis Lake, with objectives to eradicate an overabundant tui chub population in the lake. Since 1964, species identified in Odell Creek include rainbow trout, kokanee, bull trout, Atlantic salmon, brook trout, mountain whitefish, and tui chub. Odell Creek has not received any fish releases to supplement the creek fishery. Occasionally fish destined for Davis Lake have been released into Odell Creek near East Davis Lake campground when water temperatures have been unfavorable for release directly into the lake.

Odell Creeks' main fishery value is its use as a natal stream by rainbow trout from Odell and Davis lakes. Bull trout have not been documented in Odell Creek since 1979. Its small size and lack of pool habitat probably do not favor high production of resident trout. Lower Odell Creek, near East Davis Creek campground and upstream becomes important as a cool water refuge for fish in late summer in low water years as temperatures and water quality in Davis Lake become poor.

Rainbow trout in Odell Creek are predominantly adfluvial fish from Odell and Davis lakes. The percentage of resident and adfluvial fish is unknown. Fish from Davis Lake move upstream into Odell Creek in spring months to spawn. Regular redd counts have been conducted annually since 1988 except for 1995 when high water conditions prevented completion of the survey. Counts have steadily declined through that period (Table 44) and are attributed to a series of poor water years and associated poor water quality in Davis Lake.

Table 44. Odell Creek redd counts, 1988 - 1995.

Year	Number of redds
1988	721
1989	362
1990	48
1991	235
1992	164
1993	74
1994	51
1995	#

- unknown, water too high for survey, poor visibility

Odell Creek is reported to have been the major spawning tributary for Odell Lake rainbow trout also. Spawning surveys in 1947 by the OSGC noted that Odell Creek was the only stream used for spawning by Odell Lake rainbow trout (see Odell Lake section). No recent surveys have been done to document or quantify spawning from Odell Lake fish.

ODFW personnel inventoried Odell Creek in 1990 to determine species composition, size, and relative abundance. Surveyors captured a total of 376 rainbow trout at three locations that ranged from 2 - 9 inches. Survey results are included in Table 45.

Table 45. Size distribution in Odell Creek rainbow trout, 1990.

Location	Size (inches)							Minimum density (fish/m^2)
	2	3	4	5	6	7-9	9-12	
0.5 RM up Davis	112	18	14	2	0	1	0	0.085
Near FR 4660	48	16	9	3	3	1	0	0.078
Near Odell outlet	107	17	16	5	3	0	0	0.118

A number of different rainbow trout stocks have been released into Odell and Davis lakes with free access to Odell Creek. The contribution of hatchery fish to the creek is unknown. Fish were collected in Odell Creek for electrophoretic analysis in 1994. Analysis of fish samples is scheduled to be completed in 1996.

Bull trout have not been reported from Odell Creek in recent years. The last official documentation was from a USFS survey in 1979 that recorded bull trout from 14 to 18 inches at a density of 0-5 fish per 100 feet. Surveys were done by snorkeling. A spawning ground survey with the objective to document bull trout use was conducted by USFS personnel downstream of Odell Lake in 1994. Two surveys were completed in October but no redds or fish were found. Maklaks Creek has the best potential for re-establishment of bull trout in the Odell Creek system.

Mountain whitefish are the second most abundant fish species in Odell Creek, rainbow trout are the most abundant. In the 1990 survey, whitefish were captured to 16 inches and fairly abundant. All fish were captured in pool or pocket water areas.

Other species in Odell Creek are either transient or seasonal inhabitants. Kokanee often drop out of Odell Lake, move down Odell Creek to reside in Davis Lake. One kokanee was captured in Davis Lake in the 1995 trapnet set. Brook trout also have the potential to enter Odell Creek from Odell Lake or Ranger Creek. Brook trout have not been identified in Odell Creek since the 1979 USFS survey. Tui chub are seasonal inhabitants in downstream areas of Odell Creek. Like the rainbow trout, they move into Odell Creek seeking cool water temperatures in summer months, often in large numbers.

Current creel census is lacking for Odell Creek. ODFW personnel working in the area observed frequent angler use of the stream section adjacent and upstream of East Davis Lake campground. Personal communication with anglers fishing areas upstream of FR 4660 indicate fair catches of fish up to 8 or 9 inches in length.

Management Issues

1. Odell Creek was chemically treated in 1961 downstream of Odell Lake, extirpating indigenous trout species.
2. Pool habitat and cover is in low abundance throughout the stream length.
3. Odell Creek is predominantly a natal stream for rainbow trout from Odell and Davis lakes.
4. Production capacity may be more limited by spawner abundance than habitat.

MANAGEMENT DIRECTION

ODELL, RANGER, AND MAKLAKS CREEKS

POLICIES

Policy 1. Rainbow trout, mountain whitefish, and brook trout shall be managed for natural production consistent with the Featured Species Alternative for trout (ODFW 1987).

Policy 2. Bull trout shall be managed for natural production consistent with the Wild Fish Management Alternative for trout (ODFW 1987).

OBJECTIVES

Objective 1. Maintain genetic diversity, adaptiveness, and abundance of rainbow trout, mountain whitefish, brook trout, and bull trout.

Assumptions and Rationale

1. It is not known if a self-sustaining population of redband trout exists in Davis Lake tributaries.

2. A self-sustaining population of mountain whitefish exists in Davis Lake tributaries.

3. Redband trout and mountain whitefish indigenous to Davis Lake tributaries have been identified as provisional wild fish populations.
4. Extensive numbers of non-native rainbow hatchery stocks were introduced into Davis Lake beginning in 1936.

5. Electrophoresis will be used to determine if hatchery rainbow have interbred with the redband trout population.

6. Special regulations will be needed to protect stock fitness, life history characteristics, and population health of redband trout (if they exist) and mountain whitefish.

7. Monitoring of fish populations in Davis Lake will provide an indication of their stock fitness and population level.

8. Odell and Maklaks creeks were treated with rotenone during the 1961 treatment of Davis Lake and it is highly probable and indigenous fish present were eliminated.

9. Odell Creek is an important spawning tributary of Davis Lake.

ACTIONS

Action 1.1 Verify, document, and establish fish population trends in Davis Lake tributaries. Population trends will be determined through creel surveys, electrofishing, and spawning ground surveys.

Action 1.2 Determine the need for additional or modified angling regulations to protect populations of redband trout (if they exist) and mountain whitefish by monitoring the production, harvest, and catch rate.

Action 1.3 Maintain the regulations requiring the release of bull trout in Odell Creek and closure of Odell Creek during spawning season.

Objective 2. Provide a basic fishery for rainbow trout, bull trout, brook trout, and mountain whitefish in Davis Lake tributaries.

Assumptions and Rationale

1. An adequate catch rate has not been determined at this time. Statistical creel sampling would be necessary for a period of years to establish this rate for Davis Lake tributaries.

ACTIONS

Action 2.1 Monitor abundance, size, and distribution of trout by conducting periodic creel surveys, spawning ground surveys, and electrofishing.

Objective 3. Protect fish rearing and spawning habitat in Davis Lake tributaries.

Assumptions and Rationale

1. Spawning and rearing habitat for trout and whitefish is adequate to sustain a fishery at the present time.

2. Good quality habitat will benefit all aquatic species.

ACTIONS

Action 3.1 Work with the Crescent Ranger District, Klamath County and private landowners to maintain the present good quality fish habitat and minimize possible damage to Davis Lake tributaries from the impact of development.

Objective 4. Restore a resident population of bull trout in Odell Creek.

Assumptions and Rationale

1. Restoring this stock would improve the diversity of the fish community in Odell Creek.

2. Bull trout were historically found in Odell Creek.

3. These fish will change the ecological relationships in the existing fish community.

4. Population levels may be reached which would sustain a consumptive or non-consumptive fishery.

5. Restoration will occur through restoration of the population in Odell Lake as fish migrate downstream to Odell Creek.

ACTIONS

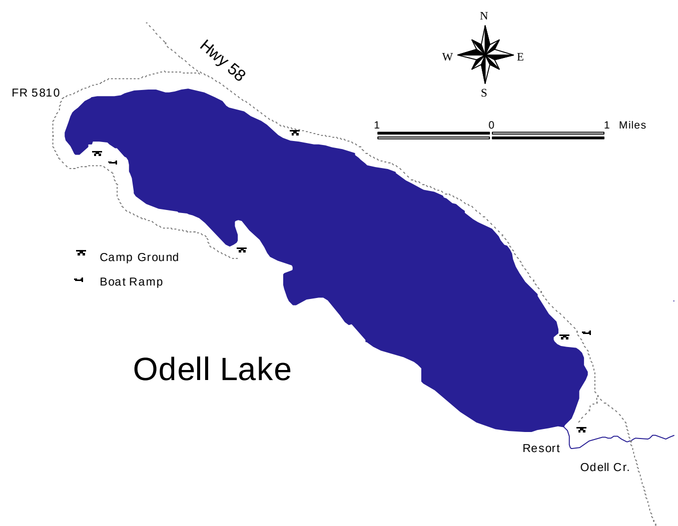
4.1 Monitor presence of bull trout through annual inventory and creel checks.

ODELL LAKE AND TRIBUTARIES

Location and Ownership

Odell Lake is located about 60 miles east of Eugene, just east of the summit of the Cascade Mountain range. It is accessible via Hwy 58 which borders the lake on its north side. Short, paved roads off Hwy 58 access the east and west ends of the lake.
The Southern Pacific RR track skirts the south side of the lake. Odell Lake is wholly on Deschutes National Forest property.

Developments on Odell Lake include five Forest Service campgrounds: Trapper Creek CG, on the west end, Princess Creek CG and Sunset Cove CG off Hwy 58, all



have boat ramps, and Odell Creek CG on the east end. The small Pebble Bay CG is accessible only by boat. Two resorts, one on each end of the lake, provide food, lodging, tackle, boat rentals and marina facilities. There are also about 70 private homes on the lake under permit from the Forest Service.

Habitat and Habitat Limitations

Odell Lake lies in a glaciated trough behind a moraine dam at elevation 4,787 feet. It has a surface area of 3,582 acres, being about 5 miles long and 1.5 miles wide. It is 282 feet deep with steep sides. The average depth is 134 feet with shoal areas, less than 10 feet deep, comprising only 4% of the surface area. Sand, gravel and rock dominate the shorelines while deeper bottom areas are largely detrital muck.

The lake has a drainage area of 37 square miles headed by Diamond Peak on the south and Maiden Peak to the north. Vegetative cover is mainly mature coniferous forest. Soils in the drainage are dominated by a pumice layer deposited by the eruption of Mt. Mazama. The pumice is very permeable and allows for rapid percolation feeding spring-fed streams and upwelling springs, mainly along the lake's south shoreline. Trapper Creek is the largest tributary carrying a combination of run-off and spring-fed waters to the west end of the lake. Crystal Creek, entering the lake from the southwest at Pebble Bay, has a relatively stable flow mainly from ground water sources. About 30 other small tributaries drain into the lake, mainly from the north, but most are intermittent or perennial seeps. The outlet, Odell Creek, flows 13 miles to Davis Lake.

In 1940, an Oregon State Game Commission survey party classified Odell Lake as oligotrophic, having low productivity. By some measures, such as transparency, it could still be called oligotrophic but based on measures of productivity and phytoplankton species composition, it would be classified as mesotrophic, having medium productivity. The increased productivity appeared in the 1960's apparently resulting from eutrophication brought on by increased development around the lake (Johnson et al. 1985).

Because of the lake's large volume and depth, water remains cool throughout the summer. Surface temperatures rarely exceed 68^{o}F. Conversely, the lake seldom freezes over completely. Thermal stratification is generally present from July through October, typically between 30-60 feet though strong winds may affect its strength and depth, particularly at the windward east end of the lake. Dissolved oxygen is generally near saturation. Lake waters are typically slightly alkaline but may exceed pH 9.0 near the surface as a result of phytoplankton blooms (Johnson et al. 1985).

During the period 1968-1976, ODFW research staff found the composition of zooplankton (July - September) to be 73% *Cyclops* and 23% *Daphnia*, with mean densities of 28,000 and 10,000 per cubic meter, respectively (Lindsay and Lewis 1978). Among the aquatic invertebrates present in the lake, midges and crayfish are common.

Trapper Creek has good spawning and rearing habitat. A rock cascade and falls between 0.25 and 0.50 miles from the mouth are barriers to fish migrating from the lake. During the summer, water temperatures typically range between 40 and 50^{o}F daily. High spring runoff flows may displace gravel and cover elements annually.

Crystal Creek has a smaller watershed, is not subject to severe high spring runoff, and has more stable spring-fed flows. Water temperature is quite constant at about 42^{o}F at the mouth throughout the summer. In the lower 0.5 mile, the gradient is low and there is abundant spawning and rearing habitat although the gravel size tends to be smaller than optimum for trout spawning. Upstream of the railroad crossing, the gradient becomes steeper and affords much less spawning and rearing habitat.

Habitat limitations are:

<u>Odell Lake</u>
1. Naturally low to moderate productivity.
2. The small proportion of shoal area reduces overall productivity and habitat for species preferring shallower near-shore areas.

<u>Trapper Creek</u>
1. Cascades and falls limit upstream migration of spawning fish.

<u>Crystal Creek</u>
1. Cinders and fine material eroding from the railroad fill degrades the quality of spawning gravel.

Fish Stocking History

Bull and redband trout and mountain whitefish are species indigenous to Odell Lake. After several introductions, the species now present in the lake are: bull, rainbow and lake trout, mountain whitefish, kokanee and tui chubs. Brook trout may be present rarely when they drop down out of tributary streams. Tui chubs were introduced sometime prior to 1940 when they were reported to be common in the lake (Newcomb 1941). Stocking records for other species are described below in order of their appearance.

Lake trout may have been introduced into Odell Lake as early as 1902 or 1905. The U.S. Bureau of Commercial Fisheries (USBCF) stocked 45,000 lake trout in Willamette Valley and mountain lakes in 1902. A Bend resident reportedly helped his father stock 8,000 lake trout into Odell and Summit lakes in 1905; those fish were brought to the Lewis and Clark Exposition by the USBCF (Gerlach 1967). The first record of lake trout stocked into Odell Lake was noted in the *Bend Bulletin* on July 26, 1917 but no numbers were reported. ODFW stocked yearling-sized lake trout annually between 1951 and 1965 with 4,900-80,000 fish per year from various sources in Canada.

"In October 1915, 1,400 Eastern Brook trout were placed in Odell Lake," (Gray 1986). Up to 153,000 brook trout were stocked annually between 1927 and 1935. No more brook trout have been stocked since except for 578 dumped in the lake from an aborted airstock flight in 1977.

One unsuccessful release of 1,200,000 grayling was made in 1925.

Historical accounts about the Odell Hatchery, built and operated in 1913 and 1914, told of rainbow trout reared there being released into Odell Lake. The source of those rainbow trout was reportedly from Gold, Davis, and Crescent lakes (Gray 1986). According to available ODFW records, rainbow trout were first stocked in 1926. In the years 1926-1935, an average of 320,000 rainbows were stocked annually. Large numbers were stocked in 1939 and 1946. Beginning in 1949 and through 1958, a combination of fry, fingerlings and yearlings were stocked; numbers per year ranged between 16,000 yearlings in 1953 to a combination of sizes totaling 257,000 in 1958. Records from 1954-58 show rainbow trout coming from five different hatcheries including fish of, at least, Oak Springs and Kamloops stocks. In 1959-62, stocking reverted to the use of fry with a range of 250,000 to 802,000 released per year; those releases included Oak Springs stock but the great majority of fish stocked were of Kamloops origin. Stocking was discontinued after 1962 except for 1,000 fingerlings dumped in the lake from an aborted airstock flight in 1977.

Twenty-one thousand sockeye salmon were planted into Odell Lake in 1932. Records do not show whether these fish were from anadromous or kokanee (landlocked) stock.

Stocking of kokanee began in 1950. Between that year and 1971, an average of 260,000 fry were stocked annually, within a range of 70,000 and 600,000. Stocking was discontinued between 1972 and 1980. In the period 1981-83, stocking was resumed in response to poor wild kokanee year-class strength the previous year. In those years, 100,000-200,000 fingerlings at 100 per pound were released annually. Evaluation of this strategy showed poor returns to the angler and stocking was again discontinued. No kokanee have been stocked since that time.

Atlantic salmon were stocked in Odell Lake from 1967 through 1971. A variety of fry, fingerling, yearling and brood-fish releases was made within that period. No more stocking of this species has been done since.

Angling Regulations

The major changes to angling regulations are listed below:

1940 Bag limit for trout 15 pounds plus one fish per day. Area east of line from Chinquapin Point to point on shoreline 200 feet west of outlet closed to angling.

1950 Dolly varden (bull) trout were included in the trout bag limit.

1951 Bag limit for mackinaw 20 inches or over changed to 2 fish per day.

1952 Dolly varden and lake trout counted with regular trout bag limit, only 2 fish over 20 inches.

1981 Bag limit 10 trout over 6 inches, not more than 5 over 12 inches nor more than 2 over 20 inches.

1990 Special kokanee bag limit of 20 kokanee per day, not more than 5 over 12 inches.

1992 Bag limit reduced to 5 trout over 6 inches, but not more than one trout over 20 inches. Closed to the taking of bull trout in lake. Area within 200 feet of the mouth of Trapper Creek closed to angling between September 1 and October 31. Odell Creek closed to the taking of bull trout.

1993 Trapper Creek was closed to angling to protect rearing and spawning bull trout.

Fish Management

Odell Lake has been managed exclusively for wild, self-sustained fish populations since 1986 when the Oregon Fish and Wildlife Commission adopted that policy in the Odell Lake Fish Management Plan in October of that year. That plan will be superseded by this basin plan.

Rainbow trout

Redband trout is one of the species indigenous to Odell Lake. Historical accounts tell of increased numbers of anglers catching many "big fish" including a 6-pound "redside" caught in 1910. In 1913, a fish hatchery was established on Odell Creek near Odell Lake. There was apparently a fish weir built on Odell Creek to capture spawners but many of the eggs were taken a Gold Lake (Salt Creek) and Crescent Lake (Crescent Creek) (Gray 1986). Newcomb (1941) reported rainbow trout to be abundant in surveys done on 1940 at Odell Lake.

Between 1913 and 1962, millions of rainbows, of various stocks, were released there. The original Odell Lake stock of redband trout may have been impacted genetically by the imported releases. In 1948, rainbow trout were reported as "conspicuously absent" from the fishery (OSGC 1948). Survival of hatchery fish was poor and there was little angler interest in the rainbows, so no more were stocked after 1962. The myxosporidean parasite, *Ceratomyxa shasta*, is present in Odell Lake and probably contributed to the poor survival of hatchery reared rainbows.

Spawning stream surveys in 1947 revealed that Odell Creek, the outlet, was the only stream used by spawning rainbow trout (OSGC 1947). A two-way trap operated on Odell Creek in 1948 found there was an interchange of rainbow trout brood stock between Odell and Davis lakes but that Odell Lake's brood stock population was "meager" (OSGC 1948).

There is still a naturally reproducing population of rainbow trout in Odell Lake; their present genetic status is unknown. Rainbows caught in a trapnet near the outlet in fall of 1992 showed two different appearances. There were small dark, distinctly marked fish that appeared typical of what would be found in a small stream contrasted to larger, silver colored fish that were obviously lake-reared fish. There is virtually no recent information on the Odell Lake rainbow trout spawning areas or on their life history.

The genetic status of rainbow trout is not known. Interbreeding with hatchery-reared trout may have occurred and changed the original genetic structure. Genetic samples have not been taken.

In the period 1977-82, less than two percent of the anglers were specifically fishing for rainbow trout. The catch of rainbows averaged 826 per year within that period with the majority of the rainbows being caught incidentally by kokanee anglers. The 1990 survey estimated a catch of 335 rainbow trout. Anecdotal evidence indicates there has been an increases in angler interest in pursuit of rainbows at Odell Lake in recent years. Specimens over 20 inches have been landed.

Bull trout

Bull trout are also indigenous to the Odell Lake drainage. Historical evidence indicates that they were once quite abundant (Gray 1986). In the 1940 survey by OSGC, Dolly Varden (bull trout) were called common in the lake (Newcomb 1941), but their numbers have diminished over the years. The OSGC Annual Report for 1947 stated that "Dolly Varden trout have been depleted in numbers by spawning stream poachers." Like elsewhere, the species was persecuted for many years at Odell Lake; not until 1951 were they included in the regular trout bag limit. Creel survey information from 1977-82 estimated an average catch of 29 bull trout per year. In the 1990 creel survey, only one bull trout was seen in the catch which resulted in an estimated catch of 8 bull trout for the season.

Bull trout have always been a wild stock in Odell Lake; no hatchery fish have ever been released. They rear in the lake to a large size at maturity. Since 1992, eight bull trout have been captured in nets set in mid-October near the outlet, Odell Creek. Mature females in this small sample averaged 24.2 inches in length, within a range of 22-27.6 inches. The lone mature male was 27.6 inches in length; an immature male measured 19.8 inches.

In 1947, "Dolly Varden" were reported as spawning mainly in Crystal Creek and to a lesser extent in Trapper Creek (OSGC 1947). Currently, their only known spawning habitat is in lower Trapper Creek. Crystal Creek still appears to be suitable, but no bull trout have been seen in that stream in recent years. Instream habitat work has been done in Trapper Creek by the USFS to improve cover and passage conditions for bull trout.

Concern about the welfare of this stock of bull trout led to regulations adopted in 1993 prohibiting the take of this species in the drainage. Anglers have been reporting the catch and release of bull trout in numbers greater than expected. Whether this is a response to increased awareness brought about by an educational effort by ODFW and USFS or an indication that there may be more fish than assumed is unknown. There is still some take of bull trout by anglers through ignorance or disregard for the regulations and by mortality from catch and release. This take is thought to be small and educational efforts will continue to minimize it. Proposed trophy regulations for lake trout should help eliminate take of bull trout due to confusion with lake trout.

The interagency Odell Lake Bull Trout Working Group is developing a recovery plan for bull trout in the Odell and Davis lakes subbasin.

Kokanee

Kokanee are the main attraction to anglers at Odell Lake. From 1965-1982, an average of 92,500 angler-hours were expended for kokanee each year. Angler effort peaked in the 1960's and early 1970's when an average of 58,000 kokanee were harvested each year at a catch rate of 0.53 fish per hour. The fishery fell off to an average harvest of less than 13,000 fish between 1975 and 1982 when the catch rate was 0.32 fish per hour. The last creel survey in 1990 estimated a catch of 17,755 kokanee in 79,900 angler-hours for a catch rate of 0.24 fish/hour.

The highest catch on record was 93,000 kokanee in 1972 and the lowest was 4,440 in 1982. Recent observation of the fishery indicate that effort and catches have likely rivaled some of the highest on record. At times, the capacity of facilities has been saturated and may be the factor limiting the fishery.

There has been speculation that Odell Lake had a wild stock of kokanee but they are not listed as a provisional wild fish population (ODFW 1992) and ODFW does not believe they are indigenous.

Kokanee (sockeye) were first stocked in 1931 but not again until 1950. OSGC found "landlocked blueback salmon" (kokanee) to be common in 1940 (Newcomb 1941). Kokanee were spawning almost exclusively in Crystal Creek in 1947 (OSGC 1947). Kokanee stocking was done annually from 1950-71. Natural production was confirmed in 1962 when kokanee fry were captured in the lake. It was subsequently determined that the hatchery fish were contributing only 12% of the catch, on average, so stocking was discontinued. OSGC research staff developed techniques for estimating kokanee year-class strength by mid-water trawling. It was theorized that hatchery fingerlings stocked the following year could be used to off-set weak, wild year-classes because the hatchery fish typically mature a year earlier than wild kokanee. Following that strategy, kokanee fingerlings were released in 1981-83. Evaluation of that practice showed that the hatchery fish did not survive any better than the wild stock. Accordingly, the hatchery fish made poor contributions to the angler catch and, once again, stocking was discontinued in favor of natural production.

The major kokanee spawning site has been the Shelter Cove area where springs well up through shoreline gravels. In recent years, large numbers of spawners have been using Trapper and Crystal creeks as well as other, smaller shoreline areas and tributaries. Spawning also occurs in the outlet, Odell Creek, in some years. The number of kokanee that escape the fishery to spawn has been large enough to seed the lake, even in years of low populations. This is a result of the self-regulating nature of the anglers. When the kokanee population is high, angling success is usually good and angler numbers increase, but when the population is low, anglers quickly lose interest, thereby leaving a greater percentage of the population to spawn.

Productivity in Odell Lake is variable year to year and the availability of food for emerging fry may determine the number of kokanee that survive their first year. After kokanee have survived their first year, the rate of mortality decreases. The number of fish left in the population influences the size of the fish. Large numbers of fish cause the size of the fish to be smaller and vice versa (Lindsay and Lewis 1978). Within the years 1959-1994, the fork-length of maturing female kokanee averaged 13.4 inches within a range of 9.7 and 18.4 inches. Between 1985 and 1994, that average was 11.8 inches.

The special bag limit of 20 kokanee, but not more than 5 over 12 inches, was implemented in 1991 to allow for additional harvest of fish in the years of high abundance. That strategy is functional but it is probably not necessary to limit the take of fish over 12 inches because of the self-regulating nature of the fishery described above. In years when maturing fish have lengths averaging near 12 inches, the over-12 regulation causes confusion and frustration among the anglers and undoubtedly leads to significant "over-bag" and mortality of released fish.

Lake trout

Lake trout, often called Mackinaw, were introduced to Odell Lake in the early 1900's but their status was called "rare" during the OSGC survey in 1940 (Newcomb 1941). Stocking of hatchery reared yearlings was done annually between 1951 and 1965 but none have been released since then.

The catch of hatchery reared lake trout peaked in 1970 when 76% was of hatchery origin. By 1980, the catch of hatchery fish had fallen to 1% reflecting the decline of those fish as a proportion of the population despite their ability to be long-lived. In the fall of 1992, a left ventral fin-clipped male, 33 inches in length, was caught in a trapnet. That fish had been released as an 8-inch yearling in 1963, making its known age 30+ years. The Oregon state record lake trout was caught from Odell Lake in 1984; that fish was 45.5 inches long and weighed 40.5 pounds. It was unmarked and presumably from natural production.

Within the period 1967-1982, an average of 1,414 anglers caught 750 lake trout from Odell Lake each year. Angler numbers ranged from 427 in 1978 to 2,979 in 1982. The catch was lowest in 1980 when 331 fish were taken to a high of 1,408 in 1982. Lake trout anglers fished an average of 12 hours (0.08 fish per hour) to catch a fish during the years 1977-1982. Estimates made in 1990 were of 1,416 lake trout anglers taking 403 lake trout at an average rate of 0.06 fish/hour.

Lake trout measured during the 1980 and 1981 creel surveys averaged 23 inches in length within a range of 16 to 38 inches. Creel data collected in 1990, showed the average lake trout in the catch was 20 inches and between 17 and 33 inches. Information was volunteered by anglers reporting catches at Shelter Cove Marina in 1992-1994. That data determined the average length of lake trout in their catches to be about 29 inches. This information is probably biased toward larger fish because anglers are more likely to report the larger fish and many lake trout anglers release "smaller" fish.

The availability of hydro-acoustic equipment, "fish-finders", in recent years has made it easier for anglers to locate and catch lake trout. Those anglers typically troll large lures or jig in deep water areas where lake trout reside during the summer months.

Lake trout normally mature at age 6 or 7 years at a length of about 22 inches. Mature lake trout were measured during egg-take operations in 1953-1956 and 1962. Females averaged 29 inches in length within a range of 22-40 inches. Males ran between 22 and 31 inches and averaged 26 inches. Forty fish sampled in fall net sets of 1992-1994 confirmed the previous data.

Because of increased angler pressure and greater catches of lake trout, the bag limit was reduced in 1991 to allow only one fish over 20 inches to be taken per day. Continued concern over the viability of the wild population has stimulated consideration of additional regulatory restrictions on the take of lake trout. Larger minimum length limits would conserve maturing fish until they had the opportunity to spawn one or more times, thereby enhancing the spawning escapement. Table 46 displays the proportions of lake trout, from net-caught spawner groups and angler catches, that would be protected with 24, 26, and 30 inch minimum length limits.

Table 46. Percentages of net sampled spawner groups and angler caught lake trout that would be protected by potential alternative minimum length limits.

Source	24 inch minimum	26 inch minimum	30 inch minimum
-Mature lake trout caught in nets, 1953-56, n=157	31	55	87
-Mature lake trout caught in nets 1992-94, n=40	78	83	93
-Lake trout in angler catch, 1980-81 creel survey, n=119	61	73	89
-Lake trout in 1992-94 volunteer angler logs, n=169	30	33	54

If the net-caught samples of mature lake trout are truly representative of the populations in 1953-56 and in 1992-94, it appears that smaller fish make up a higher percentage of the population recently than they did in the 1950's. This could be an indication of greater exploitation of larger lake trout in more recent years. That conclusion gives more weight to the need to protect larger spawners, particularly if trophy management is the chosen alternative for that species.

The alternative to protecting wild spawners is the return to stocking with hatchery reared fish; but that strategy has some serious obstacles. Oregon has no hatchery stock of lake trout. All previous stocks of record were from various Canadian sources; the best return to the angler from those stocks was less than 1%. Egg takes were made from Odell Lake fish during the late 1950's; that was a difficult and time consuming process. Once the eggs were collected and hatched, the hatchery rearing of lake trout was very difficult and expensive. They were very sensitive and had a high rate of mortality in the hatchery.

The feeding habits of lake trout have been of some concern to people fearful of what they may do to the production of kokanee, and more recently, bull trout. Table 47 shows the results of examination of stomachs from angler-caught lake trout from 1955-1961 (Gerlach 1967). Small lake trout feed primarily on insects. Once they begin to feed on fish, they target whitefish and tui chubs. Kokanee appeared in the samples no more frequently than small lake trout and no bull trout were identified in those stomachs even though their numbers were apparently more numerous in the late 1950's than now.

Table 47. Occurrence of food items in 149 stomachs from angler caught lake trout in Odell Lake, 1955-1961.

Food item	Number of stomachs	Percent frequency
Whitefish	56	37.5
Insects	43	28.5

Table 47. Continued

Unidentified, fish remains	42	28.0
Tui chub	27	18.0
Rainbow trout	4	2.7
Lake trout	2	1.3
Kokanee	2	1.3
Freshwater shrimp	1	0.7

Whitefish

Whitefish are another species indigenous to Odell Lake. They enjoy successful natural production and are numerous in the overall fish population. They attain sizes up to 20 inches in length although most of the angler-caught fish are 8-12 inches long. A few anglers do fish specifically for this species. In the creel surveys of 1977-82, the average catch was 286 whitefish per year. They could sustain a much greater exploitation. There is no bag limit on whitefish but the level of angler interest is low. Whitefish are the most important forage fish for lake trout; the same is probably true for bull and rainbow trout.

Spawning habitat for whitefish has not been documented recently. An earlier report described spawning whitefish using all inlet streams, but were particularly abundant in Trapper Creek. Habitat protection needed for the trout species will benefit whitefish as well.

Tui chub

Tui chubs are common on the shoal areas of the lake and are another important prey species. In the 1950-60's, efforts were made to control their numbers because of their competition with game fish. Since then it has been concluded that they do not pose a major problem. The small proportion of shoals in the lake limits their spawning and rearing area and, therefore, their production. Their numbers are further controlled by trout predation.

Management Issues

1. The indigenous isolated population of bull trout in Odell Lake is apparently well below the 300 spawner threshold required in the Wild Fish Policy and, therefore, is not in compliance. No definitive population estimate is available.
2. Odell Lake bull trout are likely aligned genetically with Columbia Basin stocks, but their genetic identity has not been determined.
3. Even though the take of bull trout is illegal, some mortality may occur as a result of incidental catch in pursuit of other species, either from catch and release or illegal take due to improper identification or disregard for the regulations.
4. Redband trout are/were indigenous to Odell Lake but millions of hatchery-reared rainbows of various stocks have been released there; the genetic origin of the naturally reproducing rainbow trout currently in Odell Lake is unknown.

MANAGEMENT DIRECTION

ODELL LAKE AND TRIBUTARIES

POLICIES

Policy 1. No hatchery fish will be stocked in Odell Lake or its tributaries.

Policy 2. Mountain whitefish, kokanee and rainbow trout will be managed for natural production consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 3. Lake trout will be managed for natural production consistent with the Trophy Fish Management Alternative for trout (ODFW 1987).

Policy 4. Bull trout will be managed for natural production consistent with the Wild Fish Management Alternative for trout (ODFW 1987).

OBJECTIVES

Objective 1. Maintain the genetic diversity, adaptiveness and abundance of wild bull trout in Odell Lake.

Assumptions and Rationale

1. The current level of bull trout abundance in Odell Lake is unknown, but likely very depressed and not in compliance with Wild Fish Management Policy.

2. Population levels are not adequate to support a consumptive sport fishery on bull trout. A non-consumptive fishery will remove some bull trout from the population through hooking mortality.

3. Presently, bull trout are only known to spawn in Trapper Creek.

4. Monitoring abundance, size, and distribution of bull trout in Trapper Creek and Odell Lake will provide an indication of their population status.

5. Bull trout may be mis-identified by anglers as lake trout.

6. A trophy fishery on lake trout (30-inch minimum length) will indirectly benefit bull trout if anglers mis-identify bull trout for lake trout.

ACTIONS

Action 1.1 Work with the Odell Lake Bull Trout Working Group in the development of a bull trout recovery plan for Odell Lake and tributaries. Identify and delineate critical spawning and early-rearing habitat and conduct an analysis of the factors limiting the abundance and distribution of bull trout.

Objective 2. Maintain genetic diversity, adaptiveness and abundance of mountain whitefish, kokanee and rainbow trout in Odell Lake while providing consumptive fisheries on these species.

Assumptions and Rationale

1. Odell Lake supports abundant and healthy populations of wild mountain whitefish, rainbow trout and introduced kokanee.

2. Factors controlling natural production of rainbow trout in Odell Lake are largely unknown, but production may be limited by lack of spawning and early rearing habitat.

3. Definitive reasons for changes in year-class abundance of kokanee are unknown but likely vary with natural productivity of the lake. In years of higher productivity, juvenile kokanee survival is enhanced and that year-class is more abundant when it enters the fishery, and vice versa.

4. The average size of kokanee decreases during years of large populations. The opposite occurs in years of low abundance.

5. Catch rates of 0.4 kokanee per hour provides an adequate fishery; this may be expected on year-classes from average or better lake productivity.

6. Population levels of mountain whitefish are adequate to support and increased sport fishery.

ACTIONS

Action 2.1 Conduct life history studies of rainbow trout in Odell Lake and tributaries to identify and document their spawning and rearing areas.

Action 2.2 Collect genetic samples of rainbow trout and have them analyzed to determine the origin of this population.

Action 2.3 Monitor relative abundance and length distribution of Odell Lake kokanee, rainbow trout and whitefish by conducting periodic statistical creel surveys and through annual trapnet inventory.

Objective 3. Provide a trophy fishery for naturally-produced lake trout.

Assumptions and Rationale

1. Odell Lake has historically produced large trophy-sized lake trout, including the state record.

2. There is strong public interest in angling for these large, trophy-sized lake trout.

3. Providing adequate spawning escapement through restrictive angling regulations is more practical than attempting to supplement natural production with hatchery-reared releases.

4. Restricting harvest to fish greater than 30 inches in length will allow lake trout to spawn more than once prior to harvest and will increase the abundance of large fish in the population for a trophy fishery.

ACTIONS

Action 3.1 Monitor abundance and length distribution of Odell Lake lake trout through trapnet inventory of mature lake trout.

Action 3.2 Investigate the feasibility of inventorying lake trout population abundance through hydroacoustic sampling.

Action 3.4 Implement daily bag and length limits of not more than one lake trout with a minimum length of 30 inches.

Objective 4. Protect and improve trout an whitefish habitat in Odell Lake and tributaries.

Assumptions and Rationale

1. Kokanee, lake trout, rainbow trout and whitefish spawning habitats in Odell Lake and tributaries are currently adequate to sustain natural production.

2. Location and abundance of rainbow trout and whitefish spawning habitat is currently unknown.

3. Habitat factors limiting the production of bull trout are not known.

4. The small berm at the head of Odell Creek that maintains a higher lake water level to facilitate moorage at the resorts is not a significant habitat problem.

ACTIONS

Action 4.1 Locate rainbow trout and whitefish spawning habitats.

Action 4.2 Coordinate with USFS to implement protective measures for rainbow, bull, and lake trout, kokanee and whitefish spawning and rearing habitats.

CENTURY DRIVE LAKES
CONNECTED TO THE DESCHUTES RIVER

LAVA, LITTLE LAVA, CULTUS, AND LITTLE CULTUS LAKES

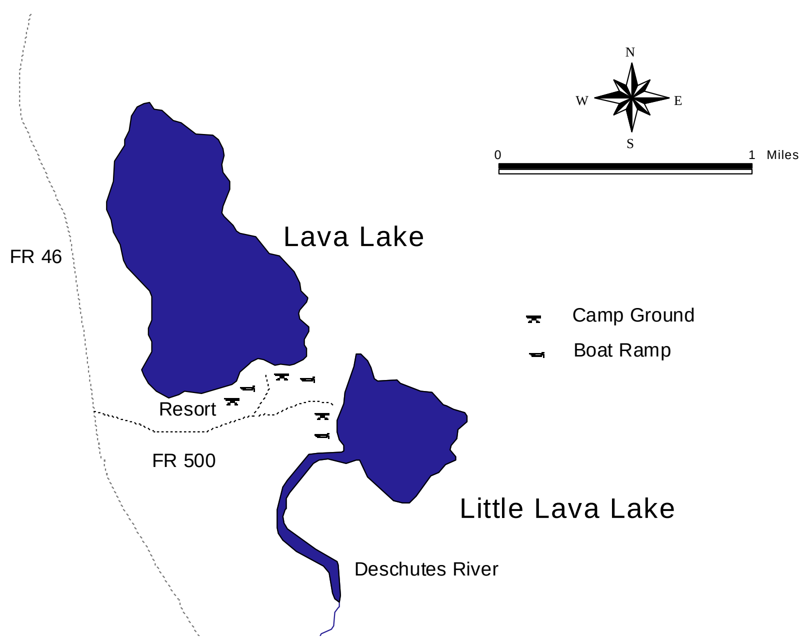
Overview

The following four lakes were separated from the other Century Drive lakes (Elk, Sparks, Hosmer, North Twin, South Twin, and Devils lakes) because they have permanent or ephemeral connections with the Deschutes River. These connections are significant and the lakes are dealt with collectively because fish populations within the lakes are sub-populations of the larger metapopulation using Crane Prairie Reservoir as the common link. Implications for fish management are the potential of released hatchery fish to move into any of the connecting water bodies which may contain wild fish.

LAVA LAKE

Location and Ownership

Lava Lake is located approximately 32 miles southwest of Bend and five miles southwest of Mt. Bachelor. Land ownership around Lava Lake is entirely



U.S. Forest Service, Deschutes National Forest. A small portion of the lake is under long term lease to the owners of Lava Lake Resort who operate the resort, an adjacent private RV campground, and offer boat rentals. There is also a public Forest Service boat ramp and campground at the lake.

Access to Lava Lake is via FR 46 (Cascade Lakes Highway) from Bend or several other secondary connections from Highway 97 south of Bend. Other roads connecting Hwy 97 and FR 46 are FR 40 (Spring River Road) near Sunriver, FR 42 (Fall River Road) and FR 43 (Burgess Road). The lake itself is approximately 1 mile east of FR 46

Habitat and Habitat Limitations

Lava Lake lies at an elevation of 4,740 feet and has a surface area of 341 acres and 3.4 miles of shoreline (Johnson et al. 1985). Depths average 20 feet with a maximum of 34 feet. The total drainage area of Lava Lake is 8 square miles.

Lava lake was formed as a result of volcanic activity and subsequent lava flows creating a dam along its east shoreline. Lava derived its name from these flows. Lava Lake is relatively old as evidenced by the extensive vegetation occurring in the shallow areas. Rushes, waterlilies and other emergent plants are especially evident on the west and northern perimeter. Another indication of the lake's aging is the 4 to 5 feet deep layer of muck located on the lake bottom as reported by divers.

Subsurface springs provide the primary inflow to Lava Lake. The springs are located in the northeast corner of the lake at a depth of 20 to 30 feet. Water temperatures from the inflow vary between 45^{o}F to 60^{o}F. There are no permanent surface streams entering the lake, however, intermittent seeps do enter the lake from Wire Meadow. Lava Lake connects with Little Lava Lake only occasionally during periods of spring high water. The outlet channel is located in the southeast corner of the lake. Water level fluctuates an average of approximately 2.5 feet annually with maximum pool occurring in late summer. Timing of the peak pool level is consistent with flow levels typical of springs in the area.

Water temperatures in Lava Lake often reach the high 60's in mid to late summer. Development of a thermocline is common in summer months and generally forms from 15 to 30 feet. During winter, the lake freezes over.

Water quality is good in Lava Lake. Phosphorous levels are uncommonly high (0.53 mg/l) for the Cascade lakes and contributes to abundant algae growth during summer months. The actual source of the phosphorous is unknown but speculated to come in naturally from springs. Oxygen levels are good through most of the year and average 8.5 ppm (Johnson et al.1985), however, when the thermocline exists, water in the hypolimnion has substantially reduced oxygen levels. Early ODFW surveys (Newcomb 1941) noted oxygen levels of 0.6 ppm below the thermocline. In these instances oxygen level is unsuitable for trout and likely restricts their distribution. Johnson et.al (1985) notes that pH levels in Lava Lake average 7.5 and classifies the lake as oligotrophic.

Lava Lake has abundant vegetation. The surrounding forest is predominantly lodgepole and ponderosa pine. There is also current, serviceberry, and bluegrass. Bulrush and waterlily are common semiaquatics around the lake perimeter. Aquatic submergent plants include *Ceratophyllum* (coontail), *Potomageton* (pondweed), and *Elodea*.

Bottom samples were collected by ODFW in 1962 to determine organisms present and results showed a composition of 60% Diptera (true flies), 28% Annelids (worms), and 8% Hirudinea (leeches). Also identified were members of the mayfly and caddisfly families. The total organisms present were quantified at 11.5 pounds per acre, but not given as to dry or wet weight (Smith et al. 1962). This figure is quite low when compared to 102 and 173 pounds per acre for nearby Crane Prairie Reservoir and Davis Lake.

Fish Stocking History

The first known record of rainbow trout stocking is 1935 when approximately 75,000 fingerlings were liberated (Newcomb 1941). This level of stocking continued through 1940 and was discontinued. Stocking of rainbow trout resumed in 1970 and continues to the present. Numbers of fish liberated have ranged from 10,000 to the current allocation of 100,000 annually. These rainbow trout have been from Wizard Falls, Oak Springs, Fall River, and Klamath hatcheries. In recent years, we have been releasing 75,000 Oak Springs rainbow (lot 53) and 25,000 Klamath rainbow (lot 28). Lot 28 rainbow trout have been stocked since 1992. Rainbow trout are stocked as fingerlings and have averaged 40/lb the last two years.

Brook trout were introduced into Lava Lake sometime prior to 1932 as evidenced by the Deschutes County Lake Survey completed in that year (USDA 1932). ODFW records since 1940 show up to 250,000 fish stocked annually through the 1950's and early 60's. Since that time, releases dropped to 150,000 annually through the 1970's and then gradually decreased to the present allocation of 25,000 fingerlings annually.

Other fish stocked into Lava Lake include silver salmon and steelhead in the 1930's. Success or return from these fish is unknown.

Angling Regulations

Lava Lake has had its season changed often during the early part of this century. The changes were minor shifts in opening and closing of the season. Substantive changes are listed below.

1937- Special bag limit for lakes established, lowered to 15 lbs plus one fish not to exceed 15 fish per day.

1945- Special bag limit of 10 fish not to exceed 15 lbs plus one fish in Lava Lake.

1947- Bag limit reduced to 5 fish not to exceed 15 lbs plus one fish Lava Lake.

1950- Closed to angling in Lava Lake.

1980- General bag limits for streams and lakes/ponds/reservoirs adopted: 10 trout per day, not more that 5 over 12", not more than 2 over 20" for lakes; 5 trout per day for streams.

1990- Lava Lake 5 trout per day, only 1 trout over 20 inches.

Lava Lake is currently open for fishing from April 27th to October 31st. The bag limit is 5 trout per day, no more than 1 fish over 20 inches.

Fish Management

Lava Lake is currently managed as a basic yield fishery that allows a harvest of 5 fish per day with no gear restrictions.

Fish species indigenous to Lava Lake were bull trout, redband trout and whitefish. The current fish population is composed of introduced brook and rainbow trout, whitefish, and illegally introduced tui chub.

Lava Lake has received complete chemical treatments on several occasions to eliminate prolific tui chub populations. However, these treatments were unsuccessful in complete removal of chubs because of underwater springs which permitted some chub survival. The first treatment occurred in 1941 followed by treatments in 1946, 1949, 1963, and 1980. Numerous spot treatments of chub populations have also occurred.

Bull trout were originally documented in Lava Lake in an USFS survey dated June 16, 1932. They were called Dolly varden. The survey does not quantify numbers or size of fish found. Fish were apparently in very low number or absent by 1941 as no bull trout were captured in nets set that year (Newcomb 1941). It is unlikely bull trout were ever present in great numbers due to lack of spawning areas, marginal water temperatures (for bull trout), and lack of regular connection with Little Lava Lake. Their disappearance was likely due to a combination of early chemical treatments and angler harvest without subsequent recolonization from downstream sources.

Redband trout were identified in the 1932 USFS survey, again no abundance figures were provided. As with bull trout, it is likely all indigenous fish were eliminated with the original treatment in 1941. Redband could have recolonized the lake following treatment, but records do not indicate they did. Presumably, all rainbow in the lake have been of hatchery origin since that time.

In recent years, stocked rainbow trout have been predominantly Oak Springs stock (lot 53). Recent analysis in January 1996 has shown these fish compete poorly in presence of the tui chub. Table 48 shows dramatic increases in catch per angler, fish per hour, and condition factor following treatment in 1980.

Table 48. Lava Lake creel census and condition factor, 1978-1987.

	Creel census		Condition factor	
Year	Fish/ang.	Fish/hr.	Rainbow	Brook
1978	1.00	0.26	1.37	1.27
1979	no creel		1.14	1.11
1980	lake treated in September		1.15	1.16
1982	0.94	0.29	no inventory	
1983	0.83	0.26	1.20	1.16
1984	1.07	0.33	none collected	
1985	3.98	0.84	1.28	1.18
1986	4.79	1.07	1.27	1.08
1987	2.33	0.91	no inventory	

Creel census collected in 1995 showed an average catch of 0.37 rainbow per hour and 1.28 rainbow per angler. The average fishermen angled 3.4 hours a day. Fish harvested ranged from 9 to 15 inches in length, with 75% of the fish between 10 and 12 inches.

Since 1992, we have stocked 25 to 30,000 Klamath rainbow trout (lot 28) annually into Lava Lake, all fish were marked with an adipose fin clip. These fish were introduced in an attempt to find a rainbow stock that compete successfully and/or utilize the tui chub. This particular stock was selected because it naturally coexists with the tui chub in Klamath Lake and utilizes them as a food source. Monitoring of these fish has not produced results that clearly indicate this stocks' success in Lava Lake.

One of the limitations has been a poor return to the creel by traditional angling techniques used at Lava Lake. Still fishing with bait is the normal angling method used at Lava Lake. The Klamath rainbow is mainly captured on lures or flies that match natural prey items. Most creel reports on these fish are qualitative and come from fly anglers who speak highly of this stock of fish. A trapnet set collected in 1995 captured only 1 Klamath rainbow out of 126 total rainbow trout. No Klamath rainbow trout were observed in the creel that year.

Size distribution of rainbow trout caught in the 1995 trapnet set are shown in Figure 24. Samples indicate growth in one year has been marginal. Most fish captured were between 8.5 and 9.5 inches with carryover fish near 12 inches. Poor growth of lot 53 rainbow trout in Lava Lake is consistent with observations in a number of other water bodies where this stock is being used and competition from chubs is present.

Brook trout were the mainstay of the fishery at Lava Lake for many years. Their drawback was that return to the creel was poor during mid summer months when water temperatures increase and brook trout move into vegetation. Rainbow trout, however, remained active and returned to the creel throughout the summers so the rainbow trout stocking program was reinstated in 1970. The current annual allocation for brook trout is 25,000 fingerlings.

A trapnet set in 1995 captured 21 brook trout with an average length of 9.2 inches. Size of these fish has declined compared with samples collected during similar time periods in the

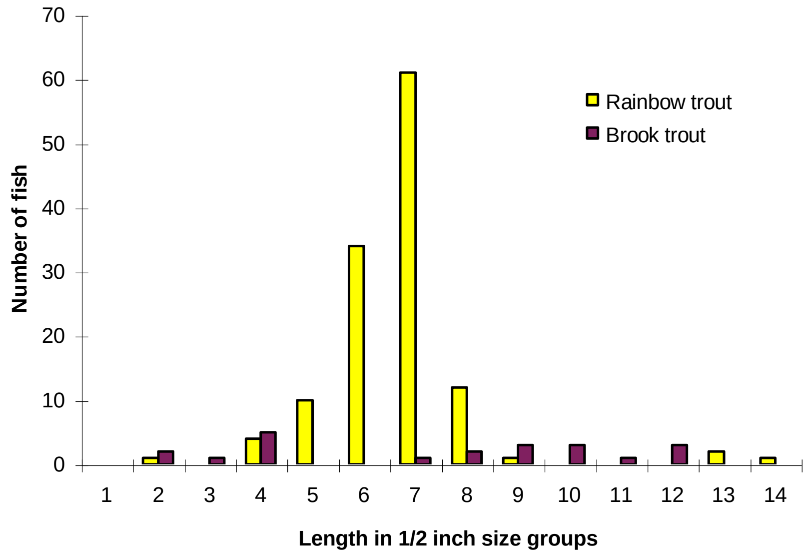


Figure 24. Rainbow and brook trout size distribution in a Lava Lake trapnet set, May, 1995.

1970's. Trapnet catches in May during the 1970's showed fish reaching 16 to 18 inch size classes that are not currently represented. This size decrease may be similar to the problems encountered with the lot 53 rainbow. Recently, the hatchery program has started utilizing brook stock naturally-reared at Hosmer Lake. Results using the new stock have not yet been determined, but should be known in the next few years.

At the present time, whitefish have not recolonized Lava Lake since the lake was treated in 1980. A series of low water years in the 1980's and 1990's has kept the overflow channel dry between Lava and Little Lava lakes. There is also a weir in the channel built by the Department in the 1960's to prevent reintroduction of tui chub. This weir has probably been somewhat effective in preventing upstream movement of all fish, including whitefish.

Tui chub were introduced into Lava Lake early in the century probably by anglers using them as live bait for trout. Their prolific nature has allowed them to dominate the fish biomass and successfully compete with the trout for food and space. Chub control has been an ongoing task since the early treatment in 1941. Complete treatments have been hampered by the presence of spring areas in the lake. Chubs apparently seek refuge in the springs during treatment and consequently complete kills have not been accomplished.

The resort owner has been very committed to spot treatments and trapping of roach to reduce their numbers. During June and July each year, the resort owner has fished up to three trapnets concurrently since 1987. These live nets are checked daily to remove the chubs and release any trout. Trapnet catches have ranged from 3,000 to 26,000 pounds annually.

A second method employed with ODFW assistance has been a 270 foot containment net. Spawning adult chub are surrounded with the net and then treated with a small quantity (< 2 gallons) rotenone. This method has been highly successful, but requires monitoring the chub population on a daily basis to determine time, location, and concentration of spawning chubs.

The third method the resort owner has used is a beach seine to capture fry and fingerlings. Fry and fingerling chub form dense schools along the shoreline in shallow water, typically near emergent vegetation. The best results were in 1989 when an estimated 6,000+ pounds of juvenile chubs were captured. This effort by the resort owner has been a definite benefit to the trout population and their condition.

Management Issues

The management issues in Lava Lake include:

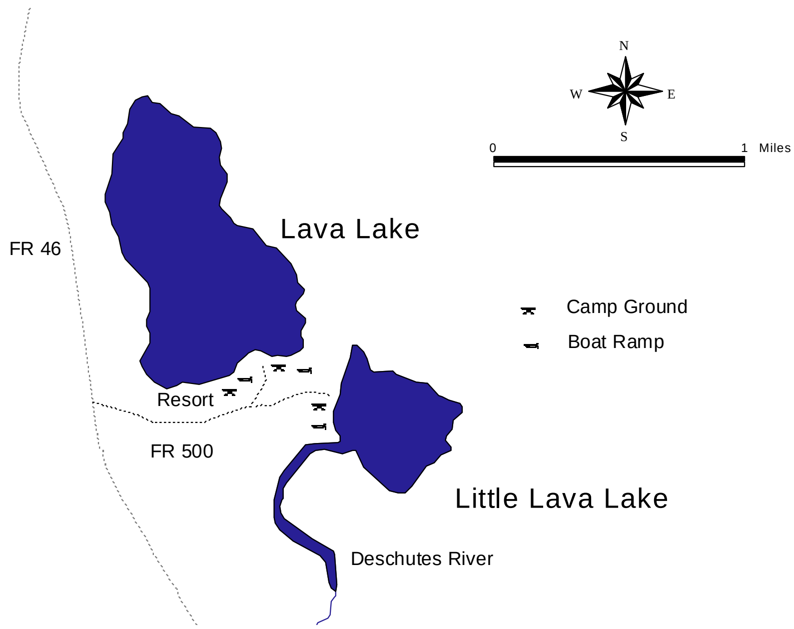
1. Indigenous fish have been eradicated by past chemical treatment projects to control tui chub.
2. No natural spawning habitat, so stocking is necessary to have a fishery.
3. Fish stocked in this lake may leave the lake and migrate downstream and interbreed with rainbow trout in the Deschutes above Crane Prairie.
4. Tui chub are present and in the past have severely impacted hatchery programs during certain years of high abundance
5. Historic stocking of brook trout has not contributed well to a fishery. There is no natural production of brook trout.

LITTLE LAVA LAKE

Location and Ownership

Little Lava Lake is considered the source of the Deschutes River. It is located approximately 1/4 mile southeast of Lava Lake. Two volcanic peaks, Broken Top and South Sister are prominent on the skyline to the north. Little Lava is located approximately 32 miles southwest of Bend and five miles southwest of Mt. Bachelor. Land ownership around the lake is entirely U.S. Forest Service, Deschutes National Forest. There is a Forest Service boat ramp and campground at the lake. Little Lava Lake does not receive as much recreational use as Lava Lake and angling use is relatively light in comparison.

Primary access to Little Lava is via FR 46 (Cascade Lakes Highway) from Bend. Secondary connections from Highway 97 south of Bend include FR 46 are FR 40 (Spring River Road) near Sunriver, FR 42 (Fall River Road) and FR 43 (Burgess Road). The lake itself is approximately 1 mile east of FR 46.



Habitat and Habitat Limitations

Elevation at Little Lava Lake is 4,739 feet. The drainage area is 18 square miles. The lake surface area is 100 acres and depth averages 8 feet with a maximum of 18 feet (Johnson et al. 1985).

Substrate in Little Lava Lake varies from detritus to bedrock with the major portion consisting of thick detrital muck.

Forest cover around Little Lava Lake is composed mainly of lodgepole pine, with little understory vegetation. The lake is relatively "old" as evidenced by the marshy areas around the shoreline. A large wetland area is located on the east shore. Most of the shoreline abounds with emergent vegetation such as rushes and other emergent macrophytes. Aquatic vegetation includes *Ceratophyllum, Potomageton,* and *Elodea*.

Water in Little Lava Lake is supplied by various subsurface springs and in extremely wet years, there is a surface connection with Lava Lake through an open channel. Surveys by Smith and Putnam (1962) indicate that most subsurface flow enters through the lava flows located on the north side of the lake at an average temperature of 45^{o}F.

The Deschutes River is the outlet of Little Lava Lake. In dry years such as the early 1990's, surface outflow occurred only during high flows in the early spring months. The rest of the year water flow from the lake to Deschutes River is subsurface (Figure 25). Annual water level fluctuation in Little Lava Lake averages about 2 feet.

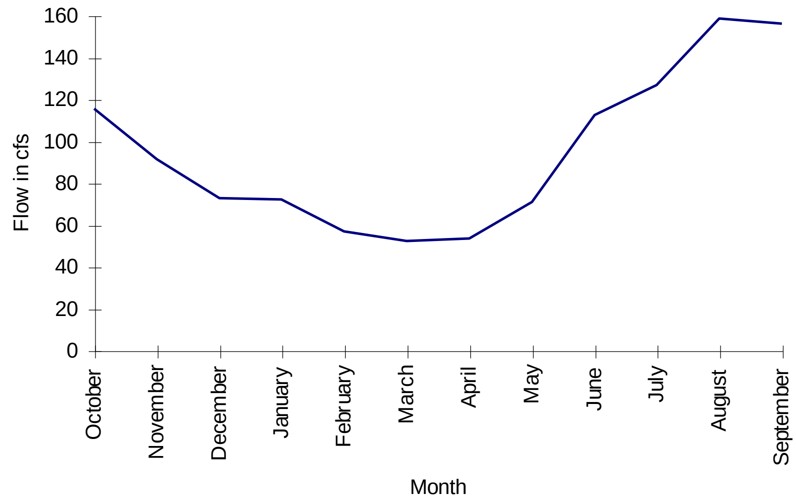


Figure 25. Average monthly flow in the Deschutes River above Snow Creek, 1923-25. Note: the data string is small and a diversion (Crater Creek Canal) within the basin drained water to Tumalo Creek.

Newcomb (1941) found that the water column below 15 feet was unsuitable for trout because of insufficient oxygen. No other dissolved oxygen or temperature problems are known to exist.

Food production for trout in Little Lava Lake is relatively low in terms of benthic organisms produced per acre. Smith and Putnam (1962) calculated bottom food production at 9.97 pounds per acre. They did note there was a wide variety of organisms. Diptera were the most abundant insect group found followed by annelids and amphipods.

Fish Stocking History

The first reported fish stocking in Little Lava Lake was the liberation of rainbow trout fingerlings in 1932, quantity unknown (Newcomb 1941). The next releases occurred in 1935 when 175,000 rainbow fingerlings were planted followed by 250,000 in 1936, and 50,266 in 1939 (Newcomb 1941). After 1939, no releases were made until 1950. Brook trout were first introduced to the lake in 1954 with a planting of 2,700, size unknown.

Since 1954, rainbow trout and brook trout have been released in most years. Numbers of fish have ranged up to 20,000 fingerlings annually for each species. Trout for Little Lava Lake are reared at Fall River and Wizard Falls hatcheries. The current allocation is for 10,000 rainbow trout (lot 53) fingerlings reared at Wizard Falls Hatchery. Brook trout have not been stocked in the last 3 years.

Angling Regulations

Angling regulations in Little Lava Lake have followed a similar pattern as in Lava Lake. Early in the century there were many changes to the season length but it is now the same as the general trout season (April 27 - October 31). Bag limits have gone down over the years as fishing pressure has increased. The bag limit in now 5 trout per day, only 1 over 20 inches. Major changes are listed below.

1932- Bag limit in lakes and tributaries in Deschutes County is 15 lbs plus one fish not to exceed 25 fish per day.

1933- Bag limit 15 lbs plus one fish not to exceed 20 fish per day.

1937- Special bag limit for lakes established, 15 lbs plus one fish not to exceed 15 fish per day.

1938- Closed to angling.

1945- Special bag limit of 10 fish not to exceed 15 lbs plus one fish.

1947- Bag limit reduced to 5 fish not to exceed 15 lbs plus one fish.

1980- General bag limits for streams and lakes/ponds/reservoirs adopted: 10 trout per day, not more that 5 over 12", not more than 2 over 20" for lakes; 5 trout per day for streams.

1990- Bag limit dropped to 5 trout per day, only 1 trout over 20 inches.

Fish Management

Indigenous species included redband and bull trout, and mountain whitefish. Fish species currently present in Little Lava Lake include introduced rainbow and brook trout, whitefish, and tui chub. The current status of redband trout in Little Lava Lake is unknown. A magazine article published in the Oregon Sportsman (Johnson 1914) noted that Little Lava Lake swarmed with redsides (indigenous rainbow trout) in 1913. By 1941 (Newcomb) tui chub were the dominant fish species present. That survey noted that only tui chub and whitefish were captured in two gill nets.

A trapnet set in 1995 captured 101 total trout comprised of 84% rainbow trout and 16% brook trout. Rainbow trout size distribution ranged from 8 to 14 inches (Figure 26) with an average length of 10.8 inches. Female rainbow trout captured by gillnet in 1994 were found maturing at an average length of 11.8 inches. Their condition factor was fair averaging 1.19.

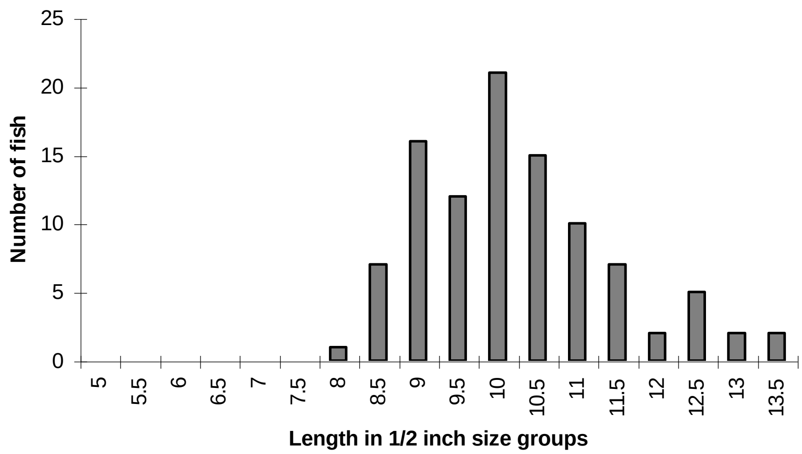


Figure 26. Rainbow trout size distribution in a Little Lava Lake trapnet set, May, 1995.

Little Lava Lake is currently stocked with fingerling rainbow trout (lot 53). Fish spawned naturally in the upper Deschutes River between Crane Prairie Reservoir and Little Lava have the potential to move into the lake during periods when live flow exists between the lake and the river. The magnitude of fish movement between the two waters is unknown. Hatchery rainbow trout are released unmarked which prevents determination of hatchery and wild fish contribution to the lake.

Brook trout have not been stocked in Little Lava Lake for the last three years. Consequently, younger age brook trout in the lake are presumed to be from natural production. The degree of spawning around the lake shore is unknown. However, brook trout do reproduce in the Deschutes River and could easily move into the lake. Gillnetting in 1994 (Figure 27) found brook trout ranging from 5.5 to 15 inches in length with most fish between 7 and 10 inches. Average length was 9 inches with a condition factor of 1.23. Female brook trout were found to be maturing at an average length of 9.25 inches.

Whitefish are present in Little Lava Lake, however, they are not presently abundant. All are naturally produced and presumably move into the lake from the Deschutes River. Sampling with gillnets in 1995 produced 8 whitefish from 7.5 to 11 inches in length. Smaller size classes are difficult to capture with the sample method used.

Tui chub are the most abundant fish in Little Lava Lake both in abundance and biomass. In the 1995 trapnet sample, tui chub were not quantified, but at least several thousand fish were captured. The chubs reproduce naturally in the lake and are quite successful. Tui chub may have substantial impact on trout production in Little Lava Lake.

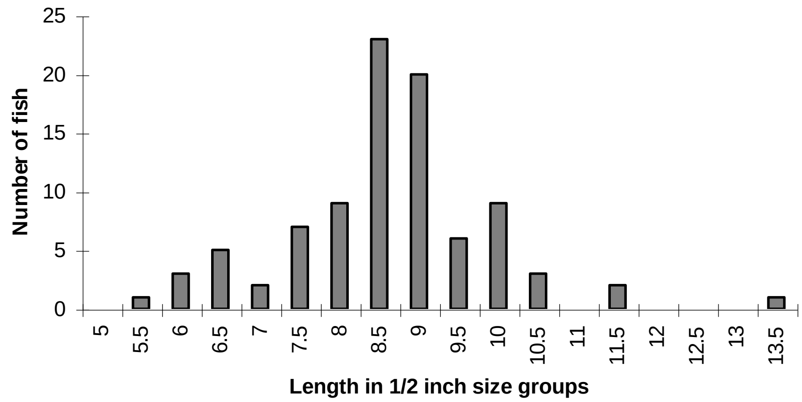


Figure 27. Brook trout size distribution in a Little Lava Lake gillnet set, June, 1994.

Attempts to remove or reduce tui chub population in other water bodies such as South Twin and Cultus lakes has shown rainbow trout growth to increase with chub removal. Total treatment of the lake is not practical because tui chubs are able to return to the system via Lava Lake and from Crane Prairie Reservoir via the Deschutes River. Other methods of control should be researched to control chub numbers. An annual program of chub removal similar to Lava Lake would likely produce similar benefits for Little Lava Lake trout, however, the Department lacks the necessary resources (manpower and funding) to do the work.

Creel sampling has not been done at Little Lava Lake in recent years. In general, angling pressure is light with most fish taken early in the season prior to warming of the water or in the early fall when the water cools. Most fishing is from the bank or boats still fishing with bait or by trolling. Angling pressure is generally light except on major weekends such as Memorial Day or the 4th of July.

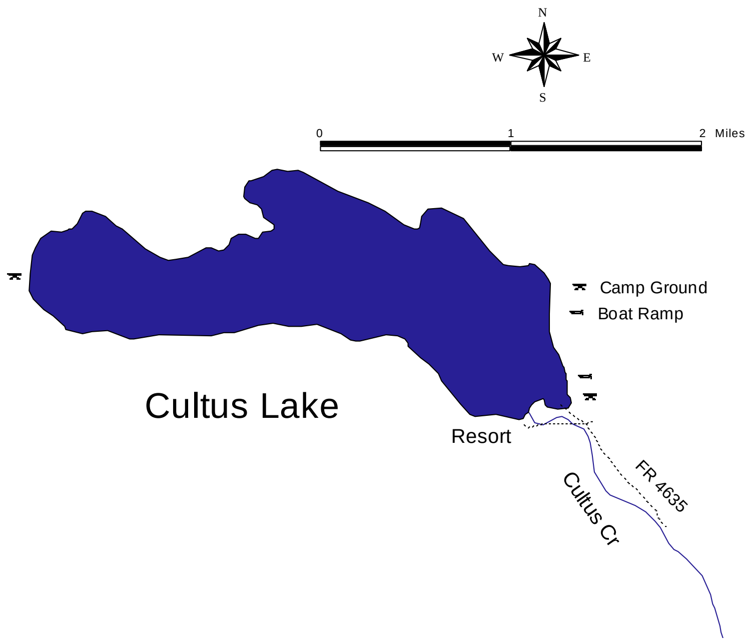
Management Issues

1. Competition for food and space from a prolific tui chub population reduces potential trout production.
2. Possible poor performance of the lot 53 rainbow trout similar to other water bodies using this stock.
3. Stocked trout interaction with naturally produced trout is unknown.
4. Contribution of hatchery fish to the lake population and fishery is unknown.

CULTUS LAKE

Location and Ownership

Cultus Lake is a natural glacier-formed lake located entirely on the Deschutes National Forest approximately 48 miles southwest of Bend. It lies at the base of Cultus



Mountain on its north side. Access is west off Century Drive (FR 46) on FR 4635 approximately 1.5 miles.

There are three Forest Service campgrounds adjacent to Cultus Lake, two with boat launches and one smaller campground on the west shore accessible only by boat. A private resort with cabin rentals and a store is located near the outlet. There are no speed limits or special boating regulations. The lake is popular for swimming, water skiing, boating and camping.

Habitat and Habitat Limitations

The lake is 4,668 feet in elevation, 791 surface acres in area, with a maximum depth of 211 feet and an average depth of 80 feet (Johnson et al. 1985). Cultus Lake has a shoreline perimeter of 6.8 miles.

Cultus Lake is relatively deep with 95% of its area over 25 feet in depth. Shoreline areas around most of the lake basin are sheer drop-offs. The western and eastern ends of the lake contain sandy and rocky shoal areas. Bottom types over the majority of the lake are detrital muck or coarse sand.

The drainage area of Cultus Lake is 35 square miles (Johnson et al. 1985). Winopee Creek is the principal tributary and enters the lake from the north and originates at Winopee Lake. Spring inflows are located in the southern, southwestern, and northern lake areas. There is also a substantial amount of subsurface seepage into the lake through the permeable volcanic terrain. The outlet, Cultus Creek, is located at the southeast corner and flows into Crane Prairie Reservoir. Cultus Creek flows are generally high in the spring and decrease through the summer (Figure 28). In late summer months, Cultus Creek dries up or does not reach Crane Prairie Reservoir because of seepage. Any trout in the creek are concentrated in a few remaining pool areas.

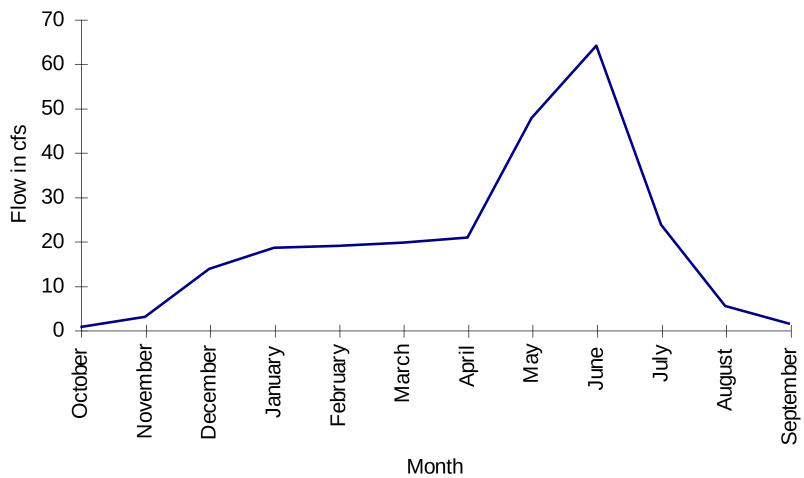


Figure 28. Average monthly flow in Cultus Creek, 1966-1995.

In late summer, water temperatures often reach 65°F on the surface and decline to 40 - 42°F at 170 feet (Smith and Putnam 1962). Dissolved oxygen is adequate at all depths for fish life. The lake stratifies in summer, with the thermocline generally occurring at about 35 feet (Johnson et al. 1985).

Very little aquatic vegetation is found in Cultus Lake which indicates low productivity. Recorded transparency is 56 feet and the trophic status is classified as ultraoligotrophic (Johnson et al. 1985). Bottom samples of aquatic food showed an average of only 28 pounds per acre (Newcomb 1941). Two-winged flies and roundworms were found to be the dominant organisms. Crayfish are present, but not abundant.

Opossum shrimp (*Mysis relicta*) were released into Cultus Lake in an attempt to provide a food source for kokanee. Ironically, the *Mysis* were stocked into Cultus about the same time kokanee stocking was discontinued. The shrimp came from Waterton Lake, British Columbia. Between 1965 and 1967, 216,000 *Mysis* were released into Cultus Lake (Wetherby 1990).

Subsequent sampling for 14 years led biologists to believe the shrimp did not survive or reproduce in the lake.

In 1988, sampling was again attempted by making vertical tows using a standard plankton net (Wetherby 1990). Every sample contained *Mysis*. Capture depths ranged from 50 to 200 feet. Impacts of the *Mysis* introduction in Cultus are unknown. In many waters, *Mysis* releases have had negative impacts on other zooplankton species such as *Cladocerans*, *Daphnia*, and *Bosmina*. Additional work should be done on the Cultus *Mysis* population to determine their density, effect on other zooplankton populations, and utilization by juvenile lake trout as a food source.

Fish Stocking History

Cultus Lake was first stocked with rainbow trout in 1937 when 25,000 were liberated, size or origin unknown (Newcomb 1941). Rainbow were again stocked in 1939. Newcomb (1941) noted the first brook trout were stocked into Cultus in 1940 and was an "emergency planting", but failed to identify the emergency. At present, only legal-size rainbow trout are stocked with an annual allocation of 6,000 fish.

Rainbow have been stocked annually since 1939 at a rate of up to 200,000 per year. Most stocking in early years were fingerling-size fish. Stocking transitioned to legal-size rainbows in the 1980's. Source of the rainbow has been Wizard Falls, Oak Springs, and Fall River hatcheries. The current allocation of 6,000 legal-size rainbow trout are reared at Fall River Hatchery.

Lake trout were first planted in 1956. The release was 23,707 fish averaging 8 inches in length and came from Odell Lake and Drews Commercial Fish Hatchery in Manitoba, Canada (Hooton 1993). Stocking continued until 1965 at which point natural reproduction supported the fishery. Annual releases peaked in 1958 at 31,000 fish and decreased to 2,130 in 1965. Some released fish have been fin clipped and were still observed 20 years after stocking. Size range of fish at liberation was from 3 to 8 inches. All releases were from fish captured and spawned at Odell Lake, and raised at Klamath Hatchery.

Other species have been released sporadically or for limited periods of time. Brook trout were released in several years since the original release in 1940. The last release of brook trout in Cultus Lake occurred in 1978. Coho and kokanee were stocked from the mid-1950's through the mid-1960's. Neither species proliferated or grew to desirable size and stocking was discontinued.

Angling Regulations

Cultus Lake has had many slight season changes over the years', significant regulation changes are listed below. Current regulations for Cultus Lake are 5 trout per day, only 1 over 20 inches. Cultus Creek has the same regulations with a special closure to angling from September 1 - October 31. Lake trout are included in the trout bag limit. A staff proposal has been submitted that recommends reducing the bag limit in 1997 to 1 lake trout per day, 24 inch minimum size.

1932- Bag limit in lakes and tributaries in Deschutes County is 15 lbs plus one fish not to exceed 25 fish per day.

1933- Cultus Lake closed to angling.

1937- Special bag limit for lakes established, lowered to 15 lbs plus one fish not to exceed 15 fish per day.

1947- Bag limit reduced to 5 fish not to exceed 15 lbs plus one fish.

1950- Closed to angling in Cultus Creek.

1952- Closed to angling in Cultus Creek.

1956- Cultus Creek opened to angling.

1966- Cultus Lake regulations are the same as the general trout season.

1980- General bag limits for streams and lakes/ponds/reservoirs adopted: 10 trout per day, not more that 5 over 12", not more than 2 over 20" for lakes; 5 trout per day for streams.

1992- Cultus Lake trout bag limit reduced to 5 trout per day. Cultus Creek closed to angling during September and October.

Fish Management

Indigenous fish species in Cultus Lake were redband trout and whitefish. Bull trout were likely present or at least transient, however, none have been documented to occur in the lake. Presently the lake contains a naturally reproducing population of introduced lake trout, rainbow trout, and whitefish. Other species that have been found or released into the lake include kokanee, coho, brook trout, steelhead, and tui chub. A single cutthroat and a single brown trout were captured on June 12, 1974 and October 29, 1963, origin unknown. These fish were likely mixed in a load of hatchery rainbow trout.

Biologically, Cultus Lake is unproductive. The only sustained fishery is for lake trout, but in some years fair numbers of naturally-reproducing rainbow trout are taken. Occasionally, angler's flyfish with streamers in the spring for lake trout, but most fishing is done by boat, trolling lures with weighted lines or by jigging lures. In 1983, it was estimated that 1,200 angler-days were spent harvesting 2,200 rainbow and lake trout (Fies, unpublished data). No extensive creel sampling has been done on Cultus Lake in recent years.

Rainbow trout are naturally reproducing in Winopee Creek. Some fish may move into Cultus Lake from Cultus Creek where Crane Prairie Reservoir rainbow trout are known to spawn. In 1995, a number of rainbow trout redds were found in Cultus Creek. We do not know whether rainbow in Cultus Lake are a lineage from the indigenous redband trout or some other strain that developed from releases of hatchery fish in past years. Fish samples were collected from Winopee Creek in 1994 to be examined for their genetic makeup. Results are pending.

Approximately 6,000 legal-size rainbow trout are released annually from Fall River Hatchery to supplement the lake trout fishery. Percent return on these fish to anglers and predation losses by lake trout and osprey are unknown.

Gillnets set in Cultus Lake in 1994 captured 15 wild rainbow trout. Fish ranged from 6 to 13 inches in length with an average length of 10.3 inches (Figure 29). The condition factor averaged a poor 1.06, however, the nets were set early in the season.

Lake trout provide the primary fishery in Cultus Lake. The fishery is comprised of a few anglers who specifically fish for lake trout at Cultus Lake and they are quite successful at times based on reports from these anglers, Oregon State Police, and Forest Service personnel. Reports from the campground host at Cultus Lake in 1995 revealed anglers catching and releasing up to 15 lake trout per day. Most fishing for this species occurs early in the season prior to water temperature increases.

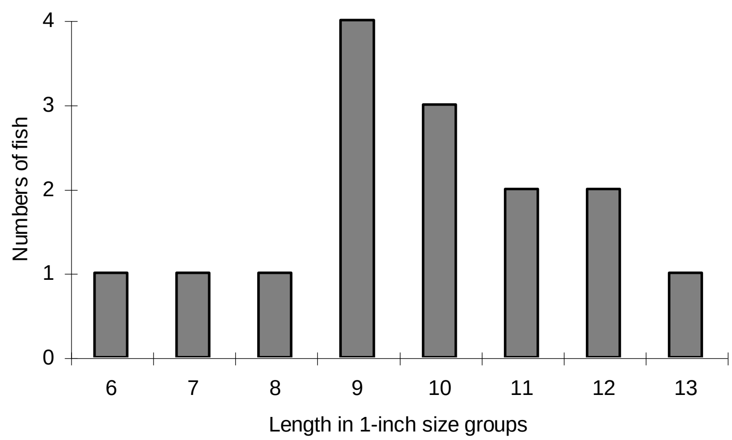


Figure 29. Rainbow trout size distribution in Cultus Lake from a gillnet set, 1994.

Lake trout were stocked in an attempt to establish a predator-prey relationship with kokanee that were released earlier. Subsequent sampling found the lake trout preferred whitefish to kokanee in their diet. Lake trout began reproducing naturally and stocking was discontinued in 1965.

Sampling conducted in June 1991 captured 6 lake trout between 12 and 21 inches. Three were immature females averaging 19.6 inches in length. Sampling with gillnets was done again in 1994. In this sample 8 individuals were captured and ranged from 21 to 30.5 inches in length.

Six of the fish were alive when the nets were retrieved and were released unharmed. Stomach contents on the 2 remaining fish each held whitefish.

Whitefish are the most abundant fish species in Cultus Lake. The whitefish is most valuable as prey for lake trout. They are largely ignored by anglers, but may offer the best potential for a new sport fishery should their popularity increase. Fish sampling in April 1994 captured 22 whitefish. Their size ranged from 9 to 16.5 inches in length (Figure 30). Their body condition was poor at the time of capture, attributable in part to sampling prior to the growing season. The abundance of fish smaller that 9 inches is unknown because they are too small to be captured in the gillnets. The smaller size groups are important because they are preferred prey by lake trout.

Kokanee were released into Cultus Lake from 1955 through 1965. Occasionally fish were captured over 14 inches in length, but most reached only 10 to 11 inches. Spawning kokanee were documented using Winopee Creek, however, the population was never self-sustaining. The last kokanee observed was captured in ODFW nets in 1966.

An occasional brook trout can be found in the lake, probably traveling down from Winopee Lake or up from Crane Prairie Reservoir. Gill net samples in recent years have not captured any brook trout. Periodically, a tui chub is captured in the net samples, but

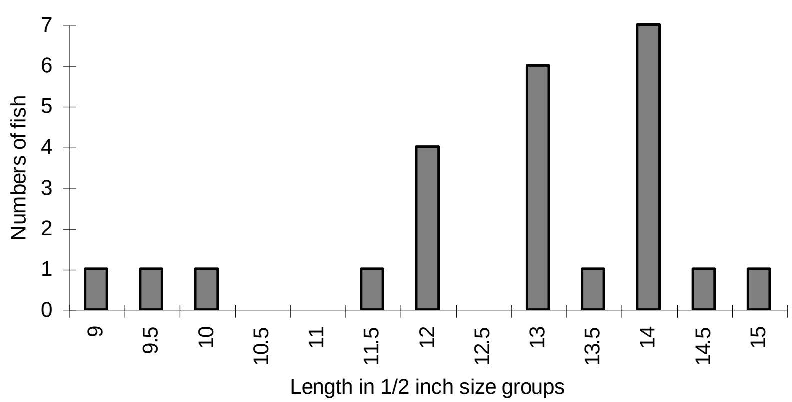


Figure 30. Whitefish length distribution in a Cultus Lake gillnet set, 1994.

the lake provides little in the way of chub habitat, specifically aquatic vegetation important for spawning.

Crayfish are present, but their abundance appears to be low as indicated by net samples.

Management Issues

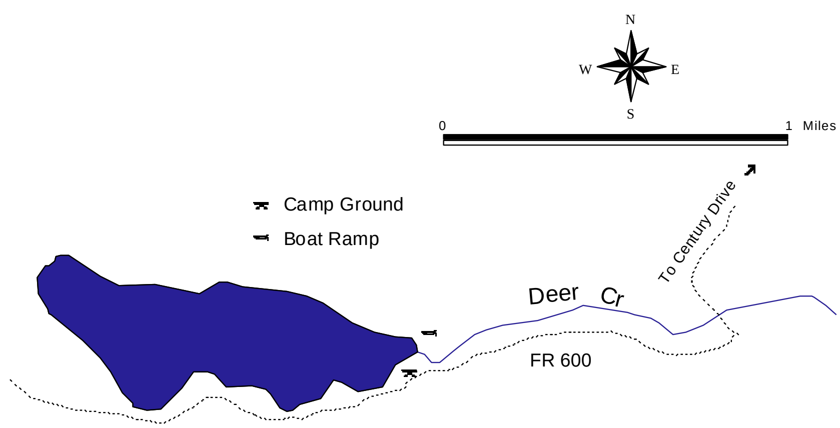
1. Poor productivity in Cultus Lake limits the fishery potential.

2. The genetic characteristics of the naturally-reproducing rainbow trout in Cultus Lake is unknown.
3. *Mysis* shrimp may negatively impact the native zooplankton population. Utilization by lake trout as forage for fish is unknown.
4. Stocked fish have the potential to move downstream into the Crane Prairie Reservoir complex and interact with other fish. Accordingly, fish can move upstream from Crane Prairie Reservoir. The extent of fish exchange is unknown.
5. The lake trout population in Cultus Lake is poorly understood including annual recruitment, feeding habits, and harvest.
6. Angler use and harvest estimates are needed especially if the new 24 inch minimum length regulation for lake trout is enacted in 1997.

LITTLE CULTUS LAKE

Location and Ownership

Little Cultus Lake is a natural lake at an elevation of 4,750 feet approximately 54 miles southwest of Bend. Access is from Century Drive (FR 46) to the Cultus Lake road (FR 4635). From the Cultus Lake road, turn south on FR 4630 and travel approximately 3 miles. Little Cultus Lake lies entirely on Deschutes National Forest land. A Forest Service campground and boat ramp is located on the south side of the lake.



Little Cultus Lake

Habitat and Habitat Limitations

Little Cultus Lake encompasses 156 surface acres and has 2.6 miles of shoreline (Johnson et al. 1985). Little Cultus was formed by a glacial moraine dam and lies within the scoured glacial valley.

Deer Creek is the surface outlet of Little Cultus Lake. The creek flows in a southwest direction approximately 3 miles until reaching Crane Prairie Reservoir (Figure 31). There are two small unnamed inlets located in the west end of the lake. One of the inlet tributaries originates at Deer Lake.

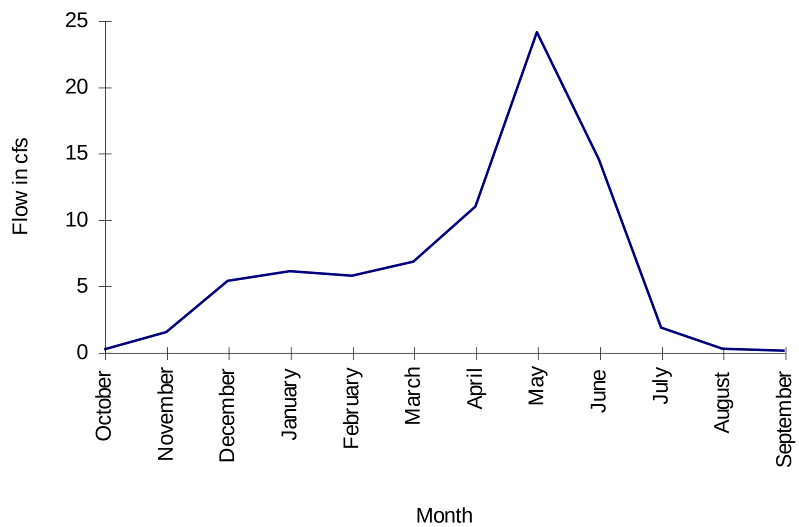


Figure 31. Average monthly flow in cfs in Deer Creek, 1966-1995.

Approximately 70% of the lake is less than 25 feet in depth. Little Cultus Lake has a maximum depth of 55 feet, and an average depth of 17 feet, and a drainage area of 11 square miles (Johnson et al. 1985). The deepest area of the lake is located near the west end. Shoal areas are composed of sand, boulders, and detritus. The shoreline is composed of mixed conifer, meadow and marsh, and rocky areas. Cultus Mountain is the dominant feature rising on the north side of the lake.

Surface temperatures can reach 72^{o}F in the summer, and the lake's thermocline generally develops between 20 and 30 feet. In late summer and early fall, a lack of oxygen for trout was noted from 35 to 61 feet in depth (Newcomb 1941). All other chemical factors in the lake are suitable for trout. The trophic status of the lake is oligotrophic (Johnson et al. 1985).

Newcomb (1941) rated production of bottom organisms and plankton as average in overall productivity. The most prominent aquatic organisms include Diptera, Neuroptera, Mollusca, and Odonata. Presently, the only known fish disease or parasites are tapeworms, which seldom cause any fish losses.

Fish Stocking History

Brook and rainbow trout are the only species that have been released in Little Cultus Lake. Newcomb (1941) noted that rainbow trout stocking began in 1937 with the liberation of 25,000 fish (size unknown) followed by a release of 50,000 fish in 1939. Brook trout were in the lake at the time of the survey, but no dates were given for the first release.

Rainbow trout were released in Little Cultus Lake from 1937 until 1969. Numbers of fish have ranged between 5,000 and 150,000 fish, all fingerlings. Fish have been raised at Klamath, Oak Springs, Willamette, and Fall River hatcheries. Rainbow stocking was discontinued in 1969. Presently, there is a population of naturally-reproducing rainbow in the lake.

Brook trout have been liberated into the lake in all but a few years since 1947. Prior to 1969, approximately 40,000 fingerling were released annually. In 1970, the allocation was reduced to 15,000 fish annually and to 10,000 in 1982. The current annual allocation is 8,000 fingerlings annually. The Little Cultus brook trout are all reared at Wizard Falls Hatchery.

Angling Regulations

As the other lakes discussed above there have been many season length changes in Little Cultus Lake, but only the significant ones are listed below.

1932- Bag limit in lakes and tributaries in Deschutes County is 15 lbs plus one fish not to exceed 25 fish per day.

1933- Bag limit 15 lbs plus one fish not to exceed 20 fish per day.

1937- Special bag limit for lakes established, lowered to 15 lbs plus one fish not to exceed 15 fish per day.

1947- Bag limit reduced to 5 fish not to exceed 15 lbs plus one fish.

1950- Closed to angling.

1952- Closed to angling in Deer Creek.

1956- Deer Creek opened to angling.

1980- General bag limits for streams and lakes/ponds/reservoirs adopted: 10 trout per day, not more that 5 over 12”, not more than 2 over 20” for lakes; 5 trout per day for streams.
1992- Deer Creek closed to angling during September 1 to October 31.

Little Cultus Lake currently follows general trout season regulations. The season runs from late April to October 31st, 10 trout per day, only one over 20 inches. The State Marine Board requires a 10 mph speed limit for powerboats.

Fish Management

Indigenous species included redband trout and whitefish. Bull trout had direct access to the lake, but were never documented. Presently, Little Cultus Lake contains rainbow and brook trout.

In 1949, the lake was chemically treated to remove an overabundant population of whitefish. Following treatment the lake was restocked with rainbow and brook trout. Of the total fish population, brook trout currently comprise approximately 75%. Whitefish have not repopulated the lake, possibly due to a weir that was built in the 1960's on Deer Creek to prevent upstream fish movement into the lake.

Angling pressure on Little Cultus Lake is generally light with the heaviest pressure occurring during the early season. Brook trout are abundant and the main target of anglers, however, the rainbow provide good return to the creel even during the warmer part of the summer when the brook trout become difficult to catch. Trolling flashers, worms and flies are quite popular. Little Cultus is generally not as crowded as other lakes in the Century Drive area, and is patronized by generally the same people every year. No creel information has been collected in recent years.

Rainbow trout in Little Cultus Lake are naturally reproducing and have not been stocked in the lake since 1969. It is unknown where the rainbow trout spawning occurs. There is a small amount of suitable spawning habitat in tributaries, but biologists have not documented use by rainbow trout. Juvenile rainbow were found concentrated in remaining pools in Deer Creek downstream of Little Cultus in 1994. These fish may originate from Crane Prairie broodstock. Samples of these rainbow trout were collected for genetic evaluation in Deer Creek and Little Cultus Lake in 1994. Results from the sampling are pending.

A trapnet set in 1994 captured 15 rainbow trout that ranged in length from 4 to 14 inches. Five of the fish were in the 10-14 inch class. Female rainbow trout were sexually mature at an average of 8 inches in length.

Brook trout are the most abundant fish species in the lake. Sampling by trapnet in 1994 captured 39 brook trout ranging in length from 4.5 to 11 inches (Figure 32).

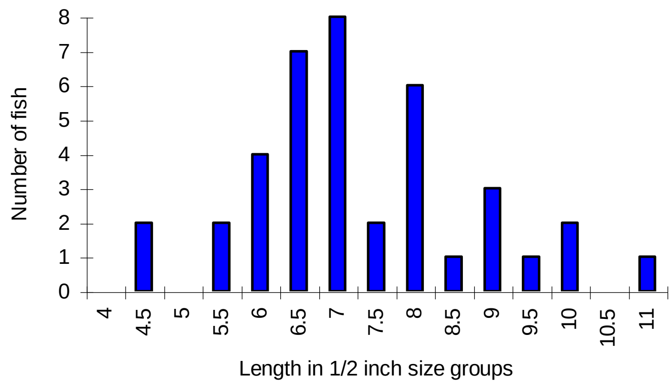


Figure 32. Brook trout length distribution from a trapnet set in Little Cultus Lake, April, 1994.

Average length was 7.5 inches. In past years brook trout had higher average lengths with reaching the 13 inch size range. Low angler harvest may be contributing to an increase in fish numbers and possibly the reduced size, or the hatchery brook trout are showing poor performance caused from genetic weakness. In an attempt to increase brook trout size, the allocation was reduced from 10,000 to 8,000 fingerlings per year beginning in 1995.

Management Issues

1. The genetic origin and spawning areas of rainbow trout in Little Cultus Lake are unknown. Results of the genetic analysis pending.
2. Competitive interaction for food and habitat between the naturally reproducing rainbow trout and brook trout are unknown.
3. Average size of the brook trout has declined in recent years. It is unknown whether this is from reduced fitness of the hatchery fish or overpopulation.
4. Contribution of hatchery fish to the brook trout population is unknown.

MANAGEMENT DIRECTION

CENTURY DRIVE LAKES CONNECTED TO THE DESCHUTES RIVER

LAVA LAKE AND LITTLE LAVA LAKE

POLICIES

Policy 1. Rainbow trout in Lava Lake will be managed for hatchery production consistent with the Basic Yield Fish Management Alternative for trout (ODFW 1987). Hatchery brook trout will no longer be stocked in Lava Lake.

Policy 2. Rainbow trout in Little Lava Lake will be managed for natural and hatchery production consistent with the Basic Yield Management Alternative for trout (ODFW 1987). Hatchery brook trout will no longer be stocked in Little Lava Lake.

Policy 3. Mountain whitefish in Little Lava Lake will be managed for natural production consistent with the Wild Fish Management Alternative for trout (ODFW 1987).

OBJECTIVES

Objective 1. Maintain the genetic diversity, adaptiveness, and abundance of rainbow trout and mountain whitefish in Little Lava Lake.

Assumptions and Rationale

1. It is not known if Lava Lake was originally fishless but all indigenous fishes have been removed through several rotenone treatments to eliminate tui chub. Little Lava Lake originally contained rainbow trout and whitefish. It is not known if bull trout are indigenous. It now contains hatchery rainbow trout, brook trout, whitefish and tui chub.

2. Monitoring the distribution, size, age-class, structure and abundance of populations of trout and whitefish will provide an indication of their health and adaptiveness.

3. It is not known if indigenous redband trout remain in Little Lava Lake.

4. Hatchery trout have been stocked since 1935 in Lava Lake and 1932 in Little Lava Lake.

5. Rainbow trout indigenous to the Upper Deschutes River and tributaries have been identified as an inland redband trout and are listed as a state and federal sensitive species.

6. Electrophoretic and morphometric measurements will aid in determining the origin of Little Lava Lake rainbow trout.

7. Electrophoretic samples have not been taken from Little Lava Lake.

8. Special regulations may be necessary to protect stock fitness and life history characteristics and to maintain healthy redband trout populations with multiple age classes.

9. The current stock of rainbow trout (Lot 53) and brook trout have been performing poorly in recent years and it is believed to be related to genetic problems.

10. The degree of fish interchange between Little Lava Lake and the Deschutes River and Lava Lake and Little Lava Lake is not known. A weir blocking fish movement from Little Lava Lake to Lava Lake is located in the channel between the two lakes, its degree of effectiveness is not known. It was originally built to block movement of tui chub from Little Lava Lake upstream to Lava Lake.

11. Tui chub are extremely productive in Little Lava Lake. They compete with game fish for food and space and negatively affect the fishery when populations are high.

12. Tui chub are a food resource for game fish.

13. There is no recreational or commercial use for tui chub at the present time and they are not limited in population throughout their range.

14. Past rotenone treatments in Lava Lake have not been completely successful in removing chubs.

ACTIONS

Action 1.1 Verify, document, and establish population trends of indigenous redband trout in Little Lava Lake if electrophoresis establishes evidence of their existence. Population trends will be determined through periodic creel surveys and netting.

Action 1.2 Assess the status of redband trout in Little Lava Lake.

Action 1.3 Establish baseline data sets on genetic characteristics of redband trout in Little Lava Lake using biochemical (electrophoresis) and phenotypic parameters and compare to existing electrophoretic data from other areas in the Deschutes basin.

Action 1.4 Investigate a new stock of rainbow trout to be used in the hatchery program. Switch to Deschutes rainbow or Crane Prairie rainbow if the hatchery program is found to be out of compliance with Wild Fish Management Policy.

Action 1.5 Document the degree of fish interchange between the Deschutes River and Little Lava Lake and Lava Lake and Little Lava Lake.

Action 1.6 Study and implement methods of controlling tui chubs to minimize negative interactions with game fish.

Objective 2. Provide recreational angling opportunities for rainbow trout in Lava Lake, and diverse angling opportunities for rainbow and whitefish in Little Lava Lake.

Assumptions and Rationale

1. Adequate spawning habitat does not exist in these lakes and periodic stocking is required to maintain the current fishery. There is little or no opportunity to improve spawning habitat.

2. These angling opportunities depend on land management that maintains the natural productive capacity of Lava Lake.

3. A statistical creel survey is needed at Lava and Little Lava lakes.

4. ODFW is currently stocking Klamath rainbow in Lava Lake to attempt a biological control on tui chub. These fish begin to feed on chubs once they reach approximately 16 inches in length. It may be necessary to maintain a significant population of large fish to provide some control on tui chubs.

ACTIONS

Action 2.1 Annually stock Lava and Little Lake with hatchery rainbow trout (Lot 53). Discontinue stocking of Klamath rainbow trout (Lot 28) in Lava Lake and discontinue hatchery brook trout in Lava and Little Lava Lake.

Action 2.2 Inventory trout populations for size, growth, condition factor, and species composition.

Action 2.3 Monitor angler effort and catch through a creel survey.

Action 2.4 Continue to adjust the stocking program to meet the lakes natural productivity and angler use.

Action 2.5 Continue to examine angling regulations for their adequacy in maintaining the fishery.

Action 2.6 Monitor trout movement in the high water channel between Lava and Little Lava lakes and the outlet of Little Lava Lake to determine the magnitude of rainbow escapement into the Deschutes River. If monitoring shows high escapement of rainbow trout resulting in a conflict with the Wild Fish Management Policy, then convert rainbow stocking in both lakes to Deschutes rainbow (Lot 66) or another compatible stock such as Crane Prairie rainbow.

Objective 3. Tui chub will be controlled to minimize competition with hatchery rainbow.

Assumptions and Rationale

1. Tui chub are extremely productive in Lava and Little Lava lakes. They compete with game fish for food and space and negatively affect the fishery when populations are high.

2. ODFW, in cooperation with the resort owner, has been operating three trapnets in Lava Lake to remove a portion of the chubs.

3. Past rotenone treatments in Lava Lake have not been completely successful in removing tui chubs.

ACTIONS

3.1 Monitor population abundance through observation during spawning times and by periodic trapping.

3.2 Continue physical removal of tui chub through cooperative efforts of the resort owners.
3.3 Investigate alternative methods for tui chub control through biological and/or chemical agents.

Objective 4. Determine the feasibility and desirability of restoring bull trout in Little Lava Lake.

Assumptions and Rationale

1. Bull trout were historically distributed throughout the Upper Deschutes River.

2. Restoring bull trout may eliminate some existing fisheries and create new fisheries with subsequent economic losses and benefits.

3. The range of bull trout will be restored which would reduce the risk of extinction in the future.

4. Stock from the Metolius River may be suitable and available for reintroduction.

5. Brook trout populations are present in the upper basin and would present potential problems related to hybridizing and competition with bull trout.

6. Bull trout are very susceptible to harvest by angling.

ACTIONS

Action 4.1 A feasibility study will be conducted to determine if the reintroduction is technically possible and what biological, social, and economic factors would be involved.

Objective 5. Maintain and improve access to Lava and Little Lava lakes.

Assumptions and Rationale

1. The boat ramp at Lava Lake has been recently improved and adequately accommodates the present fishery. There is only one unimproved boat ramp at Little Lava Lake and it is difficult to use at low water.

2. There is no designated access for disabled anglers.

3. The trail surrounding the lake could be improved to increase bank access. There is not an official trail surrounding the lake.

ACTIONS

Action 5.1 Extend the boat ramp at Little Lava Lake so it is easier to launch boats at low water.

Action 5.2 Develop access for disabled anglers.

Action 5.3 Improve the trail around the lake to increase bank access.

CULTUS LAKE

POLICIES

Policy 1. Lake trout will be managed for natural production consistent with the Featured Species Management Alternative for trout (ODFW 1987).

Policy 2. Rainbow trout will be managed for natural and hatchery production consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 3. Mountain whitefish will be managed for natural production consistent with the Featured Species Fish Management Alternative for trout (ODFW 1987).

Policy 4. Brook trout will be managed for natural production consistent with the Basic Yield Alternative for trout (ODFW 1987).

Policy 5. Crayfish will be managed as a recreational fishery.

OBJECTIVES

Objective 1. Maintain the genetic diversity, adaptiveness, and abundance of indigenous redband rainbow trout and mountain whitefish in Cultus Lake.

Assumptions and Rationale

1. Cultus Lake originally contained redband trout and mountain whitefish. It now contains lake trout, indigenous redband trout, hatchery rainbow trout, brook trout, whitefish and tui chub. It is not known if bull trout were indigenous to Cultus Lake.

2. Monitoring the distribution, size, age-class, structure and abundance of populations of trout and whitefish will provide an indication of their health and adaptiveness.

3. Hatchery trout have been stocked since 1937. Kokanee were stocked in the past but have not been stocked since 1965.

4. Rainbow trout indigenous to the Upper Deschutes River and tributaries have been identified as an inland redband trout and are listed as a state and federal sensitive species.

5. Electrophoretic and morphometric measurements will aid in determining the origin of Cultus Lake redband trout. Samples have not been taken from Cultus Lake, but have been taken from Winopee Creek. Results are pending.

6. Special regulations may be necessary to protect stock fitness and life history characteristics and to maintain healthy redband trout populations with multiple age classes.

7. The degree of interchange between fish from Cultus Lake and Crane Prairie Reservoir (Deschutes River) is not known. The outlet, Cultus Creek, dries up during the summer and limits fish passage during those months.

ACTIONS

Action 1.1 Establish baseline data sets on genetic characteristics of rainbow trout in Cultus Lake using biochemical (electrophoresis) and phenotypic parameters and compare to existing electrophoretic data from other areas in the Deschutes basin.

Action 1.2 Verify, document, and establish population trends of indigenous rainbow trout in Cultus Lake if electrophoresis establishes evidence of their existence. Population trends will be determined through periodic creel surveys, net inventories and spawning ground surveys to assess the status of the population.

Action 1.3 Document the spawning and rearing location of redband trout in Cultus Lake and monitor the influences of hatchery rainbow.

Objective 2. Provide diverse angling opportunities for rainbow trout and mountain whitefish in Cultus Lake.

Assumptions and Rationale

1. Adequate natural production of redband trout does not occur in this lake and periodic stocking is required to maintain a fishery to meet management goals.

2. Special regulations (catch and size limits) may be necessary to ensure population health and size diversity.

ACTIONS

Action 2.1 Annually stock Cultus Lake with hatchery legal-size rainbow trout.

Action 2.2 Conduct periodic inventories to assess size, growth, abundance, and condition of trout and whitefish to ensure that recreational fishery demands are met.

Action 2.3 Monitor angler effort and catch through a creel survey.

Action 2.4 Continue to adjust the stocking program to meet productivity and angler use.

Action 2.5 Investigate a new stock of rainbow trout to be used in the hatchery program. Switch to Deschutes rainbow or Crane Prairie rainbow if the hatchery program is found to be out of compliance with Wild Fish Management Policy.

Action 2.6 Continue to adjust Cultus Lake angling regulations to meet its fishery.

Objective 3. Provide a featured species fishery for lake trout in Cultus Lake.

Assumptions and Rationale

1. The lake trout catch has been increasing in recent years possibly due in part to increased efficiency of electronic fish finders. It is not known if the population can sustain increased harvest. Limiting factors to lake trout production are not known. Providing adequate spawning escapement through restrictive regulations is more practical than attempting to supplement natural production through hatchery releases.

2. Lake trout sexual maturity is usually attained at age 6 or 7 years at approximately 21 inches in length. Restricting harvest to fish greater than 24 inches in length will allow lake trout to spawn at least once prior to harvest.

ACTIONS

Action 3.1 Implement restrictive angling regulations limiting harvest of lake trout to greater than 24 inches.

Action 3.2 Verify size and age at maturity assumptions for lake trout to aid in determining angling regulations necessary to provide adequate spawning escapement.

Action 3.3 Investigate the feasibility of inventorying lake trout population abundance through hydroacoustic sampling.

Action 3.4 Investigate methods of estimating spawning for lake trout.

Objective 4. Provide a recreational fishery for crayfish in Cultus Lake.

Assumptions and Rationale

1. Crayfish are indigenous to Cultus Lake but are not classified as abundant.

2. Little is known about interspecific relationships, life history and abundance of crayfish in Cultus Lake. Recreational harvest may limit crayfish abundance and subsequently affect forage abundance for game fish.

3. These shellfish are an important food source for game fish.

4. There is a high public interest in maintaining the fishery.

5. There is no written crayfish management plan, crayfish are managed by Oregon Administrative Rules (OAR) 635-05-070 through 635-05-085.

6. Cultus Lake currently has a recreational crayfish fishery only; and would not sustain a commercial fishery

ACTIONS

Action 4.1 Establish crayfish population trends, distribution, abundance, and size in Cultus Lake.

Action 4.2 Monitor recreational effort and catch through a statistical creel sampling.

Action 4.3 Continue to adjust crayfishing regulations to protect the crayfish fishery.

Objective 5. Maintain and improve access to Cultus Lake.

Assumptions and Rationale

1. Cultus Lake is popular for boating activities other than fishing. There is one public boat ramp and one private (fee) boat ramp at Cultus Lake and during peak use access to the water may be limited. Conflicts arise between anglers and water skiers during the middle of summer due to the inadequate launching facilities.

2. The trail surrounding the lake could be improved to increase bank access. There is not an official trail surrounding the lake.

ACTIONS

Action 5.1 Work with the Oregon Marine Board to enlarge the boat ramp to meet the increased use during summer.

Action 5.2 Improve the trail around the lake to increase bank access.

LITTLE CULTUS LAKE

POLICIES

Policy 1. Redband trout will be managed for natural production consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 2.   Brook trout will be managed for natural production consistent with the Basic Yield Management Alternative for trout (ODFW 1987). Brook trout will no longer be stocked in Little Cultus Lake.

OBJECTIVES

Objective 1. Maintain the genetic diversity, adaptiveness, and abundance of wild rainbow trout in Little Cultus Lake.

Assumptions and Rationale

1. Little Cultus Lake currently supports a sustainable population of wild rainbow trout.

2. Monitoring the distribution, size, age-class, structure and abundance of populations of trout will provide an indication of their health and adaptiveness.

3. Genetic samples from rainbow trout have been taken from Little Cultus Lake and Deer Creek and results are pending. Mountain whitefish are indigenous but were eliminated by chemical treatment in 1949.

4. Rainbow trout indigenous to the Upper Deschutes River and tributaries have been identified as an inland redband trout and are listed as a state and federal sensitive species.

5. Electrophoretic and morphometric measurements will aid in determining the origin of Little Cultus Lake rainbow trout.

6. Special regulations may be necessary to protect stock fitness and life history characteristics and to maintain healthy wild rainbow populations with multiple age classes.

ACTIONS

Action 1.1 Document the spawning and rearing location of redband trout in Little Cultus Lake.

Action 1.2 Verify, document, and establish population trends of indigenous rainbow trout in Little Cultus Lake if electrophoresis establishes evidence of their existence. Population trends will be determined through periodic creel surveys and net inventories to assess the status of rainbow trout in Little Cultus Lake and tributaries.

Action 1.3 Establish baseline data sets on genetic characteristics of rainbow trout in Little Cultus Lake using biochemical (electrophoresis) and phenotypic parameters and compare to existing electrophoretic data from other areas in the Deschutes basin.

Objective 2. Provide angling opportunities for rainbow and brook trout in Little Cultus Lake.

Assumptions and Rationale

1. Natural production of wild rainbow trout is adequate to sustain a basic yield fishery.

2. Adequate natural production of brook trout does not occur, thus periodic stocking is required to maintain a reasonable catch rate.

ACTIONS

Action 2.1 Conduct periodic inventories to assess size, growth, abundance, and condition of trout and whitefish to ensure that recreational fishery demands are met.

Action 2.2 Monitor angler effort and catch through a creel survey.

Objective 3 . Maintain and improve access to Little Cultus Lake.

Assumptions and Rationale

1. There is one unimproved boat ramp at Little Cultus Lake. The ramp is adequate for the present use. Vehicle turn around space is limited especially for larger vehicles and trailers.

2. There is no designated access for disabled anglers.

3. The trail surrounding the lake could be improved to increase bank access. There is not an official trail surrounding the lake.

ACTIONS

Action 3 .1 Improve the turn around space to adequately handle boat launching.

Action 3 .2 Develop access for disabled anglers.

Action 3 .3 Improve the trail around the lake to increase bank access.

CENTURY DRIVE LAKES
ISOLATED FROM THE DESCHUTES RIVER

SPARKS, DEVILS, ELK, HOSMER, NORTH TWIN AND SOUTH TWIN LAKES

Overview

The Century Drive (Cascade Lakes Highway) Lakes include Sparks, Devils, Elk, Hosmer, North Twin, and South Twin. There are no provisional wild fish populations in these lakes or their tributaries since they were all historically fishless. The Wild Fish Management Policy does not apply to these lakes and development of a wild fish only alternative is not required.

Most of these lakes have inlets and outlets that do not connect to other water bodies. The exception to this is Sparks Lake with an inlet from Green Lakes via Fall Creek; Elk Lake has an ephemeral inlet from Blow Lake; and Devil's Lake with an inlet from Moraine Lake via Goose Creek. North Green, Middle Green, South Green, Blow, and Moraine lakes were all historically fishless. Blow and South Green lakes are part of the Cascade Mountain Lakes stocking program and Moraine Lake is not stocked following unsuccessful attempts to establish populations of golden trout and brook trout. There is natural reproduction of introduced fish in Hosmer, Sparks, Elk and Devil's lakes and fish growth depends on the natural productivity of each individual lake.

The following table compares the current management of the Century Drive Lakes.

Table 49. Fish management comparison of the Century Drive Lakes.

Lake	Species*	Fishery	Production	Stocking
Sparks	BT	consumptive/ fly only	natural/hatchery	up to 40k BT fingerlings
Devils	BT, RB	consumptive/ all methods	hatchery	5k legal RB
Elk	BT, K	consumptive/ all methods	natural/hatchery	up to 20k BT fingerlings
Hosmer	AS, BT	consumptive & non-consumptive/ fly only	natural/hatchery	up to 3k AS, 5k BT
N. Twin	RB	consumptive/ all methods	hatchery	20k RB fingerlings, 6k RB legals
S. Twin	RB	consumptive/ all methods	hatchery	20k RB fingerlings, 6k RB legals

* -BT= brook trout, RB= rainbow trout, K= kokanee, AS= Atlantic salmon

Century Drive Lakes are located within the Deschutes National Forest in six different management areas as defined in the Deschutes NF Land and Resource Management Plan (LRMP 1990). They are listed below by lake:

LAKE	LAND MANAGEMENT CLASSIFICATION
Sparks	Intensive Recreation, Winter Recreation
Devils	Research Natural Area, Intensive Recreation

Land management classification list. Continued

Elk	Intensive Recreation
Hosmer	Intensive Recreation
North Twin	Scenic Views, Eagle, Intensive Recreation
South Twin	Scenic Views, Intensive Recreation

The Deschutes NF has a Riparian Management goal of maintaining or enhancing riparian dependent resources (water quality, water quantity, fish habitat, wildlife, and vegetation) that owe their existence to riparian areas (LRMP 1990). Preference is given to riparian dependent resources over others. Non-riparian dependent resources (timber, grazing, recreation, special uses) can be exploited as long as they do not conflict with the needs of riparian dependent resources. Timber operations must not be in riparian areas or wetlands. Perennial streams, lakes, and other water bodies must have a 100-foot buffer beginning at the mean high water mark. Transportation construction and maintenance take into account sediment delivery and fish passage and appear to be adequate.

The Department finds that these and other Standards and Guidelines detailed in the LRMP are adequate to protect the productivity of the Century Drive Lakes using the best current scientific knowledge. District biologists regularly review proposed land management actions, such as timber sales, to assess impacts to fish habitat and adherence to LRMP Standards and Guidelines. As new information is found on fish and habitat relationships the Department will work with the Deschutes NF to develop interim guidelines to the LRMP.

SPARKS LAKE

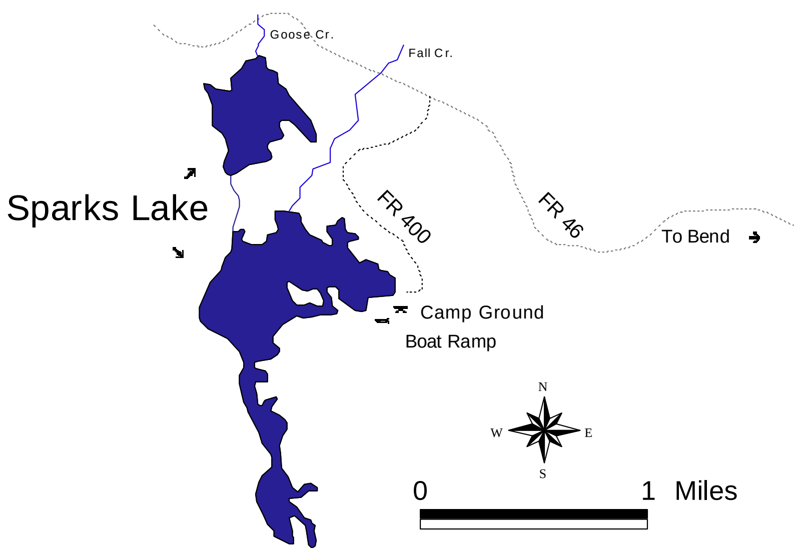
Location and Ownership

Sparks Lake is located approximately 29 miles west of Bend on Century Drive (Cascade Lakes Highway). The lake is on the Deschutes National Forest at an elevation of 5,428 feet. There are two unimproved Forest Service campgrounds and one boat ramp.

Habitat and Habitat Limitations

The lake's water supply comes from snowmelt, springs, and four tributaries; Satan Creek, Fall Creek, Goose Creek and Soda Creek. The lake water level fluctuates annually, from 200 to 600 surface acres depending on winter snowpack. The lake is shallow with a maximum depth of 12 feet. Sparks Lake has no outlet visibly connected to other water bodies. In 1977, a drought year, over one half of the lake's surface area was dry by late summer.

Sparks Lake was formed by lava flows and has a bottom composed of sand, clay, gravel, silt and detritus. The lake is a shallow remnant of a larger and deeper lake that has been filling with glacial sediment and dead vegetation. Lava is a prominent feature of the shoreline along with



wet meadows and alpine timber types. The lake contains crevices and sinkholes through which water is continually lost.

In 1966, the USFS built a dike to raise lake levels and in cooperation with the Department, plugged holes and crevices around the east shoreline. This work was only partially successful, because as lake levels rose, water escaped out new crevices in the basalt shoreline. The dike was rebuilt by the USFS in 1986, at which time they also built a floating boom to catch debris and reduce ice-caused erosion on the dam face.

The meadows at the north end of the lake have been grazed by cattle for many years under a USFS permit. Grazing resulted in a loss of riparian vegetation along the major tributaries south of FR 46 (known as the Cascade Lakes Highway or Century Drive). Recently, the Forest Service canceled the Sparks Lake grazing allotment. Remnant willow and sedges are expected to recover in the riparian areas of Sparks Lake tributaries although the process will be slow due to a short growing season.

Dam-building beaver played an important role in helping maintain the water level and fish rearing capacity of the northern part of Sparks Lake. Over the years, the beaver disappeared and have not recolonized the lake. The Department plans to reintroduce beaver to Sparks by trapping and transplanting.

Fish production at Sparks Lake is primarily influenced by the amount of annual snow pack. Maintenance of high water levels provides adequate rearing space, cover, and aquatic food production for all life stages of fish. The lake surface level drops during the summer, the peak of the trout growing season, resulting in reduced trout growth and survival. In recent years, the Deschutes National Forest and ODFW have completed small projects to enhance trout cover by placing in-lake trees and brush bundles. The capability of Sparks Lake to produce a sustainable naturally spawned (no stocking) trout population and sport fishery in the future will most likely depend on two factors: (1) maintaining high lake water levels by sealing off known water loss areas, and (2) adding large quantities of woody structure for trout cover.

Tributary streams keep the lake relatively cool with surface water temperatures reaching 66^{o}F in late summer. Oxygen levels are excellent throughout the lake and the pH is slightly alkaline. The lake produces an abundant crop of freshwater shrimp, caddis flies and mayflies, despite the sparse amount of submergent aquatic vegetation. It also contains an assortment of commonly found aquatic organisms such as roundworms, leeches, clams, and two-winged flies. Sparks Lake is considered very productive.

Fish Stocking History

Sparks Lake was originally fishless as reported by Mohler and Johnson (The Oregon Sportsman 1914), who traveled through the Cascades in 1911. The earliest stocking of Sparks Lake was reported to be in 1913 when 10,000 rainbow trout were released (The Oregon Sportsman 1914). The Oregon Sportsman (January 1916) again reported trout (brook, rainbow, steelhead) were stocked in Cascade Lakes, including Sparks. Hatchery diaries from the old Bend Hatchery showed trout eggs were collected at Sparks Lake in 1916. Hatchery diaries from Fall River hatchery showed brook trout were stocked in the years 1929-1936. Rainbow were again stocked in 1936 and one diary entry showed steelhead were stocked in Sparks sometime in the early 1930's.

Current stocking records date to 1945 when both rainbow and brook trout fingerling were released. Rainbow were stocked periodically in the late 1940's and 1950 with the last releases in 1960-61. They have not been stocked since. Atlantic salmon were tried from 1965-70, apparently without success. Brook trout have been stocked virtually every year since 1945. The majority of brook trout released have been fingerling size with occasional releases of excess hatchery brood fish. Current stocking rates range from 30-40,000 brook trout fingerling annually with a target size of 25 per pound.

Angling Regulations

Sparks Lake has had frequent minor season changes in the early part of this century, it is now grouped with the general trout season. The lake has been restricted to fly fishing only since 1945. Motorized craft are allowed, but no angling is allowed with the motor operating (1954). The State Marine Board has implemented a 10 mph speed restriction at Sparks Lake. Fishing is legally open during the general trout season from late April to October 31 with a catch limit of 10 trout per day, 6 inch minimum. No more than 5 fish can be over 12 inches and of these no more than 2 over 20 inches. Due to heavy snowfall, the access road to the lake is often not snow free until early to mid-June. Sparks Lake tributaries have the same fishing season, but the bag limit is 5 per day, no more than 1 over 20 inches, and fly angling only up to the Cascade Lakes Highway (1973). A closure on Fall Creek up to the first falls began in 1945. Currently, all tributaries are open to angling.

Fish Management

Sparks Lake is currently managed under the Basic Yield concept. It has fly angling only, general lake bag limit for trout, with naturally reproducing brook trout augmented with hatchery fingerling brook trout.

We have no current estimates of total angler use or catch rates. Random observations have found the lake is lightly used by anglers, especially in late summer when low lake water levels make boat access difficult. Lake water levels also affect angling success. Random creel census during the period of 1963-89 showed fish per angler ranged from 0.26 to 4.8 fish per angler (average 2.71). During the period 1960-86, fish landed per hour ranged from 0.07 to 2.41 (average 1.09). The lake offers a beautiful setting with a quality fishing experience and will challenge even the most experienced brook trout fly angler.

The fish population in the lake is inventoried annually using multiple-mesh gillnets. Data collected includes fish per net, size class distribution in one-inch increments, weight, and length of each fish. In addition, the fish are examined for sexual maturity, body condition, stomach contents, and parasites. The fish population in Sparks is currently 100 percent brook trout. Anglers can expect to catch fish from the legal minimum of 6 inches up to 16 inches with the average fish in the 8-13 inch range.

Brook trout in Sparks Lake are generally in very good body condition with firm pink flesh. An assessment of natural reproduction of brook trout in tributary streams has never been done, but Department biologists have felt it was insufficient to produce a sustainable fishery year to year without hatchery fish supplementation.

The lake supports large numbers of mergansers during the summer months and they may take untold numbers of young trout in the clear shallow waters. Sparks Lake is subjected to severe winter conditions; heavy ice cover and very short growing season. Trout mortality from winter conditions is unknown. In drought years, the lake surface area may be reduced by as much as half, reducing trout growth and survival.

There is potential to introduce the Twin Lakes cutthroat stock (a strain of West Slope cutthroat) into Sparks Lake. This cutthroat has been tried for several years in other Cascade high lakes with good success. They grow well, adapt to harsh environments, are easier to catch than brook trout and would have the potential to reproduce in Sparks Lake tributaries and provide a sustainable fishery without stocking. This management option would create a two-specie fishery with brook and cutthroat trout. Brook trout are fall spawners and cutthroat are spring spawners. The Sparks Lake basin is a closed system, so there would be no threat of cutthroat moving to another water body.

Under this option, the goal would be a fishery totally supported by natural spawning with no stocking. One potential drawback to this proposal is that cutthroat could be too successful in their reproduction, resulting in an over-population of stunted fish. However, this has never happened in previous introductions in Oregon, especially when stocked with brook trout and their high degree of catchability with the 10 trout bag limit should control this potential problem.

Management Issues

1. Fluctuating water levels due to snow pack affects the rearing potential of the lake. Water is lost continually during the summer through basalt fissures around the east and southern shorelines.
2. Lack of in-lake structure for trout cover.
3. Maintain "fly angling only" fishery with emphasis on a quality experience (aesthetic setting, minimal lake shore development, no angling with motors operating, naturally reproduced trout).
4. Potential for new species such as "featured species of cutthroat" if available. Reproduction of cutthroat in tributaries could eliminate need for stocking.

DEVILS LAKE

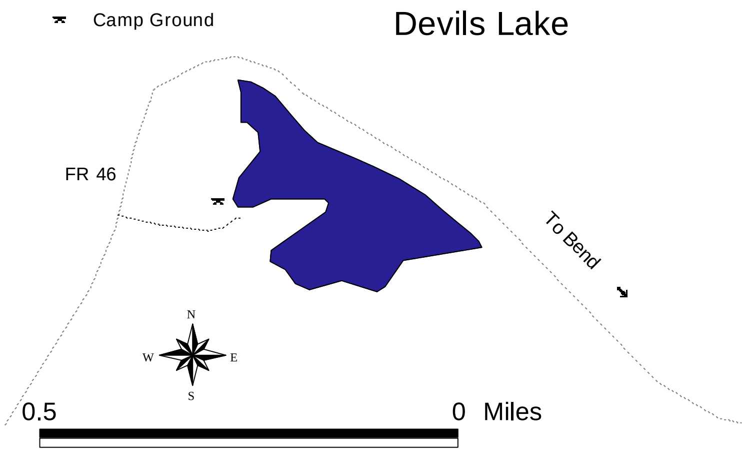
Location and Ownership

The 23-acre lake is on Deschutes National Forest land at an elevation of 5,440 feet. It is on the south side of Century Drive about one mile west of Sparks Lake and approximately 30 miles west of Bend. There is one Forest Service campground, a horse facility, and no boat ramp.

Habitat and Habitat Limitations

Devils Lake was formed by a lava flow that lies as a mass of jumbled volcanic rock at the lake's east end. It is a shallow lake with an average depth of just over three feet and a maximum depth of 10 feet.

The shoreline consists primarily of a mixture of alpine timber species with some marsh areas. The bottom is composed of clay, sand, pumice and some gravel. The lake bottom is devoid of trout cover such as aquatic vegetation or woody material. There is an occasional downed tree along the south shore. Inflow is from small surface streams- Hell Creek from the north and Tyee Creek from the west, as well as a series of small springs which discharge from the southwest slope of Devil Hill. There is no visible outlet. Lake water level depends on snowpack



and spring flow and it will vary from year to year. The lake lies in a heavy snowfall zone and the access road is often not snow free until early to mid-June.

Aquatic food production is poor with Diptera (two-winged flies) being the dominant aquatic insect species. Lesser numbers of Ephemeroptera (mayflies), Trichoptera (caddisflies) and Coleoptera (water beetles) also are present in the lake. Dissolved oxygen content in Devils Lake remains adequate because of well-oxygenated spring water flow. Temperatures in the lake are typically between 54-62^{o}F during the summer months. The trout growing season is short, generally about 4 months.

Fish Stocking History

The earliest stocking of Devils Lake was in 1913 when 2,000 brook trout were released (The Oregon Sportsman 1914). Hatchery diaries from Fall River hatchery show Devil's was stocked with brook trout in 1932, 1933, and 1936. Current stocking records date to 1945. Brook trout fingerlings were stocked in 1945 and 1950. There was no stocking from 1946-49. Legal-size brook trout were stocked during the period 1951-1956. No brook trout have been stocked since 1956. Legal-size rainbow were first stocked in 1957 and have continued to the present. Golden trout fingerlings were tried in 1962 and 1966, apparently without success.

Angling Regulations

Devils Lake had frequent season and bag limit changes in the early part of the century, but it is now the same as the general trout season. Fishing is open from late April to October 31 with a catch limit of 10 trout per day, 6-inch minimum. No more than 5 fish can be over 12 inches and of these, no more than 2 over 20 inches. There are no special tackle restrictions. The State Marine Board did not allow use of motorized boats at Devils Lake in 1945. This restriction was removed in 1967.

Fish Management

Fish management is Basic Yield, generous bag limits, with the fishery sustained by legal-size rainbow stocking. Due to the "put and take" fishery, no annual fish inventory is done at this lake. Devils Lake was first surveyed by the Oregon Game Commission in 1940. At that time, the lake contained a population of stunted brook trout. There are still a few stunted brook trout in the lake, sustained by limited natural reproduction in tributaries and springs. Most of the brook trout never reach the 6-inch minimum size for anglers and contribute little to the fishery. The Department currently releases 5,000 legal-size rainbow trout each year, starting in June and continuing into early September. The rainbow are stocked about every two weeks at a rate of 500 fish per release. The low productivity and short growing season indicate that Devils Lake is best suited for a put-and-take fishery. It is rare to see any of these rainbow survive the winter as carryover fish.

We have no current estimates of total angler use or catch, but annual observations show the lake is very popular and produces good catch rates. The clear water, beautiful setting, and proximity to Century Drive make it popular with the public. It is especially popular with juvenile anglers.

Management Issues

1. Shallow lake, low productivity, and winter kill requires stocking of legal-size trout.
2. Boat ramp access needed.
3. In-lake structure needed.

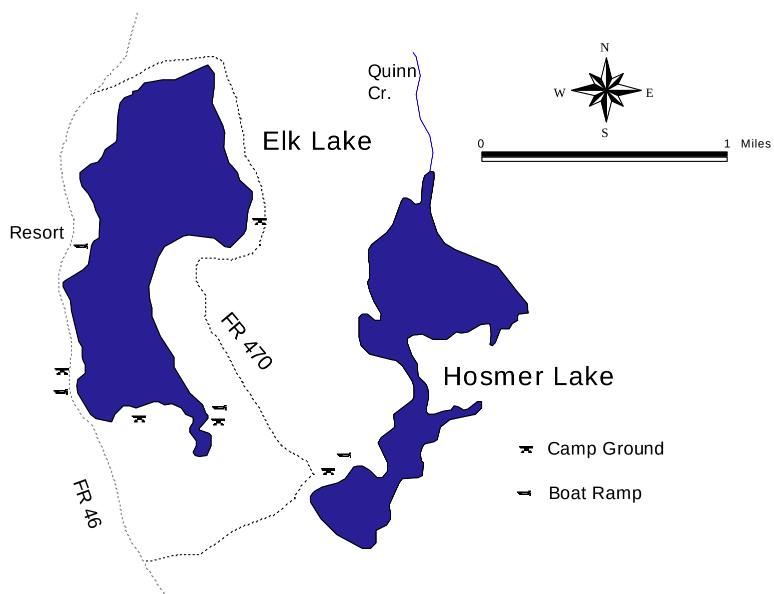
ELK LAKE

Location and Ownership

Elk Lake lies southwest of the Three Sisters Mountains, approximately 36 miles west of Bend, and is accessible from Century Drive. The lake is on Deschutes National Forest land at an elevation of 4,884 feet. There are four Forest Service campgrounds, three boat launch sites, and picnic grounds. A private resort is located on the west side with about 40 summer homes located around the perimeter of the lake.

Habitat and Habitat Limitations

Elk Lake is approximately 405 acres in size, and has a maximum depth of 62 feet. The lake is elongate in shape with the deepest parts of the lake located at the southern end. Much of the lake is less than 20 feet deep. The lake was formed as a result of volcanic activity, when a lava flow impounded the flow of several small streams. In 1969, the lake was surveyed for nutrient enrichment and bacterial contamination by DEQ. Results indicated generally good water



quality conditions, although there was some evidence of enrichment, with bacteria derived from inadequately designed or maintained sewage facilities (Johnson et al. 1985).

Most of the bottom is detrital muck and sand, interspersed periodically with lava outcroppings. Surface water flow to the lake occurs from snowmelt. Subsurface springs flowing through permeable volcanic bedrock account for the remainder of the lake's water. The lake water level increases as the summer progresses because spring inflow increases as underground aquifers are recharged from snowmelt. There is no visible outlet from Elk Lake. Benthic invertebrates available for fish are sparse, there is little aquatic vegetation and zooplankton production is poor. There is a good population of crayfish that are utilized as food by brook trout. Elk Lake is considered low in productivity.

Fish Stocking History

Elk Lake was originally fishless as reported by Mohler and Johnson on their trip through the Cascades in 1911 (The Oregon Sportsman 1914). The earliest stocking record was 1,250 brook trout released in 1912 followed in 1913 with 9,000 rainbow trout (The Oregon Sportsman 1914). Brook and rainbow trout were stocked periodically through at least 1936, according to hatchery diaries. Diaries also showed brook trout eggs were collected at Elk Lake in 1926-27.

Current stocking records date to 1945. Rainbow and brook trout were stocked from 1945-1979 when rainbow stocking was terminated. During those years, the stocking was dominated by brook trout. Brook trout stocking continues to the present. Rainbow were susceptible to tapeworm infestations and showed poor growth and survival. Kokanee were first introduced in 1957 and stocked annually through 1964. They became a self-sustaining population. Atlantic salmon were tried in 1965-68, apparently without success.

Angling Regulations

Elk Lake, as other Century Drive Lakes, has had frequent, minor season and bag limit changes in the past. In 1984, a bonus bag limit of 15 kokanee in addition to the regular trout bag limit was instituted. This limit was raised to 25 fish in 1988. Fishing season is currently the general trout season from late April to October 31, daily bag limit 10 trout, 6-inch minimum, no more than 5 over 12 inches of which no more than two can be over 20 inches. There is a bonus bag limit of 25 kokanee in addition to the trout bag limit. There are no special tackle restrictions.

Fish Management

Fish management is currently a Basic Yield approach with annual stocking of brook trout fingerlings and allowing generous bag limits for both brook trout and kokanee. Fish inventory is done with either multiple-mesh gillnets in the spring and/or live trap nets in the fall to examine spawning age fish. Data collected includes fish per net, size class distribution, length and weight. In addition, the fish are examined for body condition, sexual maturity and parasites.

Fish species present today are brook trout and kokanee. Kokanee spawn naturally in the underwater spring areas at the north end of the lake and mature at a very small size. For example, gillnet and trapnet catches from 1976-1984 showed maturing kokanee averaged 8.2 inches.

There is no known brook trout reproduction so up to 20,000 brook trout fingerlings at a target size of 100 per pound are stocked annually. Some of those fingerlings will enter the fishery the following season, but most enter the second season after stocking. It is not known specifically why brook trout do not reproduce in the same spring areas as kokanee. It may be due to the sheer numbers of kokanee on the spawning grounds concurrently with the brook trout.

Brook trout fishing is best early and late in the season. Anglers can expect brook trout size to range from 6-16 inches. Kokanee are generally available from mid-June through August, but are too small in size to attract large numbers of anglers. Kokanee in the lake could support additional fishing pressure and harvest which would help to increase the average size.

We have no current estimates of total angler use or catch, but the lake is lightly fished throughout the season. Much of the recreational use is non-angling related with sailboating, windsurfing, and swimming the predominant activities. The State Marine Board has implemented a 10 mph speed limit for motorboats.

Management Issues

1. Lack of brook trout reproduction requires annual stocking of fingerling.
2. Too much kokanee reproduction may indicate a need to further increase bag limits and/or additional publicity about the fishery. Blocking access to spawning areas in the lake would be technically difficult.
3. Angling use conflicts with other recreational uses during the peak summer months.
4. Creel census is difficult to obtain because of light angler use. Voluntary creel census boxes could provide catch trends.
5. There is a need for total angler use and catch estimates for an entire season.

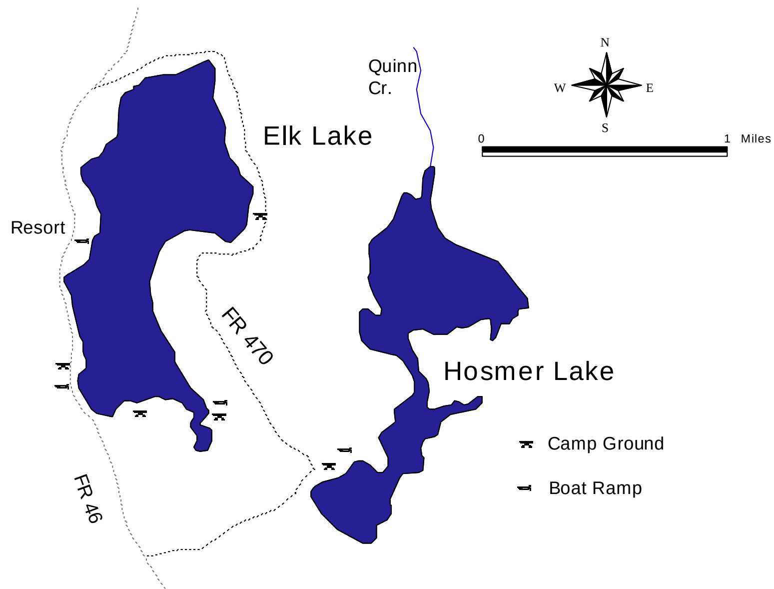
HOSMER LAKE

Location and Ownership

Hosmer Lake is on the Deschutes National Forest at an elevation of 4,966 feet. It is located east of Elk Lake just off the Cascades Lakes highway, about 39 miles from Bend. Hosmer was originally known as Mud Lake because a large population of introduced carp would stir up the fine pumice and detritus bottom causing muddy water. When the lake was first surveyed in 1940, carp were in the lake and the surveyors wrote that the carp were introduced by someone who thought they were bass (Newcomb 1941). In 1965, the name was changed to honor Paul Hosmer, a long-time resident of Bend and well-known amateur naturalist. There are two Forest Service campgrounds, one main and one overflow, and one concrete boat ramp.

Habitat and Habitat Limitations

The lake covers 160 acres and is shallow with an average depth of 3.2 feet and a maximum of 12 feet. It is probable that lava flows from Bachelor Butte (Mt. Bachelor) formed the lake by impounding the waters of Quinn Creek. The lake is long and narrow with a north-south orientation. Quinn Creek is the only tributary and is the main water source for the lake. The spring-fed stream provides a constant 25 cfs of flow with a near-constant temperature of 42^{o}F. Quinn Creek has inadequate spawning habitat because of a pumice substrate, ice scouring,



and upstream fish migration is blocked by a 6-foot high falls. The other source of water is provided by surface runoff from melting snowpack. There is some fluctuation of the water level from spring to fall and in dry years there is no water flow at the outlet.

Winters are severe with ice cover common from November until late April or early May. The outlet of Hosmer is on the southeast shore. During high water years and spring runoff, water travels for about fifty yards from the outlet and disappears into a basalt sump. In 1958, ODFW under USFS permit, built a 75-foot long rock and masonry dam on the outlet raising the lake level about four feet. The dam was fitted with an Armco gate and 24-inch pipe to control lake level. In addition to this outlet, there are several other water loss seeps in the upper lake. The fate of water leaving the lake is unknown.

Summer water temperatures in the lower lake reach 70^{o}F while the upper lake temperatures rarely exceed 50^{o}F. The pH varies from 7.1 to 8.0. Total dissolved solids (TDS) are 64 ppm. Specific conductance is 100 micromhos/cm. Dissolved oxygen ranges from 8.7 to 9.3 ppm.

The shoreline is composed of alpine timber types, lava outcrops and marsh. There are approximately 60 acres of marsh, much of which extends into the lake. The north half of the lake is quite different from the south half in terms of habitat. Since Quinn Creek enters the northernmost part of the lake, that portion is characterized by cool water, shallow flats and sparse aquatic vegetation. Cover for fish in this half is primarily undercut banks and deepwater pockets along the shoreline. The north half of the lake is joined to the south half by a narrow meandering channel characterized by extensive beds of vegetation (bulrush, pond weed, sedges, water lilies) and deeper water. This connecting channel provides an abundance of cover and aquatic food. The deepest part of the lake is in the south half. This portion of Hosmer has extensive vegetative cover and aquatic food production.

Hosmer Lake is well on its way to becoming a marsh because of vegetation encroachment. The lake bottom is composed of pumice flats, detritus, mud and peat deposits. The lake is more productive than usual for Cascade mountain lakes. The extensive vegetation, mud and peat bottom areas harbor large numbers of aquatic insects utilized by fish. An occasional crayfish can be found near rocky outcrops or sunken logs. There are no forage-fish species in the lake.

Habitat limitations at Hosmer are:

1. Shallow water and lack of cover in the north half of lake.
2. Lack of spawning habitat in Quinn Creek.
3. Short growing season and heavy ice cover.
4. Loss of water through porous basalt formations.

Fish Stocking History

The earliest known stocking of Hosmer was in 1929 when brook trout were released, as reported in diaries from Fall River hatchery. It was also stocked with brook trout annually from 1935 to 1940. Rainbow trout were reported by the 1940 survey crew to be in the lake and they noted rainbow were stocked in 1935.

Current stocking records date to 1945. Rainbow were also stocked in 1949, success unknown. They have not been stocked since. Brook trout were stocked from 1945-56 and more recently in 1984-85, 1989 and 1991-92. In 1957, the lake was chemically treated with the fish toxicant, rotenone, to eradicate populations of tui chubs, carp and brook trout. Some brook trout survived the treatment, but the chubs and carp were eliminated.

The first Atlantic salmon were released in 1958. They were a sea-run stock of Atlantic salmon from Gaspe' Bay, Quebec. From 1958 through 1965, fingerling (less than one year old) salmon were stocked. The number released annually ranged from 1,000 to 50,000 depending on success of rearing an individual age group at Wizard Falls Hatchery. From 1966 to the present, yearling-age salmon have been stocked either annually or biennially. The change to yearlings was made because of better growth rates and to assure a more stable "quality size" population. Fingerlings, surplus to hatchery needs, are occasionally stocked as forage fish. This Gaspe' Bay stock was planted each year until 1984 when a new land-locked stock from Maine, called Grand Lakes, was released in Hosmer. This stock has been planted annually from 1984 to the present.

Atlantic salmon broodstock have been maintained at Wizard Falls Hatchery since the program began in 1958. The Atlantic salmon brood fish were removed from Wizard Falls in 1994 to reduce costs, improve egg survival and provide pond space. In the future, the Atlantic salmon program will be maintained by collecting eggs from spawning-size salmon at Hosmer Lake each fall and rearing those fish to yearling age at Wizard Falls. The risk associated with only having Hosmer Lake as a source of eggs is that access to the lake may be blocked by snow or early ice cover in some years. The alternative would be to acquire eggs from either Maine or private hatcheries.

Atlantic salmon were spawned in Hosmer in 1992-93 and egg survival was about 80 percent compared to 20 percent for eggs from hatchery-reared brood fish. Numbers stocked each year vary from 1,000 to 3,000 yearlings depending on the number of adult fish available to spawn the proceeding fall. Number of adults may fluctuate due to losses from predation, winter kill and angling mortality. Up to 5,000 brook trout fingerlings are stocked as needed to maintain a large average size. Fish population status is determined each year by setting live-trap nets in spring and fall during egg collections.

Eggs have also been collected the last three years from Hosmer Lake brook trout with the objective of improving the overall quality of the hatchery brook trout program in Oregon. Improved egg survival, faster growth and improved body condition have all resulted from this action. The entire Wizard Falls brook trout brood has recently been converted to Hosmer Lake stock.

Angling Regulations

In the early part of the century the lake generally had lower bag limits and a different season than the general trout season. The lake was closed to angling from 1958 through 1960 to protect newly introduced Atlantic salmon. Prior to this, in 1957, a 30 fish bag limit allowed anglers to remove fish before chemical treatment. It was opened in 1961 with a one Atlantic salmon bag limit, fly fishing only and closed to angling from a boat while propelled by a motor. In 1962, the one-fish bag limit was removed with catch and release for Atlantic salmon with barbless flies instituted. This regulation has continued to the present.

Brook trout could be kept under the general trout bag limit until 1991 when the limit was reduced to two fish per day. Conventional outboard motors were allowed until 1990 when they were banned by the Oregon Marine Board. However, they did allow electric motors. No angling is allowed from a motor-propelled craft while the motor is operating. There is also a 10 mph speed restriction. Fishing is legally open from late April to October 31, but snow generally prohibits access to the lake until mid to late May.

Fish Management

The original management concept for Hosmer was to provide a quality "catch and release" Atlantic salmon fishery. In 1990, the Oregon Fish and Wildlife Commission adopted the Fish Management Plan for Hosmer Lake. The plan's adopted management policy states "Hosmer Lake shall be managed for hatchery and natural production under the Featured Species

Management Alternative of Oregon's Trout Plan", (OAR 635-500-706). This plan will supersede the 1990 plan.

Originally, it was hoped the Atlantic salmon would spawn successfully in Quinn Creek. However, they cannot ascend the six-foot falls in lower Quinn Creek. The pumice bottom and annual anchor-ice scouring also nullifies egg development. The population of salmon at Hosmer has been maintained solely by hatchery fish since 1958. Another serious limitation on Atlantic salmon survival in Hosmer is predation by osprey and otter. The yearling age salmon congregate in schools and cruise the lake not far from the surface in open water. They do not use the vegetation for escape cover. These characteristics combined with clear water make them easy targets for the efficient osprey. Otter tend to target the larger salmon and are especially effective at winter fishing under the ice. Otter have been effective at removing periodic releases of large brood salmon.

Brook trout stocking has been sporadic and there is limited reproduction of brook trout in spring seeps in the north half of the lake. The lake has a long history of producing exceptional brook trout. The Oregon record brook trout, until 1980, was taken from Hosmer in 1977, weighing 6 lbs, 12 oz. Brook trout were removed by trapnet from the lake when populations were high to reduce competition with Atlantic salmon. In recent years, a few brook trout have been periodically stocked to produce an occasional trophy-size fish which anglers may keep. Brook trout are very efficient at utilizing the food supply and vegetative cover in Hosmer. The only limiting factors on the brook trout population are lack of suitable spawning habitat and harvest by anglers.

Creel sampling at Hosmer is difficult because most anglers release all fish they catch. The Department has used a self-service creel box in past years to solicit catch information. During the years 1981-85, information collected at the creel box showed catch rates varied from 0.6 to 10.8 fish/angler. The best success was early in the season (late May through June) when the fish were feeding heavily or immediately following a release of yearling-age salmon. The majority of the salmon landed are in the 12-14 inch range with an occasional 20-23 inch fish. In recent years, angler reports and periodic lake visits indicate the catch rates are steady. We have no current estimates of total angler use or catch, but the lake is heavily used throughout the season and is very popular with non-residents and fly angling clubs. The lake's aesthetic setting, clear water and fish populations are also popular for viewing by non-anglers.

Opportunities to change management at Hosmer may be limited because of the long history and popularity of the Atlantic salmon fishery. A high-quality trophy fishery for another species of trout, such as rainbow, could be developed at Hosmer, but the Featured Species Management Alternative for Atlantic salmon would be negated. Brook trout are currently managed as "Basic Yield" since there are no special regulations other than the two fish per day bag limit. If brook trout were to be managed under a "Trophy" alternative, a minimum size regulation would be needed to stockpile older age fish.

The bulk of anglers and people who simply want to view fish come to Hosmer because of Atlantic salmon. The fishery as been publicized throughout North America and this publicity over the years has potentially "locked" the Department into an Atlantic salmon program. The primary constraints limiting management opportunities are the history, success, uniqueness, and popularity of the Atlantic salmon program. The constraint of popularity would be difficult to mitigate. Management for trophy trout might be possible, but only under the same restrictive regulations. Enhancement of spawning areas for brook trout is not practical nor especially desirable because of the potential for brook trout to overpopulate the lake.

Management issues

1. Maintenance of Atlantic salmon program is problematic due to difficulties in collecting eggs from brood fish at Hosmer Lake in some years.
2. Annual losses of Atlantic salmon by predators needs to be quantified.
3. Lack of good forage fish to grow Atlantic salmon to trophy size prevents this featured species fishery from achieving maximum potential.
4. Trophy brook trout management actions need to be developed and implemented in the plan actions.

NORTH TWIN LAKE

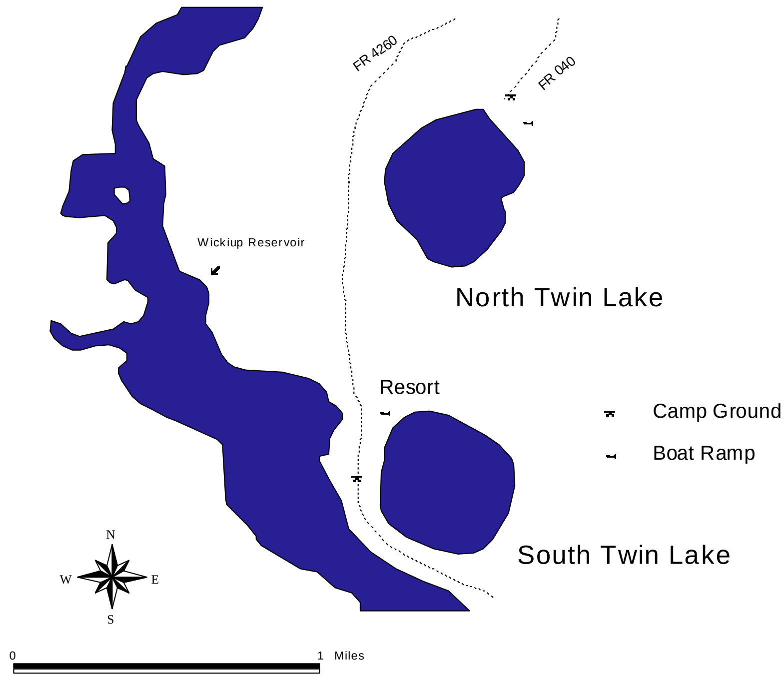
Location and Ownership

North Twin Lake is on Deschutes National Forest land at an elevation of 4,339 feet. It is located one mile north of South Twin Lake off Forest Road 4260, about 38 miles south of Bend. There is one Forest Service campground and no improved boat ramp. Boats are launched off the beach on the north shoreline.

Habitat and Habitat Limitations

North Twin Lake is 112 acres in size and has 1.6 miles of shoreline. The maximum depth is 63 feet with an average depth of 40 feet. The lake was formed when rising magma within the earth's crust came in contact with groundwater. The resulting explosion left behind a crater that later filled with water.

North Twin has no inlet or outlet and no direct underground connection with South Twin Lake has been discovered. Water is supplied by snowmelt and springs. Water levels may vary as much as 4 feet per year. The lake bottom is composed of silt, sand, detritus, and aquatic vegetation. Much of the shoreline is composed of standing dead lodgepole that extends about 5 feet into the lake. These trees provide habitat for aquatic organisms, trout rearing cover, and roosting or resting sites for various bird species. During the current drought cycle that began in 1987, it has been observed that many of the standing dead lodgepole trees have fallen into the lake. During periods of low water, the trees are exposed to the air, rot, and fall victim to wind



and ice. Submerged aquatic vegetation is abundant and is important for aquatic food production. Snails, clams, freshwater shrimp, dragonflies, and damselflies are the most abundant aquatic invertebrates available as trout food. The lake also supports a crayfish population.

Water chemistry is favorable for trout. The conductivity is well above average for Cascade lakes at 143 (umhos/cm). Sodium, potassium, calcium and magnesium concentrations are some of the highest for Cascade lakes (Johnson et.al. 1985). The pH of the water is also above average at 8.2. The concentrations of phosphorus and chlorophyll are moderate and water transparency is good. The lake stratifies during the summer and there is a tendency for oxygen depletion in the hypolimnion.

The lake was first surveyed in 1940 (Newcomb 1941). At that time, the surveyors noted the fish were heavily infested with tapeworm. Tapeworm infestations can still be found in trout.

Habitat limitations affecting trout production are fluctuating water levels and loss of standing dead timber for cover and aquatic insect production. Periodic tapeworm infestations although not a habitat limit, do also affect survival of stocked trout.

Fish Stocking History

It is believed the lake was originally fishless since there is no connection to the Deschutes River or any other water. The first record of trout stocking was reported by the Oregon Sportsman (1916), species unknown. A July 26, 1917, excerpt from the Bend Bulletin refers to lake trout being stocked into "Twin Lakes." The first known record of brook trout stocking was in 1927 as reported in hatchery diaries. They were stocked until 1948 and discontinued due to stunting as mentioned in the 1940 lake survey by Newcomb. Steelhead were stocked in the 1930's as reported in hatchery diaries. Silver salmon were stocked in 1938 (Newcomb 1941).

Current stocking records date to 1945. Those records show rainbow trout were introduced in 1945 and have been stocked to the present. Kokanee were first stocked in 1966 and discontinued after 1983. Kokanee were stocked in North Twin during the mid to late 1960's primarily to evaluate survival and growth of different kokanee races being used in Oregon. They failed to contribute to the sport fishery, similar to the results with rainbow trout. Coho salmon were stocked again in 1965, apparently without success. Cutthroat trout were stocked in 1969, 1970, 1973 and 1975, apparently without success. In October of 1993, an angler reported catching brown bullhead catfish, but their presence has not been documented by subsequent inventory efforts.

Presently, the lake only contains rainbow trout. There is no natural reproduction of rainbow in the lake. Only the present rainbow trout hatchery program has provided a suitable fishery. The lake is currently stocked with 20,000 rainbow trout fingerlings and 6,000 legal-size rainbow annually.

Angling Regulations

Like the other Century Drive Lakes, North Twin Lake generally had a slighty different season and bag limit than the regular trout season. In 1948, no motor boat fishing was allowed in North Twin. Motor boat use returned in 1967. In 1990 the trout bag limit lowered to 5 fish per day, this remains today. Fishing is open during the general trout season from late April to October 31 with a six-inch minimum and a 5 trout per day bag limit. Of these 5 fish, only 1 may be over 20 inches. There are no special tackle restrictions. Boats are allowed, but not the use of motors.

Fish Management

We have no current total angler use or catch estimates for North Twin Lake. The lake receives less fishing pressure than nearby South Twin Lake based on observations during Opening Day and holidays. Less fishing pressure is most likely because there is no resort, no improved boat ramp and one small campground. During the period 1952-1990, the catch rates averaged 2.8 fish per angler and 0.8 fish per hour, that is generally considered good trout angling. Anglers harvest rainbow from 8 inches to over 20 inches with about 75% of the fish in the 8-12 inch range.

Fish inventory is generally done annually with either multiple-mesh gillnets set in the spring or live trap nets set in the fall. Information collected includes individual fish length, weight, sex, and sexual maturity. The fish are examined for stomach contents, parasites, and general body condition.

The current management strategy for North Twin is Basic Yield, 5 trout bag limit, no gear restriction, general trout season. In 1993, the stocking was altered from a fingerling only program to fingerling plus legal-size rainbow. This is the same strategy employed for South Twin Lake. The purpose of using legal-size trout is to augment the heavy early season harvest of yearlings from the previous year's fingerling release and extend the period of higher catch rates on this small lake. In addition, some of the legal-size trout will holdover until the following year and provide fish in the 16-18 inch size range. Generally releases of legal-size trout are made twice a year, once in May and once in June. This lake is capable of supporting additional angler use and will be valuable in future years to help meet the increasing angling demand in Central Oregon.

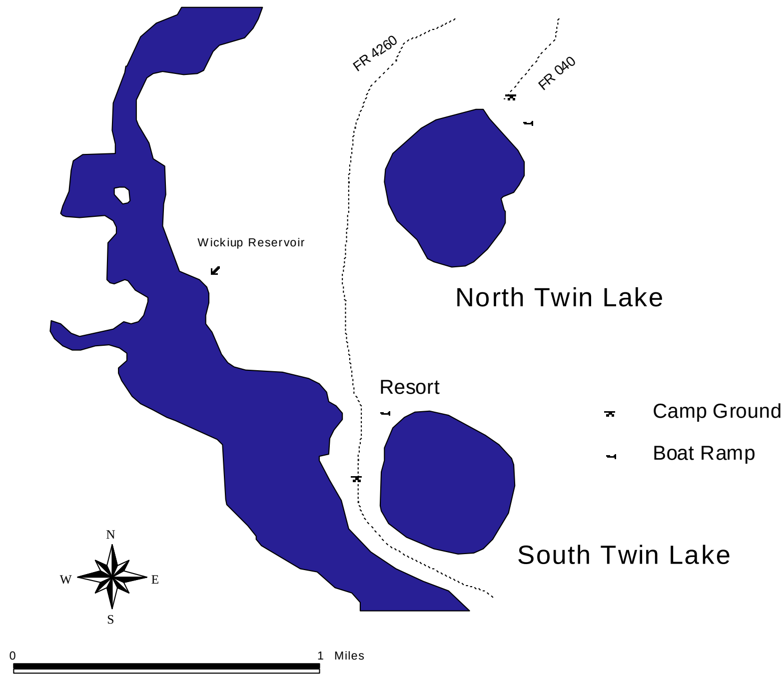
Management Issues

1. Expanded angler use of the lake in future years.
2. Difficulty in providing sufficient yearling-age rainbow trout throughout the season with fingerling only. Supplementation with legal-size rainbow is necessary and costly.
3. No natural reproduction of fish.
4. Total angler use and catch estimates for a season are needed.
5. A permanent boat ramp is needed. Campground improvement and/or expansion needed to meet future use.
6. The lake offers an opportunity for creation of specially designated juvenile and/or disabled fisheries.

SOUTH TWIN LAKE

Location and Ownership

South Twin Lake is on the Deschutes National Forest at an elevation of 4,333 feet. It is located one mile south of North Twin Lake off Forest Road 4260, about 39 miles south of Bend. There is a resort with cabins, store, restaurant and boat rentals. There is no improved boat ramp and boats are launched off the beach on the west shore. There is a large Forest Service campground adjacent to the northwest shore. A second large Forest Service campground is located across Forest Road 4260 on the Deschutes arm of Wickiup Reservoir.



Habitat and Habitat Limitations

South Twin Lake is 99 acres in area with 1.4 miles of shoreline. The maximum depth is 58 feet with an average depth of 33 feet. Like North Twin, South Twin was formed when rising magma within the earth's crust came into contact with groundwater. The resulting explosion created a crater, which later filled with water.

South Twin Lake has no surface inflow or outflow; water enters by seepage and direct precipitation. Water levels can vary as much as 5 feet and seem to correlate with drawdown rates in nearby Wickiup Reservoir; suggesting seepage from South Twin to Wickiup along the west shoreline. The bottom is composed of muck, clay, pumice, sand and aquatic vegetation. There are submerged trees, primarily on the east shoreline. The shoreline is dominated by ponderosa pine with a lodgepole pine understory.

Water quality is generally favorable for trout. Alkalinity, conductivity, sodium, potassium, calcium, magnesium and pH are all above average for Cascade Lakes. Phosphorus is moderate and chlorophyll is low (Johnson et.al. 1985). Surface water temperatures can reach 73^{o}F in late summer. During summer months, there is often no dissolved oxygen below 25-30 feet. The thermocline is generally between 15-25 feet. When the lake was first surveyed in 1940, Newcomb (1941) reported no dissolved oxygen below 25 feet. There are no known disease or parasite problems for trout at South Twin Lake.

The habitat limitations are fluctuating water levels and lack of dissolved oxygen below 25-30 feet in the summer. These two limitations reduce the maximum production potential of South Twin Lake.

Fish Stocking History

It is believed the lake was originally fishless since there is no direct connection to the Deschutes River or any other water. The first known record of trout stocking was reported in the Oregon Sportsman (1916), species unknown. A July 16, 1917, excerpt from the Bend Bulletin refers to Lake trout being stocked into "Twin Lakes." According to hatchery diaries, brook trout were stocked in 1927. Brook trout were stocked until 1938 and discontinued. Brown trout were stocked for three years, 1938-40 and discontinued. Coho salmon were stocked in 1935 and 1938 with no apparent success. Rainbow and steelhead were stocked in 1931 and rainbow have been used to the present time. The current stocking is 20,000 rainbow fingerling and 6,000 legal-size rainbow annually.

Angling Regulations

South Twin Lake has mirrored the other Century Drive Lakes in the early part of the century. The season and bag limit was usually slighty different from the general trout season. As mentioned above in North Twin Lake, motor boat fishing was not allowed in 1948, but returned in 1967. Chumming was allowed in 1956, but rescinded in 1965. In 1990, the trout bag limit was lowered to 5 fish where it remains today. Fishing is open during the general trout season from late April through October 31 with a 6-inch minimum length and a 5 trout per day bag limit. Of these 5 fish, only one may be over 20 inches. There are no special tackle restrictions. No motors are allowed.

Fish Management

South Twin Lake has been heavily used by anglers for many years and is still very popular, especially during the trout-season opening weekend and the next month or so. Opening Day boat counts have been as high as 150. We have no current total angler use or catch estimates. However, the Forest Service estimated 27,933 recreation visitor-days (RVD) were spent at South Twin in 1993. In 1989, that same estimate was 16,200 RVD's. The resort reported 4,680 boat rentals in 1993.

The fishery at South Twin has been a steady producer for many years. For example, from 1945-51, total catch and angler use studies were done which showed an average of 4,147 anglers caught an average of 9,281 trout per year (average catch rate 0.56 trout per hour). During the years of 1969-78, random creel checks showed an average catch rate of 0.77 trout per hour. In 1990, random creel checks showed an average catch rate of 0.63 trout per hour. Angler harvest is composed mainly of yearling-age 10-12 inch rainbow. Some holdover fish are seen which exceed 20 inches. It is not uncommon for trout over 5 pounds to be caught each year.

In most years, fish inventory with nets is not done because sufficient information is gained from random creel checks during the early part of the season to determine hatchery fish growth, survival, and body condition. Multiple-mesh gillnets were used in some years when tui chubs were present to determine impacts on trout growth.

Tui chub were illegally released into the lake by anglers prior to 1941 (Newcomb 1941). The chub population expanded rapidly, competing directly with trout for the available food supply, until the lake was treated with the fish toxicant, rotenone, for the first time in 1941. Since then, tui chubs have infested the lake periodically resulting in chemical treatments in 1957, 1965, 1972 and 1987. Between treatment years, the lake has produced excellent trout fishing. Tui chubs could easily be obtained from Wickiup Reservoir that is just across the road from South Twin.

Chemical treatment of the lake to eradicate all fish has been successful over the years and is a viable management tool. However, environmental concerns about toxicants may preclude future rehabilitation projects. Future management strategy for dealing with unwanted fish species may involve such things as introducing predators, electrofishing or physical trapping and removal. Illegal fish introductions are a continuing problem. On opening day of the 1994 trout season, one largemouth bass was verified as having been caught at South Twin Lake. The status of largemouth bass in South Twin is presently unknown.

The current management strategy for South Twin is Basic Yield, 5 trout bag limit, no gear restriction, general trout season. Fingerling and legal rainbow trout are stocked annually. The purpose of using legal-size trout is to augment the heavy early season harvest of yearlings from the previous year's fingerling release and extend the period of higher catch rates on this heavily used small lake. In addition, some of the legal-size trout will holdover until the following year and provide fish in the 14-18 inch range. Generally, releases of legal-size trout are made twice a year, once in May and again in June. This lake is most likely at its limit of productivity in terms of providing a high quality, decent size trout to an increasing number of anglers. Future management strategy may involve reduced bag limits, stocking additional legal-size trout or using other fish species.

Management Issues

1. Heavy angling pressure. Cannot sustain fishery solely with rainbow fingerling. Must augment with expensive legal-size rainbow.
2. Illegal fish introductions. Past experience shows the lake is easily overtaken by unwanted fish species.
3. Fewer large trout.
4. Need a total angler use and catch study.
5. Fluctuating water levels and low or non-existent dissolved oxygen below 25 feet in summer.

MANAGEMENT DIRECTION

CENTURY DRIVE LAKES ISOLATED FROM THE DESCHUTES RIVER

SPARKS, DEVILS, ELK, HOSMER, NORTH TWIN, AND SOUTH TWIN LAKES

POLICIES

Policy 1. Hosmer Lake shall be managed for hatchery produced Atlantic salmon consistent with the Featured Species Management Alternative for trout (ODFW 1987). Discontinue the stocking of brook trout. Hosmer Lake will switch to hatchery produced rainbow trout consistent with the Featured Species Management Alternative (ODFW 1987) if the Atlantic salmon egg take ever fails.

Policy 2.

Policy 2a. Sparks Lake shall be managed for naturally produced brook trout and cutthroat trout consistent with the Featured Species Management Alternative for trout (ODFW 1987). Discontinue stocking brook trout.

Policy 2b. Devils Lake shall be managed for naturally produced brook trout and hatchery produced legal-size rainbow trout consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 2c. Elk Lake shall be managed for naturally produced kokanee and for hatchery produced brook trout consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 2d. North and South Twin lakes shall be managed for hatchery produced rainbow consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

OBJECTIVES

Objective 1. Provide diverse angling opportunities for selected trout species in Century Drive Lakes of the Upper Deschutes River basin.

Assumptions and Rationale

1. There is a high level of public interest in retaining these fisheries.

2. Century Drive Lakes have been stocked since 1912.

3. Suitable spawning habitat does not exist in most of these lakes and periodic stocking is required to maintain a fishery.

4. These angling opportunities depend on land management that maintains the natural productivity of each lake.

5. Natural production of kokanee in Elk Lake is more than adequate to sustain a fishery and requires a generous bag limit to reduce stunting.

6. Suitable spawning habitat exists in Sparks Lake tributaries to maintain fishable populations of brook and cutthroat trout.

7. These angling opportunities depend on land management that maintains the natural productivity of Sparks Lake.

8. After introduction efforts are complete, hatchery stocking would not be required to maintain an adequate fishery for cutthroat and brook trout in Sparks Lake.

9. Suitable spawning habitat does not exist in Hosmer Lake and periodic stocking of Atlantic salmon will be required to maintain a fishery. Brook trout currently present in Hosmer Lake will be able to maintain a very small population through natural reproduction.

10. The public would accept the loss of the brook trout fisheries.

11. Hosmer Lake is capable of growing trophy-size (> 20 inches) rainbow trout.

ACTIONS

Action 1.1 Annually stock the Century Drive Lakes with hatchery rainbow trout, brook trout and/or Atlantic salmon according to the table below:

Lake	Species	Stocking
Hosmer	AS	up to 3k yearlings
Devils	RB	up to 5k legals
Elk	BT	up to 20k fingerlings
North Twin	RB	up to 20k fingerlings, 6k legals
South Twin	RB	up to 20k fingerlings, 6k legals
Sparks	CT	up to 40k Twin Lakes fingerlings

* - BT=brook trout, RB= rainbow, AS= Atlantic salmon

Action 1.2 Continue to adjust the Century Drive Lakes stocking program to meet the productivity and angler use of each lake as indicated by periodic survey data. As angler use increases at North and South Twin Lakes, investigate the feasibility of increasing the number of legal rainbow stocked at each lake and eventually phasing out the stocking of fingerling rainbow trout.

Action 1.3 Discontinue stocking of hatchery brook trout in Sparks Lake.

Action 1.4 Stock up to 40,000 cutthroat fingerlings annually in Sparks Lake until a self-sustaining population is established.

Action 1.5 Initiate spawning ground surveys in Sparks Lake tributaries to monitor natural production of brook and cutthroat trout.

Action 1.6 Continue to adjust the Sparks Lake fishing regulations to meet the productivity and angler use as indicated by periodic survey data.

Action 1.7 Continue to adjust the Hosmer Lake stocking program to meet the productivity and angler use as indicated by survey data.

Action 1.8 Maintain current fly angling, catch and release, barbless hook regulations at Hosmer Lake.

Action 1.9 Periodically inventory trout populations at Century Drive Lakes for size, growth, condition factor, and species composition.

Action 1.10 Periodically monitor angler effort and catch at Century Drive Lakes.

Objective 2. Protect and enhance trout habitat in the Century Drive Lakes.

Assumptions and Rationale

1. Trout habitat is generally good in most lakes, but could be improved through enhancement projects.

2. Habitat enhancement will increase the survival of trout in these waters.

3. Habitat has been altered in the past through road construction, development of campgrounds, dam construction, boat ramps, and habitat enhancement projects.

4. There is a lack of structure in most of the Century Drive Lakes which limits fish survival and growth.

5. Maintaining a higher water level in Sparks Lake will improve fish productivity.

6. Implementation of habitat projects will be done through the Mitigation and Enhancement Committee, Deschutes National Forest, and other interest groups.

ACTIONS

Action 2.1 Continue working with the Bend RD to maintain productivity of the Century Drive Lakes.

Action 2.2 Use ODFW and Bend RD surveys to determine the most effective area and type of enhancement.

Action 2.3 In cooperation with the USFS, investigate the feasibility of raising the average water level of Sparks Lake by sealing off major water loss areas.

Action 2.4 Implement habitat improvement projects as identified in Action 2.2.

Objective 3. Maintain or improve access to the Century Drive Lakes.

Assumptions and Rationale

1. Access is adequate to support the present fisheries at Elk and Hosmer lakes.

2. Access could be improved at Sparks, Devils, North Twin, and South Twin lakes.

3. North and South Twin lakes would be suitable for developing additional juvenile and disabled fishing areas.

ACTIONS

Action 3.1 Improve the low water launching of boats at Sparks Lake; construct a boat ramp at Devils Lake; construct an improved ramp at North and South Twin.

Action 3.2 Maintain the present facilities at Elk and Hosmer lakes.

Action 3.3 Work with USFS to develop juvenile and disabled facilities at North and South Twin lakes.

CASCADE MOUNTAIN LAKES

Overview, Location and Ownership

Within the Upper Deschutes Basin, fisheries in 90 of the Cascade Mountain lakes are managed for recreational angling utilizing stocked hatchery fish. These lakes are located east of the Cascade summit from Mt. Jefferson south to the northern boundary of the Douglas and Klamath county lines. A map is not included for this section of the basin plan because the lakes encompass too large a geographic area to represent graphically. Maps showing the location of each lake can be obtained from the US Forest Service or the Oregon Department of Water Resources.

All 90 lakes are located on Deschutes National Forest land and are managed under its Land and Resource Management Plan (USDA 1990). Historically, most of these lakes were barren of fish because they are geologically young and have not been connected with other water bodies. In cooperation with the US Forest Service, ODFW has stocked a variety of trout species since the 1910's (The Oregon Sportsman, August 1914).

Because there were no indigenous fish in these lakes originally, application of the Wild Fish Management Policy (ODFW 1992) for these lakes is much more limited. A "wild only" alternative is not required in this case; however, movement of hatchery fish out of the lakes and into wild populations downstream is a concern and will be addressed in this plan. Whitefish in Winopee Lake constitute the only known wild fish population identified in the Cascade mountain lakes covered in this plan. Winopee Lake has a continual outlet to Cultus Lake and the Deschutes River via Cultus Creek. The only known populations of non-game fish are longnose dace in Round Lake. It is not known if they are indigenous, but they are found in the nearby Metolius River.

Access

Most Cascade Mountain lakes are located within wilderness or roadless areas that can only be reached by non-motorized or non-wheeled travel such as by foot or horse. Early season access is generally limited by persistence of winter snows on access trails. Lakes open to road access are Irish, Taylor, Deer, Charlton, Todd, and Hand Lakes. Since increasing access by improving road quality would not be compatible with maintaining the primitive to semi-primitive nature of the fishery, the Department has recommended to the USFS that current access roads be maintained as unimproved.

Habitat and Habitat Limitations

The Cascade Mountain lakes program relies on the natural productivity of each lake to grow stocked fingerling trout to legal-size fish in one to two years. Consequently, the success of the program is contingent on maintaining the productivity of these waters. Management of lands and resources surrounding the Cascade Mountain lakes addressed here is described in the Deschutes NF LRMP.

National forest management of lakes located on federally designated land as Wilderness, Research Natural Areas, or Old Growth, where 63 of the 90 lakes are located, is generally compatible with ODFW management guidelines for primitive or semi-primitive fisheries. These lands do not have programmed timber harvest, but do allow other activities associated with mineral development, range, forest health, and fire management that may affect the natural productivity of these lakes (Meehan 1991).

Although management activities allowed on land designated as General Forest, Dispersed Recreation, Winter Recreation, Scenic Views, Metolius Special Forest, Oregon Cascades Recreation Area, or Front Country (27 lakes) can potentially affect the natural productivity of Cascade Mountain lakes, Standards and Guidelines identified in the LRMP should protect the productivity of these waters.

Three lakes are located on boundaries between management areas, which can lead to land management conflicts. These lakes are Black Crater, Johnny, and Raft lakes. As an example, the land surrounding Black Crater Lake is managed as Wilderness and Front Country. Wilderness management activities promote ecological processes, while Front Country allows management activities such as timber harvest. The Department suggests that each lake be managed under one land classification to maintain continuity.

Natural factors may limit the productivity of fish populations. Habitat deficiencies may include a lack of abundant food resources, lack of cover, (a common limiting factor) and prolonged periods of ice cover resulting in periodic winter kill.

Most Cascade high lakes have pH's of about 7.0 or neutral. Volcanic soils are dominant. These lakes are vulnerable to acid rain because there is no buffering capability of the soil. If these lakes became too acidic, they would lose ability to support aquatic life.

Fish Stocking History

The Cascade Mountain lakes were stocked as early as 1912 using packhorses. From the early 1950's through early 1980's, each lake was stocked by fixed-wing aircraft. Since then each lake has been stocked annually or biennially using a helicopter.

At the inception of the stocking program, limnological information was gathered at each lake to determine if it would support fish life. One or more trout species were stocked if the lake appeared to be suitable. Fish stocked in the past include several races of rainbow trout, brook trout, Atlantic salmon, lake trout, and cutthroat trout. Presently, fish stocking decisions are guided by periodic lake surveys, creel surveys, historical records, and anecdotal information from fishermen. The Department has determined that 90 of over 400 Cascade Mountain lakes covered in this plan are capable of sustaining trout throughout the year.

The Department currently stocks brook trout (original brood unknown, possibly from New Jersey), coastal rainbow trout (referred to as Cape Cod stock, original stock from McCloud River, California), and westslope cutthroat trout (Twin Lakes brood from Washington's Lake Chelan) in the 90 Cascade Mountain lakes. Brook trout and rainbow trout stocked are fall spawners while cutthroat are spring spawners. Inventories generally show little natural reproduction, although fish have successfully spawned in some lakes. The only known populations of wild fish in these lakes are whitefish in Winopee Lake. These fish likely spawn in the outlet or in unknown areas of the lake. Like brook trout, whitefish spawn in November to December, but it is not possible for these species to hybridize.

Angling Regulations

Other than minor season changes, temporary closures or bag limit changes in some of the lakes, the Cascade Mountain Lakes have been regulated under the general trout season and bag limit. Other significant changes are listed below:

1942 Todd Lake fly angling only. No angling from a motor-propelled craft in Irish or Taylor lakes.

1945 No angling from a boat in Lucky Lake.

1966 Fly fishing only in Charlton Lake.

1967 Motor boats allowed on Irish and Lucky lakes.

1968 Fly fishing only removed from Charlton Lake.

1977 Todd Lake open to angling from a floating device.

Currently these lakes are open for fishing from late April to the end of October (general Oregon trout season) with a 10- trout bag limit, minimum length 6 inches. Non-motorized boats are allowed. There is no bag limit for whitefish; open season is the same as for trout.

Fish Management

ODFW currently manages Cascade Mountain lakes under the Basic Yield Management Alternative in the Trout Plan (1987). Fisheries under this alternative are of a general consumptive nature and production is based on fingerling stocking and the water's natural rearing capability. One objective of this program is to provide a diversity of fisheries to anglers. This diversity may be measured in difficulty of access, or uniqueness of species or combination species available at each lake. The Department has found brook, rainbow, and cutthroat trout best suited to provide a legal-size fish within one to two years. Lakes have been stocked on an annual basis in past years, but due to current budget limitations stocking is now conducted biennially.

The stocking rate in each lake depends on size, productivity, catch rate, survey information, and past experience. The target size at stocking is 150 to 200 fish per pound. Survival and catch rates vary annually and for each lake and the number subsequently stocked is adjusted accordingly. Stocking is also dependent on availability of eggs. In 1993 the Washington Department of Wildlife did not have surplus eggs to supply to ODFW so Twin Lakes cutthroat were not stocked. Lakes (noted in Table 50) scheduled for cutthroat were planted with rainbow or brook trout.

There is no conclusive data to confirm movements of hatchery fish out of the lakes, but the potential risk to downstream wild populations affects the management alternatives. Information on each lake's outlet and inlet has been compiled from periodic Cascade Mountain lake surveys began in 1932, from Oregon Water Resources Board maps, USGS maps, and from field observations of ODFW district personnel (Table 50). Some lake outlets are ephemeral and may be open only during years of above average precipitation, others are open continuously, while others have outlets that disappear into the substrate or may be open only during periods of snowmelt. The status of lake outlets listed in Table 50 is subject to change as future high lake surveys provide updated information.

The outlet status is important because Wild Fish Management Policy (1992) directs the Department to not authorize introduction of non-indigenous fish in locations where impacts to wild populations might occur from hybridization, competition, disease introduction, or predation. Brook trout interbreeding with bull trout exemplifies such a concern. Dambacher et al. (1992) found negative interactions between introduced brook trout and bull trout in the Crater Lake watershed where interbreeding resulted in sterile off-spring and, eventually, diminished numbers of bull trout. Stocking of Table Lake (Metolius subbasin) with brook trout was discontinued in 1993 because of potential risks to Metolius River bull trout.

In recent years there has been a growing concern about the impacts of fish stocking on native lake ecosystems. Herpetologists are concerned that stocking fish into lakes may disrupt amphibian populations. Blaustein (1993) found mortality in western toad *Bufo boreas* eggs from the fungus *Saprolegnia ferax* in Lost Lake, Todd Lake, and Three Creeks Lake. While *Saprolegnia* spp. occurs naturally in these lakes, it is also a common pathogen of hatchery fish. Although *Sparolegnia* appears to be an acute cause of mortality in *B. boreas*, research suggest that their susceptibility may be exacerbated by increased levels of ultraviolet-B radiation measured at these lakes (Blaustein 1994). It is unknown at this time if stocking of hatchery fish, changes in the ozone layer, or both are causing these losses.

Liss et al. (1991) found in studies in the Washington Cascades that introduced fish populations can have substantial effects on plankton, aquatic insect, and salamander populations. The Cascade frog *Rana cascadae* is known to occur at high elevations east of the crest of the Cascades. It is listed as a Federal Category 2 species and the Department lists it as State Sensitive- Critical. The spotted frog *Rana pretiosa* also occurs in this region and is listed as State Sensitive- Critical. It is difficult to assess impacts of fish stocking since historic and current distribution and abundance of these amphibians in the region of the Cascade Mountains covered in this plan is unknown. Hopefully, further research and additional inventories of native amphibians will help answer these questions.

These issues indicate a need to examine the ODFW stocking program of the Cascade Mountain lakes with regard to its potential ecological impacts to natural ecosystems. ODFW is committed to the conservation of native ecosystems, and will work jointly with the USFS to identify the lakes appropriate for fish management activities. In 1985 through its affiliation with the International Association of Fish and Game Agencies, ODFW signed a Memorandum of Understanding with the USFS that resolution of recreation management in wilderness areas of Oregon, including fish stocking, would be addressed through cooperative development of Wilderness Management Plans. To date, the format and protocol for addressing these issues in Wilderness Management Plans has yet to be developed. This plan will provide interim direction until amended following concurrence with the USFS of new fish stocking policies for these lakes as part of jointly developed wilderness management plans.

Personnel from Deschutes NF have indicated some lakes have recreational use approaching or beyond limits of acceptable change. Recreational fishing is one activity that may be contributing to heavy use. Other factors such as distances to the trailhead, ease of terrain, distance to neighboring lakes, or outstanding scenic beauty also effect levels of use. It may be possible to redistribute anglers through reduction or discontinuation of fish stocking, removal of trail access, or other management actions. Again, these issues will be settled in the future in Wilderness Management Plans.

ODFW has committed to not stock any new lakes in the Cascade Mountains covered under this plan since 1978. Over 400 additional lakes and ponds in this region of the Cascade Mountains are not stocked. These lakes range in size from less than one acre to several acres in surface area.

TABLE 50. CASCADE MOUNTAIN LAKES

Upper Deschutes Fish District

Water Body	Map Location	Size (acres)	Depth (feet)	Elevation (feet)	Species Allocated *	Outlet	Number Stocked (1993) #	Land Management @
1. Barbie	T20S R6E S24	3	17	5,500	BT	y-i-Pygmy/Clark	235	wilderness
2. Black Crater	T15S R8E S24	8	12	5,300	BT	n-bsn	795	wilderness/ front country
3. Blow	T19S R8E S6	55	23	5,050	BT	y-i-Elk L.	6,640	wilderness
4. Blowdown	T20S R6E S36	4	8	5,500	BT	n-bsn	470	dispersed recreation
5. Bobby	T22S R6E S14	91	59	5,408	BT	y-i-Davis L.	940	dispersed recreation
					RB		900	wilderness
6. Brahma	T20S R6E S13	10	12	5,500	BT	y-unk-unk	881	wilderness
7. Cathy	T20S R7E S18	2	18	5,500	RB	n-bsn	281	wilderness
8. Charlton	T21S R6E S14	156	95	5,692	BT	y-i-Crn. Pra.	2,996	scenic views
9. Clark	T20S R6E S24	1	12	5,500	BT	y-i-unk	235	wilderness
10. Comma	T20S R7E S14	16	6	4,700	BT	y-i-Cultus L.	411	wilderness
11. Copper	T20S R7E S19	1	10	5,700	BT	n-bsn	235	wilderness
12. Deer	T20S R7E S21	52	26	4,896	BT	n-bsn	1,880	dispersed recreation
13. Dennis	T20S R6E S12	10	42	6,100	BT	y-unk	940	wilderness
14. Doris	T19S R7E S12	69	95	5,310	BT	n-bsn	3,640	wilderness
15. Big Finger	T19S R7E S33	5	15	5,400	BT	y-i-Snshe.	235	wilderness
16. Found	T21S R6E S25	6	11	5,900	BT	y-i- Crn. Pra.	940	dispersed recreation
17. Gleneden	T20S R6E S4	1	14	5,700	BT	y-i-DE	235	wilderness
18. Golden	T17S R8E S13	1	18	6,500	BT	y-Deschutes	190	wilderness
19. Goldeneye	T19S R7E S10	2	20	5,600	BT	y-i-DE	411	wilderness
20. S.Green	T17S R8E S23	8	30	6,540	BT	y-unk-M.Green	285	wilderness
21. E. Hanks	T20S R7E S30	6	22	5,500	CT	n-bsn	940-BT	wilderness
22. M. Hanks	T20S R7E S30	6	22	5,500	RB	n-bsn	940-BT	wilderness
23. W. Hanks	T20S R7E S30	8	10	5,500	BT	n-bsn	823	wilderness

Table 50. Continued

Water Body	Map Location	Size (acres)	Depth (feet)	Elevation (feet)	Species Allocated *	Outlet	Number Stocked (1993) #	Land Management @
24. Harlequinn	T20S R7E S30	3	21	5,300	RB	y-i-DE	281	wilderness
25. Hidden	T23S R5.5 S21	10	21	5,850	BT	n-bsn	940	dispersed recreation
26. Hunter	T16S R8E S35	9	10	6,200	BT	y-i-unk	530	wilderness

27. Irish	T20S R6E S25	35	16	5,550	BT	y-i-L.Cultus L.	2,820	wilderness
28. Jay	T20S R7E S29	12	10	5,000	BT	y-i-DE	529	wilderness
29. Johnny	T21S R7E S29	18	21	5,400	BT	y-i-Wick. R.	1,175	dispersed recreation/ general forest
30. Josephine	T20S R6E S13	3	10	6,000	BT	y-i-unk	294	wilderness
31. Junco	T21S R8E S18	2	13	6,100	BT	n-bsn	235	wilderness
32. Kershaw	T20S R7E S30	4	13	5,500	BT	y-unk-unk	646	wilderness
33. Kinnikinnic	T20S R7E S30	2	12	5,500	BT	y-unk-unk	294	wilderness
34. Lady	T20S R6E S24	2	15	5,500	BT	n-bsn	353	wilderness
35. Lemish	T21S R7E S5	16	13	5,200	BT	y-i-L.Cultus L.	1,469	general forest
36. Lily	T21S R6E S12	15	44	5,700	BT	y-unk-unk	940	dispersed recreation
37. Lindick	T20S R6E S1	8	25	6,100	BT	n-bsn	940	wilderness
38. Lodgepole	T20S R7E S30	4	10	5,500	BT	y-unk-unk	235	wilderness
39. Long	T19S R7E S29	10	9	5,250	BT	n-bsn	353	wilderness
40. Lucky	T19S R8E S20	30	52	5,250	BT	y-unk-unk	1,880	wilderness
41. N. Mathieu	T15S R8E S28	5	15	5,850	BT	y-unk-unk	285	wilderness
42. Merle	T20S R7E S20	8	17	5,500	BT	y-unk-unk	529	wilderness
43. Phantom	T20S R7E S30	4	6	5,500	BT	n-bsn	294	wilderness
44. Puppy	T19S R7E S21	10	13	5,300	BT	n-bsn	294	wilderness
45. Pygmy	T20S R6E S24	1	12	5,500	BT	y-i-DE-Brbi.	235	wilderness
46. Raft	T20S R7E S29	10	27	4,900	BT	y-unk-unk	705	wilderness/ research natural area
47. Red Slide	T20S R6E S24	2	18	5,500	RB	n-bsn	281	wilderness
48. Rim	T17S R9E S17	4	12	7,500	BT	n-bsn	190	wilderness
49. Rock Rim	T20S R6E S13	4	13	6,000	BT	n-bsn	411	wilderness
50. Simon	T20S R7E S19	2	10	5,700	BT	n-bsn	235	wilderness
51. L. Snowshoe	T19S R7E S33	8	12	5,100	BT	y-i-Wnpe. L.	823	wilderness
52. M. Snowshoe	T19S R7E S33	3	13	5,150	BT	y-i-L.Snwshe. L.	235	wilderness

Table 50. Continued

53. U. Snowshoe	T19S R7E S29	30	8	5,150	BT	y-unk-unk	940	wilderness
54. Strider	T20S R7E S29	3	22	5,000	BT	y-unk-unk	281	wilderness
					RB		281	wilderness
55. Swede	T20S R7E S19	1	10	5,700	BT	y-i-unk	235	wilderness
56. Taylor	T20S R6E S25	40	11	5,550	BT	y-i-L.Cultus L.	2,820	dispersed recreation
57. N. Teddy	T20S R7E S10	30	26	4,900	BT	n-bsn	940	wilderness
					RB		900	wilderness

58. S. Teddy	T20S R7E S10	5	10	4,900	BT	y-i-Cultus L.	1,880	wilderness
59. Timmy	T20S R6E S24	2	15	5,500	RB	y-unk-unk	235	wilderness
60. Todd	T18S R9E S7	29	60	6,151	BT	y-DE-Bare L.	1,998	dispersed recreation
61. Tranquil	T20S R7E S19	1	10	5,700	BT	y-i-DE	235	wilderness
62. Winopee	T19S R7E S33	37	42	4,351	BT	y-Cultus L.	940-BT, 900-BT	wilderness
63. Yapoah	T15S R8E S34	30	25	7,200	RB	n-bsn	538	wilderness

Klamath Fish District

64. Bell	T25S R6E S6	2	34	5,920	BT	n-bsn	350	OCRA
					RB		500	
65. Bonnies	T23S R51/2E S27	6	24	6,200	BT	y-i-Karen's L.	750	wilderness
66. Darlene	T25S R6E S7	11	27	5,950	BT	y-i-DE	1,000	OCRA
67. Effie	T24S R51/2E S14	5	14	5,950	BT	n-bsn	500	wilderness
68. Elf	T24S R51/2E S36	3	15	5,900	CT	y-i-DE	300	OCRA
69. Farrell	T24S R51/2E S23	4	11	5,580	BT	n-bsn	500	wilderness
70. Fawn	T24S R6E S4	43	27	5,680	BT	y-i-DE	2,000	wilderness
71. Gray Jay	T25S R51/2E S1	5	15	5,875	BT	y-i-DE	500	OCRA
72. Hidden	T23S R51/2E S21	11	21	5,850	RB	n-bsn	500	wilderness
					CT		500	
73. Horsepasture	T23S R51/2E S13	2	5	5,100	BT	y-i-Odell L.	Nat. Prod.	wilderness
74. Lil's	T23S R51/2E S22	4	18	5,980	RB	y-i-DE	200	wilderness
					CT		200	
75. Maiden	T23S R6E S1	6	23	6,360	BT	n-bsn	500	dispersed recreation
76. Meek	T24S R5E S26	11	38	5,580	BT	y-i-Crescent L.	1,000	OCRA

Table 50. Continued

					CT		500	
77. Oldenburg	T25S R6E S10	28	29	5,200	BT	y-i-DE	1,500	OCRA
78. Rosary, Lower	T23S R6E S3	42	50	5,710	BT	y-i-Odell L.	2,000	dispersed recreation
					RB		1,000	
					CT		1,000	
79. Rosary, Middle	T23S R6E S3	9	31	5,830	BT	y-i-L. Rosary L.	500	dispersed recreation
80. Rosary, Upper	T23S R6E S3	8	21	5,835	BT	y-i-M. Rosary L.	500	dispersed recreation
81. Snell	T24S R51/2E S23	9	17	5,555	BT	n-bsn	1,000	wilderness
					CT		500	
82. Sowbug	T24S R51/2E S14	3	14	6,020	BT	n-bsn	300	wilderness

83. Stag	T23S R6E S35	20	27	5,840	BT	n-bsn	1,500	wilderness
84. Suzanne	T25S R6E S7	10	47	6,000	BT	y-i-DE	500	OCRA
					CT		500	
85. Windigo, W.	T25E R61/2E S29	5	19	5,880	BT	y-i-Big Marsh	500	OCRA
86. Windy, E.	T25S R51/2E S12	14	14	6,190	BT	y-i-Crescent L.	1,000	OCRA
87. Windy, N.	T25S R51/2E S1	2	27	6,190	BT	y-i-Crescent L.	500	OCRA
88. Windy, S	T25S R51/2 E S12	11	28	6,225	BT	y-i-DE	500	OCRA
					CT		500	
89. Windy, W.	T25S R51/2E S12	16	18	6,220	BT	y-i-E. Windy L.	750	OCRA
90. Yoran	T23S R51/2E S27	32	44	6,000	RB	y-i-Odell L.	2,000	wilderness

*- refers to BT= brook trout, RB= rainbow trout, CT= cutthroat trout. @- refers to Deschutes National Forest Land and Resource Management Plan (1990). n= no, y= yes, bsn= basin lake with no outlet, DE= outlet present and flows to ground water or water body listed, i=intermittent flow to water body listed, unk= unknown status, bull trout refers to no longer stocked due to concerns about bull trout downstream; #- numbers listed for reference, for example- 900-BT refers to numbers and change in species due to shortage in allocated species. OCRA- Oregon Cascades Recreation Area.

MANAGEMENT DIRECTION

CASCADE MOUNTAIN LAKES

POLICIES

Policy 1. Whitefish in Winopee Lake will be managed for natural production consistent with the Featured Species Management Alternative for trout (ODFW 1987).

Policy 2. Cascade Mountain lakes in the Upper Deschutes Subbasin will be managed for natural and hatchery production consistent with the Basic Yield management alternative for trout (ODFW 1987).

Policy 3. Hatchery rainbow, brook, and cutthroat trout will be stocked into the lakes listed in Table 50.

Policy 4. No fish will be introduced into Cascade mountain lakes not currently stocked.

Policy 5. Hatchery trout will not be stocked into high lakes which drain into waters with wild fish populations if there is a risk to the genetic integrity of these wild populations.

OBJECTIVES

Objective 1. Maintain abundance, distribution, and genetic integrity of whitefish in Winopee Lake.

Assumptions and Rationale

1. Winopee Lake supports a healthy population of indigenous whitefish which can support an increased sport fishery.

2. Management of this population will contribute to diversity of fishing opportunities in the Cascade Mountain lakes.

3. Monitoring abundance, size, age-class structure, and distribution of whitefish will provide an indication of their health and adaptiveness.

ACTIONS

Action 1.1 Continue to monitor population abundance, size, and age class structure and distribution of whitefish in Winopee Lake through periodic gillnet inventory.

Action 1.2 Monitor, through creel checks, angler effort and catch.

Action 1.3 Continue to stock Winopee Lake with hatchery trout to provide a diversity of fishing.

Objective 2. Provide diverse angling opportunities for selected trout species in Cascade Mountain lakes of the Upper Deschutes River basin.

Assumptions and Rationale

1. There is a high level of public interest in retaining this fishery.

2. These high lakes have been stocked periodically since the 1910's.

3. Suitable spawning habitat does not exist in most of these lakes and periodic stocking is required to maintain a fishery.

4. These angling opportunities depend on Deschutes NF adhering to Standards and Guidelines in the LRMP to maintain the natural productive capacity of each lake.

5. There may be opportunities to stock additional trout species in the high lakes.

6. Diversity may be measured in difficulty of access or the trout species or combination of species available at each lake.

ACTIONS

Action 2.1 Stock the lakes listed in Table 1 with hatchery rainbow trout, brook trout, and/or cutthroat trout.

Action 2.2 Inventory trout populations in stocked lakes for size, growth, condition factor, and species composition.

Action 2.3 Monitor angler effort and catch.

Action 2.4 Continue to adjust the high lakes stocking program to meet the productivity and angler use of each lake.

Action 2.5 Investigate the possibility of introducing new trout species into lakes currently stocked to increase the diversity of the fishery.

Action 2.6 Continue to work with Deschutes NF to document adherence to Standards and Guidelines.

Objective 3. Maintain and enhance fish habitat in the Cascade Mountain Lakes.

Assumptions and Rationale

1. Trout habitat is generally good in most lakes, but may be improved through enhancement projects.

2. Habitat enhancement may increase the survival and production of trout in these waters.

3. Implementation of habitat projects will be done through cooperation and funding from the Mitigation and Enhancement Committee, Deschutes National Forest, and other interested groups.

4. There may be opportunities to improve spawning habitat in some lakes.

5. Surveys will need to be done to determine enhancement opportunities.

ACTIONS

Action 3.1 Continue working with the Bend Ranger District to maintain productivity of the Cascade Mountain Lakes.

Action 3.2 Use ODFW and Bend Ranger District surveys to determine the most effective area and type of enhancement.

Objective 4. Minimize the impacts of hatchery trout on the production and genetic integrity of wild trout in the Deschutes River basin.

Assumptions and Rationale

1. Some high lakes have outlets that may allow hatchery fish access to waters containing wild fish populations.

2. Effects of emigrating hatchery fish on wild fish populations is unknown, but poses certain risks.

3. Where high lakes have connections to waters containing wild trout, maximizing harvest or eliminating stocking will minimize impacts to wild fish.

4. Information on the outlet status of some high lakes needs to be confirmed.

ACTIONS

Action 4.1 Survey high lake outlets that drain into the Upper Deschutes River subbasin to determine if wild trout or naturalized populations of introduced trout are present. If hatchery trout stocked in the lakes have access to downstream wild trout populations, electrophoresis or morphometric measurements may be necessary to determine the degree of interaction between wild and hatchery trout.

Action 4.2 Continue to use hatchery stocks that demonstrate a minimum of migratory behavior.

Action 4.4 Determine if elimination of stocking is needed to minimize impacts of hatchery fish on wild fish and act as necessary.

Action 4.5 Determine outlet condition of those lakes listed in Table 1 with unknown status.

Objective 5. Manage Cascade Mountain lakes fisheries consistent with wilderness management plans to be jointly developed with Deschutes National Forest personnel.

Assumptions and Rationale

1. Recent research has shown introduced hatchery fish populations negatively impact native amphibian and macroinvertebrate populations and plankton ecosystems in high lakes. It is unknown at this time if these actions are causing a serious depletion in these ecosystems in Cascade Mountain lakes.

2. Some effects of introduced hatchery fish may be irreversible.

3. There may be a relationship between riparian habitat damage by recreationists and the fisheries in the high lakes.

4. Without a Wilderness Management Plan in place, the Upper Deschutes Basin plan will provide direction in the interim.

ACTIONS

Action 5.1 Work with the Deschutes NF to investigate if the stocking of hatchery fish in high lakes has negatively affected native species ecosystems.

Action 5.2 Work with the Deschutes NF to determine the cause of damage to land surrounding high lakes stocked with hatchery fish. Manage the fishery to minimize the problem if the attraction of people to the fishery is the source of the damage.

Action 5.3 Identify jointly with USFS lakes that have intrinsic values that preclude fish stocking and discontinue stocking.

Action 5.4 Develop a monitoring plan with Deschutes NF to assess the impact to Cascade Mountain lakes as a result of fish stocking.

MISCELLANEOUS WATERS

THREE CREEKS LAKE, LITTLE THREE CREEKS LAKE, SHEVLIN POND, CENTURY POND, SPRAGUE PIT POND, FIREMAN'S POND

THREE CREEKS LAKE

Location and Ownership

Three Creeks Lake lies at an elevation of 6,550 feet on the Deschutes National Forest approximately 25 miles northwest of Bend and 15 miles south of Sisters.

Primary road access is provided by Forest Road 16 south from Sisters and secondary access by Forest Road 370 north from FR 46 (Century Drive). The surrounding land is managed by the Deschutes National Forest and the Three Sisters Wilderness boundary is just south and west of Three Creeks Lake. The Forest Service maintains two unimproved non-fee campgrounds, one at the south end of the lake and one at Three Creek Meadow. There is no improved boat ramp at the lake, but it is possible to launch small boats from the east shore. A private concessionaire maintains a small store with boat rentals under Forest Service special use permit.

Habitat and Habitat Limitations

Three Creeks Lake is 76 acres in size with a small drainage basin of 1 square mile. The maximum depth is 30 feet with an average depth of 11 feet. Forty-nine percent of the lake area is classified as shoal and the shoreline is 1.5 miles in length (Johnson, et al 1985).

The small, steep drainage basin provides water to the lake from snowmelt in the spring and summer along with two small unnamed streams (Johnson, et al 1985). Three Creeks Creek is the only outlet of the lake and is unscreened.

Three Creeks Lake is a natural lake which was dammed in the early 1900's to create irrigation storage. The dam was rebuilt in the 1920's. The dam raised the lake level approximately 10 feet and increased its storage capacity by approximately 1,267 acre-feet at any given moment. Snow Creek originally flowed into the lake, then was diverted via an irrigation ditch into Squaw Creek; at present the irrigation ditch is no longer diverting the water. The outlet of Little Three Creeks Lake was diverted to flow into the northern end of Three Creeks Lake. This man-made ditch provides spawning habitat for Three Creeks Lake trout.

The dam was deemed unsafe in 1988 by the Oregon Water Resources Department which ordered the headgate opened in October 1992 to lower the lake level and take pressure off the dam. Several years were spent identifying owners with water rights of record who might be willing to take responsibility for the dam and needed repairs. In this process, the majority of the water rights to Three Creeks Lake and Three Creeks Creek were abandoned, and the Forest Service Office of General Counsel determined that the dam is property of the United States. The Forest Service is therefore, responsible for the dam and is working to secure water rights for fisheries and recreation. The Forest Service is willing to repair the dam, but has been unable to secure adequate funding for the project.

Water chemistry in Three Creeks Lake is typical of mountain lakes in the Cascades, with low concentrations of ions, alkalinity, and conductivity. Phosphorus and chlorophyll concentrations are also low and the transparency is high; the bottom is visible even at the deepest portion of the lake. Because of the high altitude, water temperatures remain quite low even in summer, and biological productivity is low. By all indicators, Three Creeks Lake is oligotrophic (Johnson, et al 1985).

Fish Stocking History

It is unknown if Three Creeks Lake contained any fish originally. The Oregon Sportsman, September 1914, reported 2,000 rainbow trout (stock unknown) were stocked in the lake in 1913. Newcombe (1941) reported brook trout were stocked in the lake in 1936, although it is likely brook trout were introduced much earlier based on their presence in other nearby waters in the early 1900's. Current records date to 1945 and show rainbow trout stocked annually to the present. Brook trout stocking continued from 1945 through 1965. Brook trout are maintained by natural production. Rainbow trout stocking has been predominantly legal-size fish and the current allocation is 4,000 legal-size (3 per pound) annually.

Angling Regulations

Angling regulations for Three Creeks Lake have generally followed the general trout season dates and bag limits for lakes and reservoirs. There have been no gear restrictions and the lake has been closed to the use of motorboats since at least 1948.

The current regulations are: April 27 to October 31 season, 10 trout per day; no more than 5 over 12 inches and of these, no more than 2 over 20 inches; 6-inch minimum length. No gear restrictions. No motors allowed.

Fish Management

Three Creeks Lake is managed as a Basic Yield fishery for introduced naturally reproducing brook and rainbow trout, and hatchery legal-size rainbow trout.

Fish inventory is conducted periodically using gillnets. The last inventory work was done in 1995 when two gillnets captured 57 brook trout ranging from 4.8 - 14.7 inches in length, 6 naturally produced rainbow trout ranging from 5.8 - 8.8 inches in length and three hatchery legal-size rainbow trout. No holdover hatchery rainbow trout were captured. Thirteen female brook trout were maturing at an average length of 11.1 inches, indicating good growth for a lake at this elevation with a short growing season. In contrast, the naturally-produced female rainbow trout were maturing at an average length of 6.9 inches, barely above the 6-inch minimum legal size for anglers.

Since rainbow trout were stocked as early as 1913, and there is no record of indigenous redband trout presence in Three Creeks Lake, it is likely that hatchery rainbow trout have spawned successfully to maintain a small population of rainbow trout. Spawning habitat is marginal at best for rainbow trout and the oligotrophic character of the lake limits growth. Three Creeks Lake naturally-produced rainbow trout have not been analyzed for their genetic characteristics.

Three Creeks Lake is seldom checked for angler success and recent catch information is lacking. There are no total catch and angler use estimates. Periodic reports from Forest Service personnel and individual anglers indicate the fishing has been good, especially when access first opens from mid-June to early July. Anglers also report catching brook trout in the fall, however as is typical, brook trout are difficult to catch during mid-summer.

A small percentage of the hatchery legal-size rainbow trout survive the angling season they are stocked, grow, and carryover to the next season where fish 14-16 inches in length are caught.

Management Issues

1. The outlet of Three Creeks Lake is unscreened and it is unknown how many trout may be lost from the lake each year.
2. The dam has not been repaired by the Forest Service resulting in a low lake water level which reduces aquatic food production and fish habitat.
3. Brook trout are self-sustaining in the Three Creeks Lake system, and the population is abundant, but anglers report low harvest rates.
4. The self-sustaining rainbow trout population has not been analyzed for genetic characteristics.

LITTLE THREE CREEKS LAKE

Little Three Creeks Lake is located at an elevation of 6,720 feet on Deschutes National Forest land approximately one-half mile west of Three Creeks Lake. The lake is reached from FR 900 and Trail 97.

Little Three Creeks Lake was a natural lake on which a dam was constructed in 1924 to raise the water level to supply irrigation water to Snow Creek Irrigation Company.

The lake impounds about 11 surface acres with an maximum depth of 17 feet. The drainage basin for the lake encompasses 237 acres. The shoreline is 0.63 miles in length. The lake's substrate is comprised of glacial silt. The water is very clear and slightly alkaline with a pH of 7.8. The lake is fed by three small unnamed surface streams and underground springs. Lake shore vegetation is a mixed stand of lodgepole pine, white bark pine and alpine fir. Very little low growing vegetation is present; soils in the area are of pumiceous origin.

Little Three Creeks Lake contains naturally reproducing brook trout and rainbow trout. It is unknown if any fish were indigenous to the lake. Current records show brook trout were stocked in 1959 and 1961 by aircraft, however, it is likely brook trout were stocked in the lake in the 1920's or earlier when brook trout stocking in Cascade lakes began. No fish have been stocked into the lake since 1961. It is unknown when rainbow trout were first introduced and there are no current records showing rainbow stocking for the lake. It is likely rainbow trout migrated to Little Three Creeks Lake from Three Creeks Lake via the irrigation ditch. Rainbow trout have been planted in Three Creeks Lake since at least 1947.

There are no records of physical lake surveys by the Department for Little Three Creeks Lake. The Deschutes National Forest has limited information on the physical characteristics of the lake. The last record of fish inventory was in 1967 when one gillnet caught 9 brook trout from 7-10 inches in length and 3 rainbow trout from 6-13 inches in length.

The Department has no recent creel census data showing harvest or catch rates. Anecdotal reports from anglers indicate good fishing for brook trout in recent years. The lake needs to surveyed both physically and biologically.

SHEVLIN POND

Shevlin Pond is a small 1/2 acre pond located in Shevlin Park approximately 4 miles west of the city of Bend via Shevlin Park Market Road. Shevlin Park is owned and operated by Bend Metro Park & Recreation District. The pond's water supply is provided by an inlet channel from Tumalo Creek and the outlet returns to the stream.

The pond has been stocked by the Department since 1977 with legal-size rainbow trout during the regular April to October season. Currently, the annual trout allocation for the pond is 1,000 fish per year.

In 1980, the pond was reconstructed in a cooperative project by Bend Metro Park and Recreation District, Sunriver Anglers Club, and ODFW. The pond was deepened, shaped, and new inlet and outlet structures built. In addition, Sunriver Anglers Club built an arch bridge over the pond accessible by people with wheelchairs.

Technically, the pond falls under State angling regulations for lakes, ponds, and reservoirs. However, Bend Metro Park and Recreation District has signed the pond open for juveniles, and disabled persons, with a 2 fish daily limit, open during the general trout season. Angler use at the pond is heavy and is especially popular with young anglers. In the winter, ice conditions permitting, the pond is used for ice-skating.

Shevlin Pond offers an opportunity to create a state-designated juvenile/disabled persons fishing area with enforceable regulations.

CENTURY DRIVE POND

Century Drive Pond is located on Deschutes National Forest land approximately 1/4 mile west of the junction of FR 46 (Century Drive) and FR 4635, the road to Cultus Lake. The pond is approximately 46 miles southwest of Bend.

The pond covers about 3 acres when full of water. The pond is a Forest Service gravel extraction site which fills with water from annual snowmelt. The amount and duration of water in the pond is directly proportional to the amount of winter precipitation in the area. The maximum depth of water at full pool is about 15 feet. There is no visible outlet.

The pond has been stocked by the Department with legal-size rainbow trout since 1970 and the current allocation is 1,000 fish per year. In poor water years, stocking is often terminated early because of low water and high surface water temperatures.

In cooperation with the Deschutes National Forest, Bend Ranger District, the pond site was examined for potential development as a site for physically-challenged anglers. The Deschutes Forest spent a fair amount of effort drawing up plans including restrooms and paved walkways, but lack of funding prevented the project from being initiated. The potential still exists for the project.

Although the Department has no current creel census data, the pond is heavily used by a variety of anglers especially seniors and juveniles.

Physically, the pond area could be enlarged, deepened in some areas and reshaped to accommodate more anglers in the future.

SPRAGUE PIT POND

Sprague Pit Pond is located on Deschutes National Forest Land approximately one mile southeast of the FR 40/46 (Century Drive) junction. The pond is approximately 3/4 mile north of Crane Prairie Reservoir.

The pond site was created as a result of gravel extraction by the Forest Service. When full, the pond surface area is about 2 acres with a maximum depth of 10 feet. Water is supplied from annual snowmelt and subsurface percolation from the Deschutes River. There is no visible inlet or outlet. The quantity of water in the pond is determined by the amount of annual precipitation in the surrounding basin. The pond does not go dry, however, stocking has been terminated in some years due to insufficient water and high surface water temperatures.

The Department has stocked legal-size rainbow trout in the pond since 1987 and the current allocation is 1,000 fish per year. The pond is very popular, especially for senior-age anglers and juveniles. The pond area could be expanded with additional gravel removal.

FIREMAN'S POND

Fireman's Pond is located on City of Redmond property approximately 1/4 mile east of Highway 97 and 1/2 mile south of Highway 126.

This pond used to be called Lion's Pond because the Redmond Lions Club took an interest in developing the pond for local youth. The pond name was changed on behalf of the Redmond Fire Department whose members adopted renovation and maintenance of the pond as a civic project. They cleaned debris from the area, deepened the pond, removed some dense stands of cattails, and built access ramps to the pond for physically challenged persons.

Water is supplied to the pond by Central Oregon Irrigation District with water rights held by the City of Redmond. When full, the pond occupies approximately 3 surface acres with an average depth of 2 feet and maximum depth of 8 feet.

The Department first stocked trout in the pond in 1985. These were surplus large rainbow and brook trout from the abatement pond at Wizard Falls Hatchery. Trout can only be stocked very early in the fishing season because the pond's water supply is Deschutes River water and *Ceratomyxa shasta* will kill non-resistant trout when the water temperatures increase in early summer. Since 1987, the Department has stocked one early release of 500 legal-size rainbow trout annually just before the start of general trout season. In addition, the City of Redmond in cooperation with the Redmond Fire Department, purchases private hatchery rainbow trout to use for a kid's fishing day.

In addition to the trout, the Department has stocked largemouth bass and bluegill since 1994 to provide a fishery the remainder of the year. The Department will continue to add warmwater fish as needed. These fish species are resistant to *C. shasta.*

The City of Redmond has signed the pond restricted to juveniles and disabled persons, but there are no such state designations. The pond offers an opportunity to create a state-designated juvenile and disabled persons fishing site with enforceable regulations.

MANAGEMENT DIRECTION

MISCELLANEOUS WATERS

POLICIES

Policy 1. Three Creeks Lake shall be managed for hatchery, legal-size rainbow trout and naturally-produced brook and rainbow trout consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 2. Little Three Creeks Lake shall be managed for naturally-produced brook and rainbow trout consistent with the Basic Yield Management Alternative for trout (ODFW 1987).

Policy 3. Shevlin, Sprague Pit and Century Drive ponds shall be managed for hatchery-produced, legal-size rainbow trout consistent with the Intensive Use Management Alternative for trout (ODFW 1987).

Policy 4. Fireman's Pond shall be managed for hatchery-produced, legal-size rainbow trout consistent with the Intensive Use Management Alternative for trout (ODFW 1987). Warmwater fish shall be managed for natural and hatchery production of bluegill and transfer of stock-size bass and bluegill consistent with Basic Yield Management in the Warmwater Fish Plan (ODFW 1987).

OBJECTIVES

Objective 1. Provide diverse angling opportunities for selected trout species in miscellaneous waters of the Upper Deschutes River basin.

Assumptions and Rationale

1. There is a high level of public interest in retaining these fisheries.

2. Stocking in these waters began as early as 1970.

3. Suitable trout spawning habitat exists only in the Three Creeks and Little Three Creeks lakes basin. Warmwater fish may be able to spawn in Fireman's Pond. The other waters have no natural spawning capability.

4. These angling opportunities depend on maintenance of a water body capable of supporting fish life.

ACTIONS

Action 1.1 Annually stock the miscellaneous waters with hatchery rainbow trout and warmwater fish.

Action 1.2 Continue to adjust the Miscellaneous Waters stocking program to meet the angler use of each lake.

Objective 2. Continue to adjust angling regulation to fit the fisheries at the Miscellaneous Waters.

Assumptions and Rationale

1. There is a need for additional state-designated juvenile, senior and disabled anglers accessible waters.

2. The City of Bend and Bend Metro Parks and Recreation District has quasi-designated the fishery at Shevlin Pond for juveniles only with a two fish bag limit. The State does not have a bag limit restriction or special designation for Shevlin Pond. Enforcement of regulations at Shevlin Pond is virtually non-existent and relies on the "honor" system for compliance.

3. Fireman's Pond is the only public water of its kind available to juveniles, seniors and disabled anglers near the City of Redmond.

ACTIONS

Action 2.1 Designate Shevlin Pond as juvenile only fishing with a bag limit of two fish per day in the angling regulations.

Action 2.2 Designate Firemen's Pond as juvenile, senior and disabled anglers only fishing in the angling regulations.

Objective 3. Protect and enhance trout habitat in the Miscellaneous Waters.

Assumptions and Rationale

1. Trout habitat is generally good in most of these waters. The use of Three Creeks Lake as an irrigation reservoir limits its ability to support fish life. Shevlin Pond's water supply is provided by a diversion from Tumalo Creek and periodic high water events have damaged the intake structure. Fireman's Pond water is provided by a diversion off a COID irrigation canal.

2. There may be opportunities to improve habitat in Three Creeks Lake and Little Three Creeks Lake.

3. The shallow, warm water in Fireman's Pond and the presence of *C. shasta* limits its ability to support trout except early in the season. It is managed as a warmwater fishery after the water temperature increases.

ACTIONS

Action 3.1 Continue to work with the land managers to maintain the ability of these waters to support these fisheries.

Objective 4. Maintain or improve access to the Miscellaneous Waters.

Assumptions and Rationale

1. Access is presently adequate for most anglers at these waters, but not adequate for seniors and disabled anglers.

ACTIONS

Action 4.1 Work with the land managers to develop access for seniors and disabled anglers at these waters.

Objective 5. Develop additional Miscellaneous Waters as opportunities become available.

Assumptions and Rationale

1. Additional sites near population centers would increase fishing opportunities for juveniles, seniors and disabled anglers.

2. These sites may provide opportunities to introduce more of the general public to angling.

3. The most promising opportunity for new fishing water at the present time exists with cities, counties, irrigation districts and developers.

4. Additional sites may increase opportunities for angler education especially in conjunction with schools.

ACTIONS

Action 5.1 Encourage and seek out opportunities to develop additional miscellaneous waters.

APPENDIX A

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APPENDIX B

GLOSSARY

Adaptiveness- Tending toward, fit for, or having a capacity for adaptation.

Adfluvial- A fish life history where juveniles are born in streams, move to lakes to rear, and then migrate back up to streams to spawn. Migrating between lakes and streams.

Adipose- Small fleshy fin between the caudal fin and dorsal fin on salmonid fishes.

Allozyme- An allele of an enzyme. An allele is a particular form of a gene at a particular locus.

Alluvial- Sediment deposited by flowing water.

Amphipods- Small crustaceans of the order Amphipoda.

Anadromous- A fish life history where juveniles are born in streams, move to the ocean to rear, and then migrate back up to streams to spawn. Moving from the sea to fresh water for reproduction.

Aquatic invertebrate- Animals which have at least part of their life cycle in water.

Benthic invertebrate- Aquatic animals which spend their in-water life on the bottom of a body of water.

Benthic- Relating to, or occurring at the bottom of a body of water. The substrate of a water body (freshwater, estuarine, or marine).

Biomass- The total mass of living matter within a given volume of environment.

Carex- Genus name of a number of emergent aquatic plants in the sedge family.

Category 1 candidate- Taxa for which the USFWS has sufficient information to support a proposal to list as Threatened or Endangered under the ESA.

Category 2 candidate- USFWS candidates which need additional information in order to propose as Threatened or Endangered under the ESA.

Ceratomyxa shasta- Mxyosporidean parasite. Spread through ingestion of spores in the water from infected fish. Becomes infective when water temperatures reach 50-53 ^{0}F. There is no treatment available, always results in death of affected fish.

Ceratomyxosis- Disease caused by *Ceratomyxa shasta*

Ceratophyllum demersum- Aquatic plant with the common name hornwort.

Cfs- Cubic feet per second, a measure of water flow.

Chironomid(ae)- A diverse and ecologically important family of aquatic insects. An important food item for fish commonly known as midges.

Cladoceran- Aquatic crustaceans of the order Cladocera.

Competitive interaction- Interaction where two species compete for resources.

Conductivity- The ability or power to conduct or transmit.

Conservation- The controlled use and systematic protection of natural resources.

Copepods- Group of marine and freshwater crustaceans of the order Copepoda.

Cover- Habitat which hides or conceals from view. With fish this may be logs, boulders, substrate, depth or surface turbulence.

Creel survey- A survey interviewing anglers for catch information.

Daphnia- Small freshwater crustaceans, commonly used as aquarium food.

Degradation- Erosional removal of materials from one place to another. Degradation lowers the elevation of the streambed and floodplain.

Detritus- Undissolved organic or inorganic matter resulting from the decomposition of parent material

Dewater- Lowering of the water table in a stream caused by a channel shift or flow reduction.

Diatomaceous- Consisting of diatoms or their siliceous skeletons.

Diatoms- A class of minute planktonic unicellular or colonial algae with silicified skeletons.

Diptera- A large order of insects which includes the true flies and mosquitoes.

Displacement- Interaction between fishes where one moves the other out of position or the area.

Electrofishing- Non-lethal method of catching fish by the use of electricity conducted through water. Fish are temporarily stunned, dipnetted, examined and released.

Electrophoresis- The separation of molecules in an electric field.

Elodea canadensis- Aquatic herb of the order Hydrocharitaceae (Frog's-bit family).

Ephemeral- Streams that flow briefly and in direct response to local precipitation, and whose channel is always above the water table.

Ephemeroptera- Order of aquatic insects with the common name of mayflies.

Eutrophic- A rich aquatic environment which favors the growth of plant life over animal life; is high in mineral and organic nutrients and low in dissolved oxygen.

Extirpated- Removed from or no longer existing in a particular area.

Fecundity- Capable of producing offspring.

Fish Commission- ODFW was formerly made up of the Fish Commission and State Wildlife Commission, they merged in 1975.

Fitness- Suited, adapted, or acceptable for a given circumstance or purpose.

Fluvial- Pertaining to streams or rivers, or produced by stream actions. Also, a fish life history where juveniles are born in streams, move to a main river to rear, and then migrate back up streams to spawn.

Freshet- A sudden overflow of a stream resulting from a heavy rain or a thaw.

Gastropod- A mollusk of the order Gastropoda; snail, slug, cowry or limpet.

Habitat potential- The ability of a given habitat to produce fish.

Hooking mortality- Death cause by catching and releasing fish.

Hydrograph- A graph showing water flow over time in a stream or river.

Impoundment - Any structure that impedes the flow of a stream or river, usually used to indicate a reservoir.

Indigenous- Descended from a population that is believed to have been present in the same geographic area prior to the year 1800 or that resulted from a natural colonization from another indigenous population.

Introgression- To combine with another as in hatchery fish naturally spawning with wild fish and their genes combining together.

Large woody debris- Trees and roots that enter water bodies and form fish habitat.

Large woody material- Same as large woody debris.

Legal size- Fish that are legal size, 6 inches or larger. Hatchery fish stocked as legal-size are generally 9-10 inches in length to provide a more desirable product for the angler. These are sometimes referred to as catchable-size fish.

Life history- The life pattern of a fish species. Includes time of spawning, time of emergence, freshwater residence time, and time of migration.

Littoral- Pertaining to or existing on the shore.

Lotic- Of or in running water such as a river or stream.

Low head barriers- Barriers to fish that are small in height.

Macroinvertebrate- Aquatic insects large enough to be seen with the naked eye.

Maladaptive genes- Genes that do not increase the fitness of an organism.

Meristic- Modified by the changes in the number or placement of entire body parts, as contrasted with modification by gradual change of the entire organism.

Mesotrophic- Water bodies that are between oligotrophic and eutrophic in productivity; medium in productivity.

Metapopulation- Groups of populations evolving with significant connections between them.

Microohms- One millionth of an ohm.

Mollusca- A phylum of shellfish with over 100,000 members.

Morphology- The science of form and structure.

Myriophyllum- Group of aquatic plants in the Haloragaceae or water milfoil family.

Myxosporidean- Class of Protozoa that are parasitic and spore forming. They are incapable of locomotion and resemble amoeba. Three groups that occur in salmon in the Pacific Northwest are Myxosporidia, Microsporidia, Haplosporidia.

Natal- Place of birth, stream where a fish was born.

Naturally produced- Produced in nature as opposed to hatchery-produced. May be indigenous or introduced fish.

Nematodes- A worm of the phylum Nematoda having unsegmented, thread-like bodies many of which are parasitic.

Neuroptera- An order of insects with four net-veined wings; includes ant lions, dobson fly, and lacewing.

Odonata- An order of predacious insects which includes dragonflies and damselflies.

Oligotrophic- Lacking in plant nutrients and having an abundance of dissolved oxygen throughout.

Omnivorous- Eating both plants and animals.

Ostracod- An order of aquatic freshwater crustaceans which have a bivalve carapace.

Pelecypoda- The order of lamellibranches.

Periphyton- Sessile organisms that live attached to surfaces projecting from the bottom in a freshwater aquatic environment.

Phenotype- The environmentally and genetically determined observable appearance of an organism.

Phenotypic- Characters arising from reactions to environmental stimulus.

Phytoplankton- Minute, floating aquatic plants.

Piscivorous- Fish eating.

Plankton- Plant and animal organisms that float in water.

Plecoptera- The order of insects that includes stoneflies.

Pool-to-riffle ratio- A measure of habitat quality. The number of pools versus the number of riffles expressed as a number.

Potomogeton- A group of aquatic plants in the Najadaceae or water nymph family.

Reach- A section of a river or stream.

Redband- The group of rainbow trout that evolved East of the Cascade Mountains. Coastal rainbow trout developed West of the Cascades.

Redd- A nest made by a fish containing its eggs.

Resident fish- Fish that do not migrate to the ocean for part of their life history.

Resolution- The action or process of separating or reducing something into its constituent parts.

Riffle- Shallow section of stream or river with rapid current and a surface broken by gravel, rubble or boulders.

Riparian- Area with distinctive soils and vegetation between a stream and the adjacent upland.

RM- River mile.

Rotenone- Commonly used fish toxicant which is derived from the derris root.

Salvage logging- Logging small groups or single trees for reasons such as blowdown, disease, or danger to life or property.

Semivoltine- Taking a year or more to develop.

Snorkel surveys- Surveys done using a mask and snorkel while swimming in a water body. May be qualitative or quantitative.

Spatial interaction- Interaction between individuals trying to occupy the same space.

Standing crop- The weight of organic material that can be sampled or harvested by normal methods at any one time from a given area.

Thermocline- The region in a thermally stratified body of water, as a lake, in which the temperature decrease with depth is greater than that of the water above and below it. The epilimnion is below and the hypolimnion is above.

Thermograph- an electronic instrument for measuring and recording temperature over extended periods of time.

Toxaphene- A toxic, solid compound used as an insecticide, $C_{10}H_{10}Cl_8$.

Trichoptera- An order of aquatic insects commonly called caddisflies.

Turbidity- Clouded with stirred up sediment; a darkening or clouding up of what should be clear.

Ultraoligotrophic- Referring to the trophic status of a lake defined by the nutrient concentrations. Ultraoligotrophic lakes are very nutrient poor.

Under-escaped- Not enough escapement. An inadequate amount of fish escaping to reproduce.

Weir- A notch or depression in a dam or other water barrier through which the flow of water is measured or regulated. Also a barrier constructed across a stream to divert fish into a trap or to raise the water level or divert water flow.

Width/depth- The ratio of width to depth. An indicator of environmental health.

Wild- Occurring, growing, or living in a natural state; not domesticated, cultivated, or tamed.

Yearling- A fish that has not completed its second year.

Zooplankton- Small (often microscopic) animals suspended or weakly swimming in water. Zooplankton feed on phytoplankton and are a critical food item for small fish In lakes and reservoirs.

APPENDIX C

Questionnaire

CENTRAL OREGON ANGLER OPINION SURVEY

1. Do you **primarily** prefer angling with bait, with lures, with flies, or some combination? (Circle one number)

    1. BAIT
    2. LURES
    3. FLIES
    4. PREFER A COMBINATION

2. In your opinion is the access to reservoirs and streams in Central Oregon for boat and for bank fishermen adequate or inadequate? (Circle one number for each)

	ADEQUATE	INADEQUATE	NO OPINION
a. For boats	1	2	3
b. For bank fishing.........	1	2	3

    2a. Please list any areas where access is inadequate.

3. Please indicate whether or not you think more Central Oregon waters should be managed for each species listed below. If you think more should be managed, please indicate the bodies of water. (Circle one number for each)

	More waters managed? NO	YES	Where needed? BODIES OF WATER
a. Trout	1	2	____________________
b. Landlocked salmon	1	2	____________________
c. Bass	1	2	____________________
d. Crappie	1	2	____________________
e. Others- specify	1	2	____________________

4. Which of the following fish species do you **primarily** fish for? (Circle one number)

    1. TROUT
    2. LANDLOCKED SALMON (examples - coho, kokanee and Atlantic salmon)
    3. WARMWATER FISHES (examples - bass, crappie and catfish)

5. Presently, the following streams, lakes and ponds are stocked with legal size hatchery rainbow trout. Should stocking be continued at present levels, or increased, decreased or eliminated? (Circle one number for each)

	Continue Stocking	Increase Stocking	Decrease Stocking	Eliminate Stocking	No Opinion
Deschutes River (Sunriver to Wickiup)	1	2	3	4	5
Fall River	1	2	3	4	5
Metolius River	1	2	3	4	5
Blue Lake	1	2	3	4	5
Devil's Lake	1	2	3	4	5
Fireman's Pond	1	2	3	4	5
Sprague Pond	1	2	3	4	5
Cultus Pond	1	2	3	4	5
Ochoco Creek	1	2	3	4	5
Marks Creek	1	2	3	4	5
Walton Lake	1	2	3	4	5
Haystack Res.	1	2	3	4	5
Lake Simtustus	1	2	3	4	5

6. The following waters are restricted to fly fishing only. Do you agree or disagree with this restriction? (Circle one number for each)

	AGREE	DISAGREE	NO OPINION
Davis Lake............	1	2	3
Hosmer Lake..........	1	2	3
Fall River..............	1	2	3
Metolius River.........	1	2	3
Sparks Lake...........	1	2	3

6.a Should more waters be restricted to fly fishing only? (Circle one)

1. NO
2. YES

Which waters?

7. Other regulations that have been suggested for trout angling in selected waters are more restrictive bag limits and/or size limits. Do you favor more restrictive bag limits and/or size limits in any area? (Circle one)

1. NO
2. YES

List water(s) and suggested regulation.

8. About how many times, altogether, did you fish Central Oregon <u>lakes and reservoirs</u> last year? (Circle one number)

1. DID NOT FISH LAKES OR RESERVOIRS
2. 1-10 TIMES
3. 11-20 TIMES
4. 21-40 TIMES
5. OVER 40 TIMES

9. Please rate last year's fishing on <u>lakes and reservoirs</u> as good, fair or poor for each species listed. (Circle one number for each.

	GOOD	FAIR	POOR	NO OPINION
a. Trout.............	1	2	3	4
b. Landlocked salmon..	1	2	3	4
c. Bass...............	1	2	3	4
d. Crappie............	1	2	3	4
e. Catfish............	1	2	3	4

10. About how many times, altogether, did you fish Central Oregon <u>streams and rivers</u> last year? (Circle one number)

1. DID NOT FISH IN STREAMS LAST YEAR
2. 1-10 TIMES
3. 11-20 TIMES
4. 21-40 TIMES
5. OVER 40 TIMES

11. Please rate last year's fishing on streams and rivers as good, fair or poor for each species listed. (Circle one number for each)

	GOOD	FAIR	POOR	NO OPINION
a. Trout.............	1	2	3	4
b. Bass..............	1	2	3	4

12. Do you fish for crayfish? (Circle one)

1 NO
2 YES

How many trips last year? (Fill in number)

____________NUMBER

Which waters did you fish?

13. How do you feel about fishing pressure on Central Oregon waters? (Circle one number)

1. TOO HIGH
2. ACCEPTABLE AT PRESENT LEVEL
3. CAN STAND MORE PEOPLE
4. NO OPINION

14. What is your permanent place of residence?

CITY____________________

STATE___________________

APPENDIX D

SURVEY RESULTS

Questionnaires distributed	700
Questionnaires returned	209 (30%)

Angler type	*N*	Percent returning questionnaire
General trout	149	71.3
General landlocked salmon	28	13.4
General warmwater	27	12.9
No response	5	2.4

1. Preferred Angling Method:

Bait	6.7%
Lures	8.6%
Flies	38.3%
Combination	45.9%
No response	1.0%

2. Access rating:

	Boats	Bank Fishing	No Opinion	N.R.
Adequate	72.2%	58.4%	6.5	5.0%
Inadequate	16.3%	19.6%	12.4	9.6%

2a. Areas Where Access is Limited. Although access was judged adequate by the majority of respondents, 33% provided comments where they felt access was limited. Responses were categorized according to rivers and lakes as follows:

Number of Responses	
12	Deschutes River-from its headwaters to Bend
10	Deschutes River-from Bend to Lake Billy Chinook.
8	Wickiup and Crane Prairie Reservoirs- low water levels were repeatedly mentioned.
8	Lake Billy Chinook
7	Crooked River
8	Ochoco and Prineville Reservoirs- low water levels were repeatedly mentioned.
3	Metolius River-mainly the lower section.
3	Little Deschutes River
8	Odell and Crescent Lakes.

Other lakes and reservoirs mentioned were: Davis, East, Paulina, Three Creeks, Haystack, Simtustus and Hosmer receiving less than 2 responses each.

6 General responses- These varied from all streams to 5 responses indicating access is too adequate and it is unnecessary to create more.

3. Should More Waters be Managed For:

	Trout	Landlocked Salmon	Bass	Crappie
Yes	35.4%	23.0%	15.3%	14.8%
No	38.8%	34.9%	39.2%	39.3%
No response	25.8%	42.1%	45.5%	45.9%

Bodies of Water Where Management Needed. Responses numbered categorized according to species.

Number of Responses

Trout waters identified and included:

6 Deschutes River
8 Metolius River
3 Crooked River
17 Subbasin lakes and reservoirs which included Wickiup, Davis, Walton, Paulina, East, Sparks, Crane Prairie, Odell, Crescent, and Lava.
4 Other tributaries included Fall and Spring rivers, and Tumalo Creek.

Landlocked salmon waters identified and included:

23 Subbasin lakes and reservoirs which included Crane Prairie, Hosmer, East, Odell, Paulina, Billy Chinook, Crescent, high mountain and Prineville lakes and reservoirs.

Bass waters identified and included:

3 Crooked River
22 Subbasin lakes and reservoirs which included Wickiup, Crane Prairie, Prineville, Ochoco, and Lake Billy Chinook.

Crappie waters identified and included:

20 Subbasin lakes and reservoirs which included Prineville, Crane Prairie, Haystack, Lake Billy Chinook and Wickiup.

General responses that varied from all inclusive, e.g., “all waters in Central Oregon,” to "too many are being managed already."

Other Species That Should be Managed and in What Waters.
Responses were categorized according to species.

Number of Responses

4	Walleye were suggested for Lake Billy Chinook, Prineville Reservoir, Crooked River, East Lake.
4	Salmon or anadromous fish were suggested for Billy Chinook and Paulina and Deschutes River.
5	Did not specify species or water, rather made an observation e.g., emphasize wild and anadromous trout, too many are being managed already.

4. Species primarily fished for:

Trout	71.3%
Landlocked salmon	13.4%
Warmwater fishes	12.9%
No response	2.4%

5. Trout stocking in the following lakes, ponds, streams and reservoirs: Percentages wanting the following programs.

	Continue stocking	Increase stocking	Decrease stocking	Eliminate stocking	No opinion
Deschutes River (Sunriver-Wickiup)	38.8%	21.5%	3.4%	9.1%	17.2%
Fall River	33.0%	16.7%	2.9%	13.9%	19.6%
Metolius River	34.4%	21.1%	4.3%	15.3%	15.3%
Blue Lake	36.8%	10.5%	2.4%	4.3%	29.2%
Devil's Lake	36.4%	10.5%	2.0%	4.3%	30.1%
Fireman's Pond	26.3%	9.6%	1.0%	3.8%	41.0%
Sprague Pond	23.0%	7.2%	1.0%	4.3%	44.5%
Cultus Pond	24.4%	10.0%	1.4%	4.8%	41.6%
Ochoco Creek	32.1%	11.5%	1.0%	9.1%	29.7%
Marks Creek	28.7%	9.1%	1.4%	9.6%	33.0%
Walton Lake	32.5%	13.9%	1.9%	3.8%	31.1%
Haystack Res.	35.9%	18.7%	2.4%	4.8%	24.4%
Lake Simtustus	34.0%	12.0%	1.9%	6.7%	28.7%

6. Fly fishing only restrictions within the following waters.

	Favor	Oppose	No opinion	No response
Davis Lake	67.9%	14.4%	13.4%	4.3%
Hosmer Lake	72.7%	11.5%	12.0%	3.8%
Fall River	75.1%	8.6%	12.0%	4.3%
Metolius River	73.2%	12.9%	12.0%	2.0%
Sparks Lake	66.5%	12.4%	16.3%	4.8%

6.a More waters be restricted to fly fishing only?

Favor	28.2%
Oppose	63.2%
No response	8.6%

Waters suggested as more waters for fly fishing only:

Number of Responses

19 Deschutes River including entire river to portions of the river only.

16 Crooked River including entire river to portions of the river only.

3 Metolius River including entire river.

14 Subbasin lakes and reservoirs which include Crane Prairie, Little Cultus, Walton, and Little Lava.

7. Favor more restrictive bag limits and/or size limits in any area?

No	47.4%
Yes	44.5%
No response	8.1%

List Waters and Suggested Regulation.

Number of Responses

4 Metolius River with catch and release restriction.

3 Crooked River with 2 fish bag limit, 12- to 14-inch minimum lengths.

7 All waters bag limits from 2 to 10 with five of the responses for the 2 fish per day limit.

14 No water specified but various regulations suggested, e.g., catch and release of all wild fish,bag limits should stay or be increased, make morerestrictive bag limits on all rivers and lakes, fishing in areas fish are spawning should be restricted.

8. Times Fished Central Lakes and Reservoirs:

None	7.2%
1-10 times	41.1%
11-20 times	19.1%
21-40 times	12.4%
More than 40 times	18.7%
No response	1.5%

9. Last Years Fishery Ratings:

	Trout	Landlocked Salmon	Bass	Crappie	Catfish
Good	16.3%	10.1%	3.8%	2.4%	4.3%
Fair	45.9%	21.1%	20.1%	6.2%	6.2%
Poor	18.7%	18.2%	8.1%	14.4%	9.1%
No opinion	11.5%	31.6%	43.5%	50.2%	54.1%
No response	7.6%	19.0%	24.5%	26.8%	26.3%

10. Times Fished Central Streams and Rivers.

None	21.1%
1-10 times	35.9%
11-20 times	21.5%
21-40 times	8.1%
More than 40 times	13.4%

11. Last Years Fishery Ratings:

	Trout	Bass
Good	12.9%	1.9%
Fair	50.2%	9.6%
Poor	16.3%	10.0%
No opinion	15.8%	52.7%
No response	4.8%	25.8%

12. Harvest Crayfish:

Yes	12.4%
No	87.1%
No response	1.0%

Average number of times last year: 3

Waters Crayfished:

Numbers of Responses	
6	Deschutes River
1	Crooked River

18	Subbasin lakes and reservoirs which included Ochoco, Lake Billy Chinook, Odell, South Twin, Walton, East, and Haystack.
2	Outside subbasin-Alsea drainage and in Washington.
3	Other comments e.g., should be illegal , would like to fish for these in the future.

13. Fishing pressure on Central Oregon Waters:

Too high	31.0%
Acceptable	60.3%
Can Stand More People	4.3%
No opinion	2.0%
No response	2.4%

14. Place of Residence:

Oregon	91.7%	Oregon:	
California	4.3%	East of Cascades	65.0%
Washington	2.0%	West of Cascades	35.0%
Other states	1.0%		
International	1.0%		

Survey Results

Questionnaires distributed	700
Questionnaires returned	209 (30%)

Angler type	*N*	Percent returning questionnaire
General trout	149	71.3
General landlocked salmon	28	13.4
General warmwater	27	12.9
No response	5	2.4

1. Preferred Angling Method:*

ANGLER TYPE

	Trout	**Landlocked Salmon**	**Warmwater**
Bait	7%	14%	0%
Lures	2%	29%	26%
Flies	52%	4%	0%
Combination	39%	54%	74%

2. Access rating:

	Adequate	Inadequate	No Opinion
For Boats			
Trout	75%	13%	7%
Landlocked Salmon	75%	18%	7%
Warmwater	63%	30%	4%
For Bank Fishing			
Trout	61%	22%	9%
Landlocked Salmon	57%	0%	29%
Warmwater	48%	26%	15%

3. Should More Waters be Managed For:

	Trout	Landlocked Salmon	Bass	Crappie	Other Species
Opinion - YES					
Trout	46%	19%	8%	9%	9%
L. Salmon	4%	53%	0%	4%	11%
Warmwater	4%	19%	74%	59%	19%
Opinion - NO					
Trout	37%	36%	44%	42%	30%
L. Salmon	36%	25%	43%	43%	32%
Warmwater	59%	44%	15%	26%	11%

* Survey results do not include non-response percentages.

4. See angler type and percent returning questionnaire above question #1.

5. Trout stocking in the following lakes, ponds, streams and reservoirs: Percentages wanting the following programs.

	Continue stocking	Increase stocking	Decrease stocking	Eliminate stocking	No opinion
Deschutes River (Sunriver to Wickiup)					
Trout	39%	24%	3%	13%	10%
L. Salmon	46%	7%	4%	0%	36%
Warmwater	30%	26%	4%	0%	37%
Fall River					
Trout	30%	20%	3%	19%	13%
L. Salmon	46%	4%	0%	0%	39%
Warmwater	37%	11%	4%	4%	33%

Metolius River					
Trout	34%	22%	5%	20%	9%
L. Salmon	5%	4%	0%	0%	32%
Warmwater	22%	30%	4%	4%	33%
Blue Lake					
Trout	38%	11%	2%	6%	26%
L. Salmon	39%	7%	0%	0%	42%
Warmwater	33%	11%	4%	0%	37%
Devil's Lake					
Trout	37%	12%	3%	6%	25%
L. Salmon	39%	0%	0%	0%	50%
Warmwater	30%	15%	0%	0%	41%
Fireman's Pond					
Trout	26%	9%	1%	5%	39%
L. Salmon	29%	4%	0%	0%	57%
Warmwater	30%	22%	4%	0%	33%
Sprague Pond					
Trout	21%	9%	1%	6%	42%
L. Salmon	29%	0%	0%	0%	61%
Warmwater	26%	7%	4%	0%	48%
Cultus Pond					
Trout	25%	11%	1%	7%	38%
L. Salmon	29%	4%	0%	0%	61%
Warmwater	19%	15%	4%	0%	48%
Ochoco Creek					
Trout	28%	11%	1%	13%	29%
L. Salmon	39%	4%	0%	0%	46%
Warmwater	41%	26%	0%	0%	22%
Marks Creek					
Trout	23%	9%	1%	13%	34%
L. Salmon	36%	4%	0%	0%	50%
Warmwater	52%	15%	7%	0%	19%
Walton Lake					
Trout	28%	15%	2%	5%	32%
L. Salmon	43%	4%	0%	0%	43%
Warmwater	33%	33%	11%	0%	15%
Haystack Res.					
Trout	35%	16%	1%	7%	26%
L. Salmon	46%	14%	0%	0%	32%
Warmwater	44%	22%	4%	0%	19%
Lake Simtustus					
Trout	34%	11%	1%	9%	28%
L. Salmon	50%	4%	4%	0%	32%
Warmwater	26%	19%	11%	4%	33%

6. Fly fishing only restrictions within the following waters.

	Favor	Oppose	No opinion
Davis Lake			
Trout	73%	13%	9%
L. Salmon	54%	21%	21%
Warmwater	56%	15%	30%
Hosmer Lake			
Trout	77%	11%	8%
L. Salmon	61%	14%	21%
Warmwater	63%	11%	26%
Fall River			
Trout	79%	8%	8%
L. Salmon	64%	11%	21%
Warmwater	67%	11%	22%
Metolius River			
Trout	80%	11%	7%
L. Salmon	57%	18%	21%
Warmwater	52%	19%	30%
Sparks Lake			
Trout	73%	11%	11%
L. Salmon	57%	18%	21%
Warmwater	44%	19%	37%

6.a More waters be restricted to fly fishing only?

Favor	
Trout	36%
L. Salmon	7%
Warmwater	4%
Oppose	
Trout	56%
L. Salmon	75%
Warmwater	93%

7. Favor more restrictive bag limits and/or size limits in any area?

No	
Trout	42%
L. Salmon	68%
Warmwater	56%
Yes	
Trout	53%
L. Salmon	18%
Warmwater	26%

8. Times Fished Central Lakes and Reservoirs:

None	
Trout	9%
L. Salmon	0%
Warmwater	0%
1-10 times	
Trout	50%
L. Salmon	21%
Warmwater	19%
11-20 times	
Trout	18%
L. Salmon	36%
Warmwater	15%
21-40 times	
Trout	9%
L. Salmon	18%
Warmwater	22%
More than 40 times	
Trout	13%
L. Salmon	25%
Warmwater	44%

9. Last Years Fishery Ratings:

	Trout	Landlocked Salmon	Bass	Crappie	Catfish
Good					
Trout	18%	7%	3%	1%	3%
L. Salmon	18%	36%	4%	4%	7%
Warmwater	7%	0%	11%	7%	11%

Fair					
Trout	51%	21%	15%	4%	4%
L. Salmon	25%	39%	7%	4%	4%
Warmwater	37%	7%	56%	19%	22%
Poor					
Trout	17%	17%	5%	7%	3%
L. Salmon	25%	21%	4%	11%	7%
Warmwater	26%	19%	30%	59%	41%
No opinion					
Trout	9%	32%	48%	56%	59%
L. Salmon	14%	4%	64%	61%	61%
Warmwater	22%	59%	0%	7%	19%

10. Times Fished Central Streams and Rivers.

None	
Trout	15%
L. Salmon	54%
Warmwater	26%
1-10 times	
Trout	38%
L. Salmon	36%
Warmwater	30%
11-20 times	
Trout	23%
L. Salmon	11%
Warmwater	26%
21-40 times	
Trout	9%
L. Salmon	0%
Warmwater	7%
More than 40 times	
Trout	15%
L. Salmon	0%
Warmwater	11%

11. Last Years Fishery Ratings:

	Good	Fair	Poor	No Opinion
For Trout				
Trout	17%	54%	15%	11%
L. Salmon	7%	21%	18%	43%
Warmwater	0%	52%	19%	15%
For Bass				
Trout	1%	5%	7%	56%

L. Salmon	4%	7%	7%	71%
Warmwater	7%	37%	30%	15%

12. Harvest Crayfish:

Yes

Trout	11%
L. Salmon	11%
Warmwater	26%

No

Trout	89%
L. Salmon	89%
Warmwater	70%

13. Fishing pressure on Central Oregon Waters:

Too high

Trout	34%
L. Salmon	18%
Warmwater	26%

Acceptable

Trout	58%
L. Salmon	71%
Warmwater	59%

Can Stand More People

Trout	4%
L. Salmon	7%
Warmwater	4%

No opinion

Trout	2%
L. Salmon	4%
Warmwater	4%

14. Place of Residence:

Oregon		California		
Trout	100%		**Trout**	0%
L. Salmon	89%		**L. Salmon**	11%
Warmwater	100%		**Warmwater**	0%

Central Region 1991 Angler Survey Summary

During 1991, an angler opinion questionnaire was developed for use in ODFW's Central Region. The survey covered waters in the upper Deschutes subbasin including the Deschutes River from its headwaters downstream to Pelton Dam and major tributaries such as the Metolius, Crooked and Little Deschutes Rivers and others. Subbasin reservoirs and lakes were also included.

One of the purposes of the questionnaire was to survey angler opinion on a variety of fishery issues that would be used in the development of a fish management plan for the region's subbasins.

Distribution of the questionnaire included an effort to canvas all representative fisheries and angler types in the basin. The percentages of various angler types that returned the questionnaire were: general trout angler 71%, general landlocked salmon angler 13%, and general warmwater angler 13%.

Results

Percentages are calculated on the basis of the number of respondents that answered the question, not on the number of questionnaires distributed.

Of the 700 questionnaires distributed, 30% were completed and returned. Distribution included lake resorts, lodges and stores, campground hosts, Oregon State Police game officers, ODFW reservoir creel employees, ODFW offices, and organized angling groups.

Type of Angler: Most (46%) of the respondents preferred to use a combination of angling methods (bait, lures and flies) rather than a single method. Over one-third (38%) of the respondents preferred using flies when angling.

Most of the respondents fished for trout (71%) with 13% fishing for landlocked salmon and an equal number (13%) fishing primarily for warmwater fishes.

Seventy three percent of the respondents fished the region's lakes and reservoirs from 1 to 40 times in 1991, and 19% more than 40 times. The majority of respondents (66%) fished streams and rivers 1 to 40 times with 57% of that majority fishing 1 to 20 times. Thirteen percent of the respondents fished more than 40 times. Twenty one percent of the respondents did not fish streams and rivers in 1991.

Only 12% of the respondents indicated they harvested crayfish an average of 3 times in 1991. Various sites in the subbasin including rivers, lakes and reservoirs yielded crayfish.

Place of Residence: Most of the respondents (92%) were from Oregon (65% from eastern Oregon and 35% from western Oregon). The next largest group was from California (4%) and Washington (2%). Other states (1%) and outside of the U.S. (1%) provided the remainder of the anglers.

Angling Experience: The stream fisheries were predominantly rated fair for trout and equally split between fair and poor for bass, however 79% of the respondents had no opinion or did not respond to the question regarding rating bass angling. Lake and reservoir fishing was rated fair for trout, landlocked salmon and bass. Fishing for crappie and catfish was divided between fair and poor but no opinion and response categories were also high (over 75%) for these two species. The majority of respondents (65%) did not feel that angling pressure was too high in Central Oregon, however, angling pressure was rated to be too high by approximately one-third (31%) of the respondents.

Access: Access was considered adequate for boat access and bank anglers with a higher percentage of the respondents considering boat access adequate (72%). Areas where access is considered limited are primarily the Deschutes and Crooked Rivers, Wickiup, Crane Prairie, Ochoco and Prineville Reservoirs, Lake Billy Chinook and Odell and Crescent lakes.

Angling Regulations: Respondents favored existing fly fishing only restrictions in the subbasin but opposed (63%) any more waters be added to this restriction. Of those that favored restricting more waters to flyfishing or barbless lures (28%) additional waters suggested were primarily the Deschutes and Crooked Rivers and subbasin lakes and reservoirs.

Respondents were evenly split when asked if they favored more restrictive bag limits and/or size limits with 47% of the respondents saying no and 45% saying yes. Suggestions included bag limits from 2 to 10 fish with the predominance wanting the 2 fish per day limit on all waters in the basin, catch and release of all wild fish, and fishing in areas when spawning occurs should be restricted.

Rainbow trout stocking: Continuation of the current stocking programs in the subbasin's lakes, ponds, streams and reservoirs was favored by the majority of the respondents. A majority of respondents wanted stocking to continue or increase however, many respondents had no opinion or no response when asked about specific bodies of water on the subject. One-half of the respondents favored continuing or increasing stocking in Fall and Metolius Rivers with 20% wanting to decrease or eliminate stocking, however, 29% of the respondents had no opinion on this.

Species Mix: When asked if more Central Oregon waters should be managed for trout, landlocked salmon, bass, crappie or other species, respondents were evenly split for trout between yes and no. Respondents indicated no for more waters being managed for landlocked salmon, bass and crappie. Waters where anglers felt management was most needed were Deschutes and Metolius Rivers and subbasin lakes and reservoirs for trout, subbasin lakes and reservoirs for landlocked salmon, Crooked River and subbasin lakes and reservoirs for bass and subbasin lakes and reservoirs for crappie.

APPENDIX E

State and Federal Wild and Scenic River Designations in the Upper Deschutes River Subbasin

State Wild and Scenic Designations

River Mile	Description
Deschutes River	
120 - 157.2	Lake Billy Chinook to Deschutes Market Road
158.9 - 163.6	Tumalo State Park to Sawyer Park
171 - 192.6	COID Diversion to Harper Bridge
199 - 226.6	General Patch Bridge to Wickiup Gauging Station
243.6 - 252	Snow Creek to Little Lava Lake

Federal Wild and Scenic Designations

River Mile	Description
Big Marsh Creek	
0 - 15	Crescent Creek to Headwaters
Crescent Creek	
18.7 - 29.7	RM 18.7 to 1.8 miles downstream from Johnson Creek
Crooked River	
8 - 15	Opal Springs to National Grasslands Boundary
62.5 - 70.5	BLM boundary to Arthur Bowman Dam
North Fork Crooked River	
0 - 40.5	Williams Prairie - 1 mile upstream from mainstem
Deschutes River	
120 - 140	Lake Billy Chinook to Oden Falls
172 - 175	Bend Urban Growth Boundary to Lava Island Camp
175 - 186.2	Lava Island Camp to North Boundary of Sunriver
186.2 - 226.7	North Boundary of Sunriver Wickiup Dam
Little Deschutes River	
83.8 - 97.4	Hemlock Creek down 1.8 miles to Headwaters
Squaw Creek	
25 to 38.2	McAllister Ditch to Wilderness Boundary
38.2 - 39.4	Wilderness Boundary to Headwaters

APPENDIX F

Recommended Minimum Flows For Deschutes Basin in cubic feet per second

Stream and Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
					Deschutes River							
Bend to Round Butte Reservoir	200	200	200	200	200	200	200	200	200	200	200	200
L. Deschutes R. to Spring R.	400	400	400	400	400	400	400	400	400	400	400	400
Spring River to Bend	660	660	660	660	660	660	660	660	660	660	660	660
Wickiup Dam to Little Deschutes R.	300	300	300	300	300	300	300	300	300	300	300	300
Crane Prairie Dam to Wickiup Res.	80	80	80	80	80	80	80	80	80	80	80	80
At USGS Gauge 14-0500	40	40	60	60	60	40	40	40	60	60	60	60
					Squaw Creek							
Below USGS Gauge 14-0750	20	10	10	10	10	10	10	10 10/20 30	20	20		
Below Camp Polk		10	10/20 30	30	30	20	10	10	10	10	10	10
					Indian Ford Creek							
Below Glaze Meadow	4	3	3	3	3	3	3	3	3/4	6	4	4
					Tumalo Creek							
Below South Fork Tumalo Creek	35	35	47	47	47	5	10	10 10/35 47	35	35		
					Spring River							

Mouth	300	300	300	300	300	300	300	300	300	300	300	300
				<u>Little Deschutes River</u>								
Below Crescent Creek	80	80	80	200	200	150	100	100	100	100	200	200
				<u>Fall River</u>								
Below Indian Creek	70	70	100	100	100	70	50	50	50	100	100	100
				<u>Browns Creek</u>								
Mouth	15	15	25	25	25	15	15	15	25	25	25	25
				<u>Quinn River</u>								
Mouth	20	20	20	20	20	20	20	20	20	20	20	20
				<u>Cultus Creek</u>								
Below Cultus Lake	20	20	32	32	32	20	5	5	5/20 32	20	20	
				<u>Cultus River</u>								
USGS Gauge 15-0505	50	50	50	50	50	50	50	50	70	70	70	70
				<u>Snow Creek</u>								
Mouth	15	15	30	30	30	20	15	15	15	30	30	20
				<u>Quinn Creek</u>								
Mouth	20	20	20	12	12	12	12	12	12/20 35	35	35	
				<u>Soda Creek</u>								
Mouth	20	20	20	6	6	6	6	6	6/20	31	31	31
				<u>Fall Creek</u>								
Mouth	35	35	35	20	20	20	20	20	20/35 46	46	46	

Goose Creek												
Mouth	7	7	7	4	4	4	4	4	4/7	10	10	10
Three Creek												
Below Snow Creek	7	7	10	10	10	7	2	2	2/7 10	7	7	

APPENDIX G

Partial List of Oregon Administrative Rules Relating to the Upper Deschutes River Subbasin Fisheries Management Plan

General Fish Management Goals
635-07-510 to 515

Natural Production Policy
635-07-521 to 524

Wild Fish Management Policy
635-07-525 to 535

Wild Fish Gene Resource Conservation Policy
635-07-536 to 538

Hatchery Fish Gene Resource Management Policy
635-07-540 to 541

Transgenic Fish
635-07-595

Fish Species- Salmon
635-07-800 to 805

Statewide Angling Regulations
635-11-050 to 175

Instream Water Rights
635-400-000 to 040

State Agency Coordination Program
635-405-000 to 045

Steelhead, Trout and Warmwater Fish Management
635-500-010 to 120

Upper Deschutes River Subbasin Plan
635-500-3100 to 3300