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Sandy
Subbasin Summary

May 17, 2002

Prepared for the
Northwest Power Planning Council

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DRAFT: This document has not yet been reviewed or approved by the Northwest Power Planning Council

Sandy Subbasin Summary

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Introduction

The Sandy Subbasin is a key watershed in north-central Oregon. Its proximity to the Portland metropolitan area, popular sport fisheries, dams and water storage facilities, and habitat quality in the upper subbasin make the management of the fish and wildlife resources a high-priority endeavor. According to the Sandy River Basin Watershed Council (1999a): "The waterways of the Sandy River Basin and their accompanying watersheds are rich with resources that are part of a heritage that needs to be passed on to future generations. Here within the basin are scenic treasures, cultural and historical resources, unique geologic formations and other natural features. The diverse landscapes of the watersheds that make up the basin – its forests, wetlands, riparian areas, alpine meadows, anadromous fish habitat, rugged mountain ranges, deep gorge-like canyons, breathtaking vistas, cascading waterfalls, seasonal ranges for wildlife, and more – add a dimension to this geographic region that gives it an importance to many different people in many different ways."

Although the Sandy River is renowned for its sport fisheries, the winter steelhead, spring and fall chinook, and coho salmon populations are all severely depressed relative to historic levels. This is primarily because dams and other passage impediments have blocked fish passage to upstream habitats, and have changed natural temperature and flow regimes in many subbasin streams. Additionally, while the majority of the upper subbasin falls within federal ownership, much of the fish and wildlife habitat in the subbasin, and especially riparian habitat, has been and continues to be degraded by human activities primarily related to agriculture, urban development, transportation and forestry. These habitat losses present significant opportunities for mitigating fish and wildlife population losses and protecting and restoring the subbasin's ecosystems.

There are many management efforts on-going in the subbasin to address the causes for these habitat and population losses. This Subbasin Summary attempts to provide a foundation for understanding these losses, the many factors contributing to their decline, and the ongoing programs. The cooperative nature of current programs and coordinating agencies and entities, and the variety of innovative, effective on-the-ground projects are an asset in implementing recovery and restoration efforts. Improving and expanding on existing, successful efforts, including habitat enhancement, passage improvement, research and monitoring activities, is key to meeting restoration goals within the subbasin.

This Subbasin Summary was prepared to meet the need for a facilitated, subbasin project review by the Independent Scientific Review Panel. Termed the "rolling provincial review," this review and renewal process will establish the budgets and approved activities for existing and newly-funded Bonneville Power Administration (BPA) projects. Also, the Summary is a substantial beginning towards developing the final Sandy Subbasin Plan - a comprehensive document meeting the objectives and standards set forth in the Northwest Power Planning Council's amended Fish and Wildlife Program and against which future proposed projects will be assessed. These plans will be crucial for implementation of the BPA's Endangered Species Act responsibilities in its funding decisions.

Subbasin Description

General Description

Subbasin Location

The Sandy Subbasin (Figure 1) is located in the mid-eastern section of the Lower Columbia Ecological Province, within Multnomah and Clackamas Counties in Oregon (EPA Reach 17080001). It drains an area of about 508 square miles (330,000 acres). The Sandy River and many of its tributaries originate high on the slopes of Mount Hood. The Sandy River flows about 56 miles in a northwesterly direction and joins the Columbia River near Troutdale at Columbia river mile (RM) 120.5.

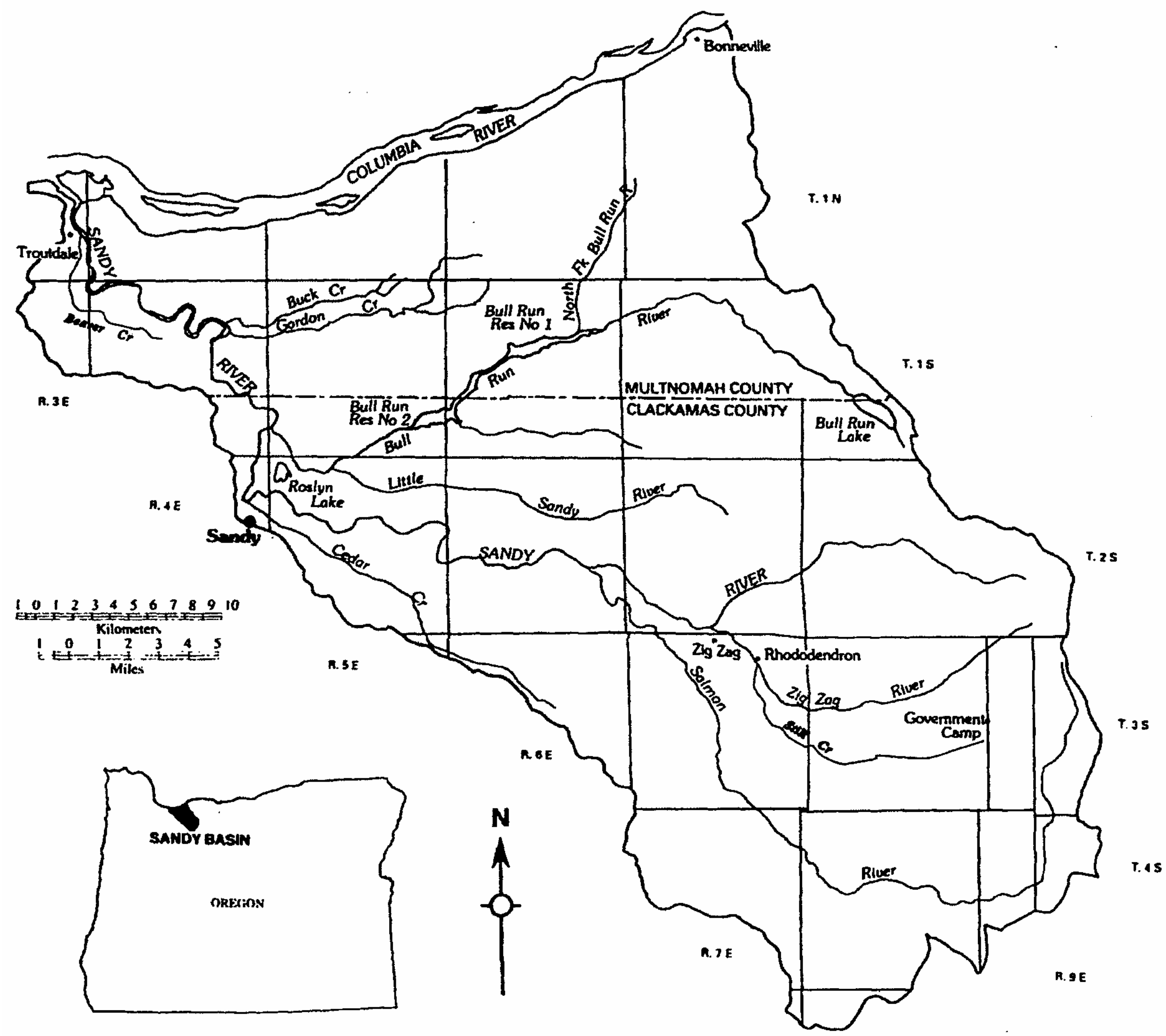

Figure 1. Oregon Water Resources Department's administrative boundaries for the Sandy River Basin, which includes the Columbia Gorge tributaries

The Sandy Subbasin is comprised of several watersheds, many of which are uniquely distinct in terms of hydrology and geomorphology. Principal tributaries include the ZigZag River, Still Creek and Salmon River in the upper subbasin, and the Bull Run River, Little Sandy River, Gordon Creek, Cedar Creek and Beaver Creek in the lower subbasin (Figure 1). Many other smaller tributaries located throughout the subbasin contribute significantly to stream flows, and provide habitat for a wide array of fish and wildlife assemblages.

Drainage Area

The Sandy Subbasin drains a portion of northwest Oregon (about 508 square miles), flowing 55 miles from its source on Mount Hood to its mouth at on the Columbia River. The subbasin is part of the Lower Columbia-Sandy watershed area. The Lower Columbia-Sandy watershed drains about 1,139 square miles, with a perimeter of 189 miles.

The headwaters of the Sandy and ZigZag Rivers are greatly influenced by glaciers and steep unstable slopes on the western flank of Mount Hood, an active volcano with an elevation of 11,235 feet. During summer, glacier ice melts and large quantities of sediments trapped in the ice flush into associated headwater streams (primarily the Muddy Fork and the upper Sandy River), and the mainstem Sandy River often remains turbid until high elevation temperatures drop in early fall. Glacial sediment and sand deposits are evident throughout the mainstem Sandy River. Snow pack accumulations and glaciers at higher elevations on Mount Hood also maintain favorable flows and cool water temperatures for fish throughout summer.

The Salmon River and Still Creek are two large-order tributaries in the upper subbasin and are recognized for providing fish high quality spawning and rearing habitat. The Salmon River originates on the south slope of Mount Hood and empties into the Sandy River at RM 38. Still Creek also heads on the south-facing slopes and is a tributary to the ZigZag River. Since most glaciers on the south-facing slopes have mostly vanished due to climatic changes over the past several thousand years, these streams are not presently glacially influenced and do not receive the sediment loads that streams originating from the west and north facing slopes do. The Salmon River usually runs clear all year and provides significant miles of spawning and rearing habitat for both anadromous and resident fish species. Final Falls is a 60-foot high cascade located at about RM 14 on the Salmon River and is the upstream limit of anadromous fish distribution.

The Bull Run River is a large, clear water tributary that enters the Sandy River at Dodge Park (RM 18.5) near the City of Sandy. The mainstem is approximately 25 miles long, and originates from Bull Run Lake (elevation 3,160 feet), a large natural lake to the northwest of Mount Hood. Many large tributary streams also contribute significantly to the flows produced in the Bull Run watershed. Historically, flows from this watershed represented a significant amount of the average annual flow in the Sandy River entering the Columbia River, and about 32 miles of stream habitat was available to large runs of migratory fish. However, in 1892 President Benjamin Harrison proclaimed the Bull Run watershed as a reserve for the City of Portland’s domestic water supply. Though the first water diversion structure was built in 1891, it is believed that the Headworks Dam (RM 6;

20 feet high) was the first facility in the Bull Run watershed to prevent upstream fish passage. In addition, at certain times of the year most of the water draining from this watershed is impounded and transported out of the watershed, primarily for municipal use.

The Little Sandy River is a large tributary stream that empties into the Bull Run River at RM 3. However, fish passage has been blocked since 1911 by a small diversion dam, which is owned and operated by Portland General Electric (PGE) and is located about 1.7 miles upstream from its confluence with the Bull Run River. Other significant tributary streams in the lower basin include Gordon, Beaver, Buck and Cedar Creeks.

Climate

The Sandy Subbasin is considered to have a maritime climate similar to that for western Oregon, which is generally characterized by seasonally mild temperatures and wet winters (Franklin and Dyrness 1973). Precipitation and temperature vary with elevation. Annual precipitation varies from 40 inches near the mouth of the Sandy River to more than 110 inches near its headwaters (Oregon State Parks 1983). The heaviest precipitation occurs during from November through January and the lowest in July and August.

At higher elevations rain precipitates as snow, which may not completely thaw until the end of summer. Snowfall on Mount Hood may average more than 300 inches a year (Green 1983). The Reid, ZigZag and Sandy glaciers, on the west and northwest slopes of Mount Hood, are ice formations developed from large snowfalls occurring annually over thousands of years. Snow that falls in winter combined with stored glacier ice act as reservoirs that consistently release cool flows during the summer. This improves base summer flows and reduces water temperatures, and is important for late spring and summer migrating fish such as summer steelhead and spring chinook. Coho and early migrating fall chinook may benefit as well.

Topography and Geomorphology

The upper Sandy River, ZigZag River and the upper reaches of the Salmon River are very high gradient and carve through unstable volcanic ash and rock deposits. The Sandy River descends from its source at 6,200 feet on the western flank of Mount Hood to an elevation of 1,600 feet at its confluence with the ZigZag River, only 13 miles downstream (NWPPC 1990). The average gradient in the upper subbasin is about 288 feet per mile (NWPPC 1990), but may exceed 1,000 feet per mile in the upper elevations. Substrates underlying the lower reaches of the upper subbasin near the towns of Rhododendron and Zig Zag are typically composed of loose alluvial rock. Substrates in the neighboring Salmon River are composed largely of basaltic lava rock.

The reach of the Sandy River from the confluence with the ZigZag River (RM 43) downstream to Marmot Dam (RM 30) is generally broader and less steep than the upper subbasin. The gradient is moderate and consistent, and averages about 70 feet per mile (fpm) from the confluence with the ZigZag River downstream to the Sleepy Hollow Bridge, and about 33 fpm from the Sleepy Hollow Bridge downstream to the Marmot Dam (Willamette Canoe and Kayak Club 1994). The substrates in this reach are composed largely of small boulders, cobbles and gravel. Glacial sediment deposits may be high where the gradient lessens, and spawning gravels are often entrenched.

Below Marmot Dam, the Sandy River descends for about 5 miles into a scenic narrow gorge that is characterized by steep canyon walls, constrained chutes, and deep trench-like pools. The substrate evident in the strata of the canyon walls is interspersed with basalts, sandstone sediments and compacted volcanic ash conglomerates. Substrates in the active channel are typically composed of large and small boulders because the narrowness of the canyon manifests strong turbulent flows in winter that moves smaller cobble and gravel downstream.

Below Revenue Bridge (RM 24) the active channel widens and the river begins to meander. High bluffs, composed of sandstone and sediments, rise over 200 feet in places. In-channel substrates are generally composed of small boulders and cobble with some gravel deposits at the tail end of the larger pools. Further downstream, the Sandy River merges with the Bull Run River at RM 18.5, and descends into the rugged and remote Sandy River Gorge. The reach from Dodge Park downstream 12.5 miles to Dabney State Park (RM 6) is designated both a federal Wild and Scenic River and a State Scenic Waterway. Canyon walls are generally composed of sandstone and other sedimentary rock. However, rock and volcanic ash conglomerates are also evident. Overall, in-stream substrates are composed of small boulders and cobbles with some gravel deposits at the tail end of pools.

Below Indian John Island, the Sandy River lessens in gradient. Overall gradient of the river channel from Dodge Park downstream to Metro's Oxbow Regional Park (RM 13) is about 23 fpm (Willamette Canoe and Kayak Club 1994). The gradient lessens significantly, and large gravel deposits are evident at the tail end of most pools. The gradient of the Sandy River from Oxbow Regional Park downstream to Dabney State Park lessens to about 8 fpm, and below Dabney State Park the river continues to its confluence with the Columbia River at gradients of less than 6 fpm (Willamette Canoe and Kayak Club 1994). As the gradient of the channel lessens, large sand deposits become evident.

Where the Sandy and Columbia Rivers merge, sediments have deposited over the millennia to form a large delta. This is called the Sandy River Delta and covers approximately 1,400 acres (USDA 1996). This land tract was designated a Special Management Area in the 1986 legislature, was purchased by the U.S. Forest Service (USFS) in 1991, and is part of the Columbia River Gorge Scenic Area. The Sandy River Delta was acquired to protect and enhance the natural resource values of the site, particularly the floodplain character and associated wetlands and to provide for compatible recreation uses. The mouth of the Sandy River is typically shallow and underlain almost entirely with sand and other fine sediments. It is unknown how this shallow condition affects fish passage from the Columbia River into the Sandy, especially in summer and early fall. However, the mouth has some tidal influence and flows from the Sandy are usually adequate for fish passage, even during summer when water levels drop.

Hydrology

Most water in the Sandy Subbasin is derived from the upper watersheds, primarily in the form of melting snow. Because the upper subbasin's origin is above tree line, little vegetation exists to stabilize the banks and sediment inputs and bedload movement is high. Fish production in these high elevation reaches is limited by an extreme gradient and hydrologic turbulence.

In the lower reaches of the upper subbasin, high flows may greatly affect channel configurations as was observed in both the 1964 and 1996 floods. Interestingly, substrates in the neighboring Salmon River are composed largely of basaltic lava rock, and channels are generally more constrained and less prone to large scale shifting during floods (NWPPC 1990). The hydrological habitat components in the upper reaches of the Sandy and ZigZag Rivers are typically composed of long rapids and riffles interspersed with short pools. In the reach of the Sandy River from the confluence with the ZigZag River (RM 43) downstream to Marmot Dam (RM 30), channels are braided and alder stands are evident on many of the in-stream islands.

Below Marmot Dam, deep trench-like pools characterize the Sandy River, and three boulder-choked rapids make for hazardous passage to drift boats and rafts in this section. Below Revenue Bridge (RM 24) the river is composed mostly of long riffles, rapids and glides. Some pools exist, but are not typically large relative to the width of the active channel. The upper reach of the gorge from the confluence with the Bull Run River down to Indian John Island (RM 15) is characterized by long rapids of moderate gradient and large deep pools. Below Indian John Island, pools are typically large and often deep, and are separated by shorter riffles and glides than the upper section. Below Dabney State Park some channel braiding occurs; however many of the banks are now armored with riprap to protect private property and roads in the lower basin from erosion, which affects the hydrologic mechanisms needed for natural braiding to occur.

The U.S. Geological Survey measures discharge at several points in the Sandy Subbasin. Figure 2 and Figure 3 display the hydrograph of stream flows (January 1980-September 2000) and the 10-year average discharge by month (1986 to 1995) for gauge 14137000 and gauge 14142500, respectively. Gauge 14142500 is located just downstream of the confluence with Bull Run River (RM 18.5) and is the furthest downstream gauge site location in the subbasin. This gauge reflects cumulative discharge in cubic feet per second (cfs) for most of the Sandy Subbasin (some tributaries, such as Beaver, Gordon and Trout Creeks, are downstream of the gauge and are not represented in the data).

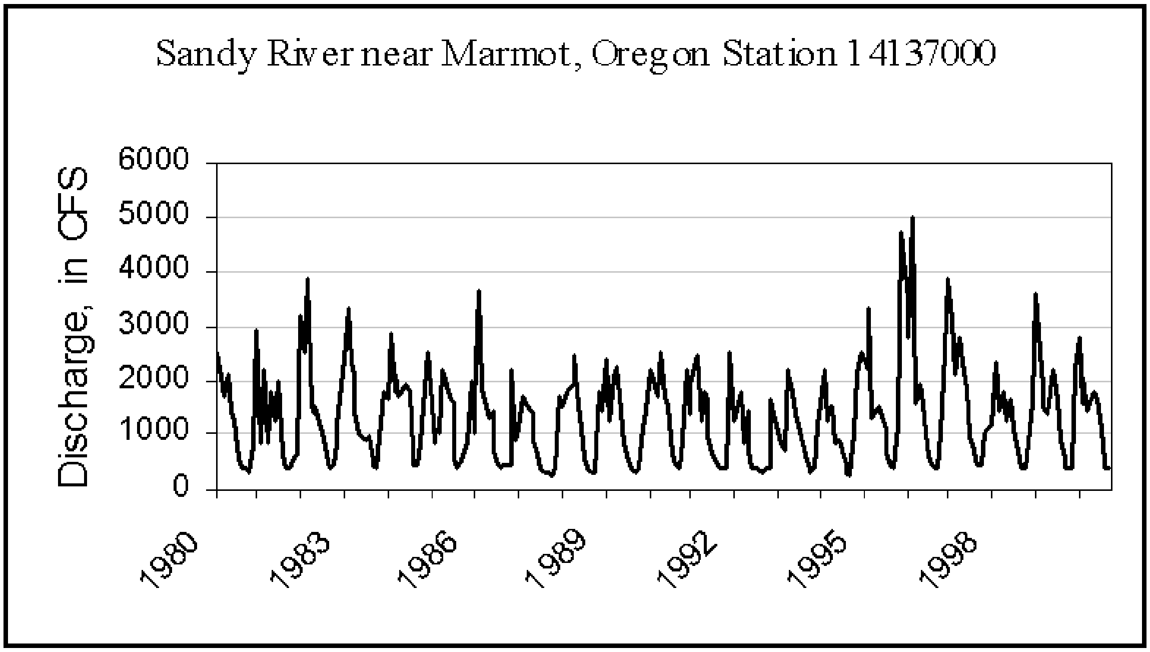

Figure 2. Hydrograph of stream flows at Sandy River gauge near Marmot, Oregon, January 1980-September 2000

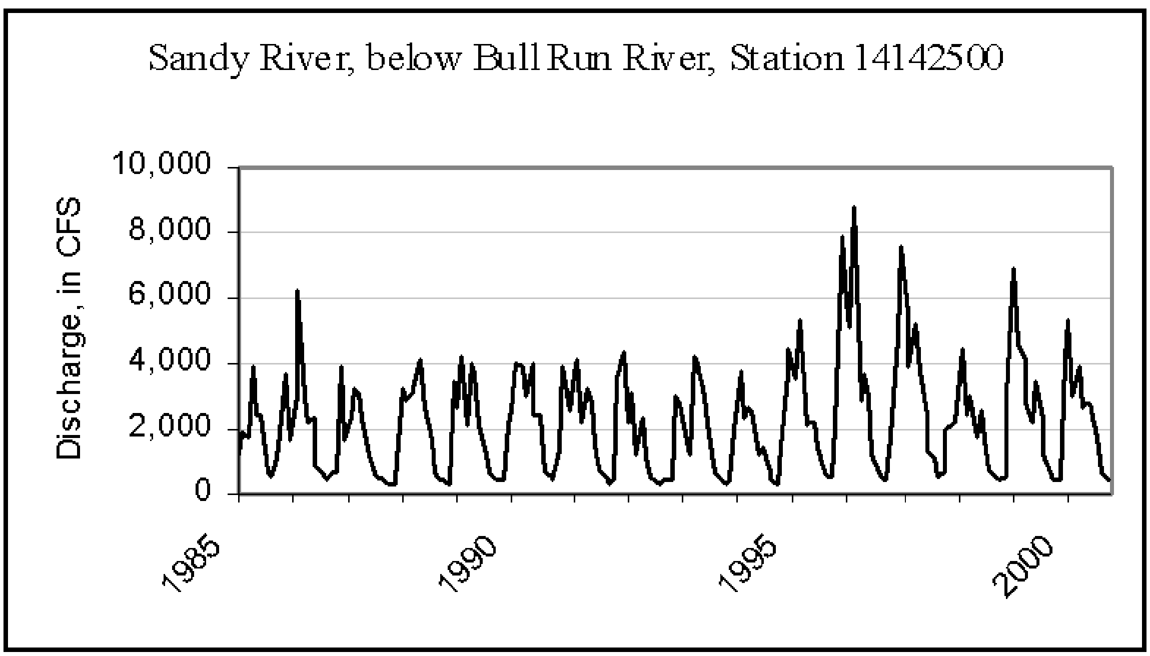

Figure 3. Hydrograph of stream flows at Sandy River gauge below Bull Run River, January 1985-September 2000

The average monthly cfs values at gauge 14142500 for water years 1986-1995 ranged between a low of 377 cfs in September to a high of 3,437 cfs in February. However, flows in the Sandy River are variable, ranging widely between days and months within water years. The absolute minimum for the 10-year period was 190 cfs (October 1990), and the absolute maximum was 65,800, during the February flood of 1996. The estimated flow entering the Columbia River (18 miles downstream) was about 85,000 cfs (21.6 feet gauge height) during the February flood event. The estimate exceeded the 1964 flood event when an estimated flow of 82,000 cfs (21.3 feet gauge height) entered the Columbia River (personal communication, River Forecast Center, Portland, 1996).

Discharge during the dry period from June to October at sites 14137000 and 14142500 is similar, but discharge at the lower site (14142500) increases greatly over flow recordings at the upper site (14137000) during the rainy period of November to May. This occurs largely as a result of water storage patterns in the Bull Run River. It should be noted that some tributaries entering the Sandy River between Marmot Dam (RM 30) and the confluence with the Bull Run River (RM 18.5), particularly Cedar Creek, may affect flows measured at the lower site. During the late fall and winter months, after reservoirs in the Bull Run watershed are filled, surplus water is spilled and combines with the Sandy River downstream, which increases the values of the flow data recorded downstream of the Bull Run River. However, during the drier periods of summer, most of the water entering the impoundments in the Bull Run watershed is stored, and therefore, does not contribute to flow measured downstream in the Sandy River. A very high proportion of the water that historically flowed into the Sandy River from the Bull Run watershed is being stored.

Flow regimes in the Sandy Subbasin are greatly affected by high precipitation that falls as rain in the lower elevations and accumulates as snow during winter at higher elevations, primarily on Mount Hood. It is important to understand that fish native to the subbasin have naturally adapted to these local climatic conditions and to the hydrologic profile of the watershed over thousands of years. However, several dams and diversion structures have been constructed in the subbasin over the past century that have greatly modified the river's hydrologic profile and subsequently impacted fish migratory and rearing strategies. The major dams in the watershed are Marmot Dam on the Sandy River (RM 30), the Little Sandy Diversion Dam at RM 1.7 on the Little Sandy River, the Headworks Dam at RM 6 on the Bull Run River, and the Sandy Hatchery weir on Cedar Creek at RM 0.5.

Three types of aquifers make up the Lower Columbia-Sandy watershed (Table 1). The Puget-Willamette Lowland aquifer system and the volcanic and sedimentary-rock aquifer are the two most common.

Table 1. Principle aquifers in the Sandy Subbasin

Aquifer Type	Rock Type
Puget-Willamette Lowland aquifer system	Unconsolidated sand, gravel
Volcanic and sedimentary-rock aquifers	Basalt, other volcanic-rock
Miocene basaltic-rock aquifers	Basalt, other volcanic-rock

Water Quality

The Oregon Department of Environmental Quality (DEQ) has identified the Sandy Subbasin as water quality limited. These streams are habitat areas for winter steelhead, coho salmon, spring chinook, and fall chinook. Water quality limited means instream water quality fails to meet established standards for certain parameters for all or a portion of the year. Water quality parameters (and standards) of temperature (64°F/55°F, rearing/spawning), dissolved oxygen (98% saturation), habitat modification (pool frequency), and flow modification (flows) relate to the beneficial use for fish life. Standards for bacteria (fecal coliform) relate to the beneficial use for recreation. The subbasin has three streams on DEQ's 303(d) list for temperature: the Bull Run River from its mouth to Bull Run Reservoir 2, the Salmon River from its mouth to Boulder Creek, and the Sandy River from its mouth to Marmot Dam. The listing for the Sandy River is likely due to the diversion of water at Marmot Dam for hydropower generation at the Bull Run facility (ODFW 1997).

In-stream Water Rights

Oregon Administrative Rule (OAR) 635-400-005 states: "It is the policy of the Oregon Department of Fish and Wildlife Commission to apply for in-stream water rights on waterways of the state to conserve, maintain and enhance aquatic and fish life, wildlife, and fish and wildlife habitat to provide optimum recreational and aesthetic benefits for present and future generations of citizens of this state. The long-term goal shall be to obtain an in-stream water right on every waterway exhibiting fish and wildlife values."

The In-stream Water Right (IWR) Act of 1987 [Oregon Revised Statute (ORS) 537.332] allows the Oregon Department of Fish and Wildlife (ODFW), and the departments of Parks and Recreation and DEQ to apply for water rights to maintain in-stream flows for designated public uses. The Oregon Water Resources Department (WRD) is the agency responsible for reviewing in-stream water right applications. One provision of the IWR Act provides for the conversion of previously established (prior to September 27, 1987) minimum perennial streamflows to in-stream water rights. Upon conversion, the effective date of the minimum perennial streamflow is retained, giving them seniority over water rights established at a later date.

The ODFW adopted administrative rules (OAR 635-400-000 through 635-400-040) for the IWR program in October 1989. They define ODFW policies and methodologies to be used to determine in-stream flows required for fish and wildlife, and generally govern the agency's internal IWR application process. As required by rule (OAR 635-400-020), ODFW prioritized streams needing in-stream water rights based, in part, on whether the following factors were present: 1) sensitive, threatened, or endangered species; 2) state scenic waterway or federal wild and scenic river status; 3) native anadromous fish species; 4) court-ordered, legislative, or commission mandated priorities; and 5) potential threats to the aquatic ecosystem.

In 1991, ODFW applied for 18 in-stream water rights in the Sandy Subbasin to provide fish with adequate flows at specific times of the year. The priority date for all IWR's applied for by ODFW in the subbasin is April 30, 1991. In 1996, Final Orders were issued by WRD in cooperation with ODFW for these in-stream water rights (Table 2).

Some water rights were certified at flow values less than what ODFW originally applied for on April 30, 1991. In order for in-stream water rights to be effective, streamflows must be monitored. In each IWR application, ODFW requests that WRD establish a gauge at an appropriate location if none already exists. The likelihood of this happening for each IWR is very remote, at least in the short term. By law, WRD is responsible for monitoring streamflows and regulating junior users in times of shortage. In reality, WRD is currently not staffed at the field level (Watermasters Office) with sufficient personnel to adequately monitor in-stream flows.

Vegetation

Much of the upland area of the Sandy Subbasin is forested, especially within the National Forest boundary. Alpine plants characterize the upper basin above timberline. At the timberline, mountain hemlock and sub-alpine fir predominate. White bark pine is present but uncommon. Below timberline, mountain hemlock dominates, but western hemlock, true firs, western white pine, and Douglas fir are also common. At elevations of 3,000 to 4,000 feet, a diverse tree and vegetation zone occurs. Species of trees in this location include western hemlock, Douglas fir, true firs, western red cedar, and western larch. Western hemlock and Douglas fir predominate in the forests between 1,000 and 3,400 feet. In general, timber harvest activities have not occurred in most designated wilderness areas of the upper subbasin, and many old growth reserves persist.

In general, most land in lower elevations is privately owned, and logging and agricultural activities may be intense. Land bounding the Sandy River from about Marmot Dam downstream to Sandy is managed for timber, Christmas trees and to a lesser extent livestock. From Sandy downstream to Troutdale, land is primarily managed for nursery stock production, with some farms also in operation. However, the Sandy River from Dodge Park downstream to Dabney State Park is under State Scenic Waterway and Wild and Scenic River status, and a relatively wide corridor of mixed forestland bounds both sides of the river. Urban development in the lower reaches of the Sandy basin has greatly modified natural vegetative communities. Many properties are landscaped with lawns, and non-native flowers and ornamental trees.

Land Uses

The USFS, Mt. Hood National Forest, owns and manages about 70% of the land in the Sandy Subbasin (DEQ 2001). The remaining land is in private ownership (22%), 4% is owned by the Bureau of Land Management, 2% is owned by the City of Portland, and the remainder owned by the state, local government, or PGE (DEQ 2001). About 19.5% of the land is designated as wilderness. Forests cover about 85% of the subbasin. Public land includes the Salmon-Huckleberry (44,600 acres) and Mount Hood (47,160 acres) Wilderness Areas. The subbasin has nearly 60 river miles of National Wild and Scenic River designations including the Sandy River from Dodge Park to Dabney State Park (also a state scenic waterway); the upper Sandy River from its headwaters to the boundary of the Mount Hood National Forest; and the entire Salmon River.

Table 2. ODFW in-stream water right applications for Sandy Subbasin streams by month

Stream > Parent Stream	App. No.	CFS/month							
		Jan-Feb	Mar-May	Jun	Jul	Aug	Sep	Oct	Nov-Dec
Alder Cr > Sandy R	71544	25	25	15/10	8/5	4	4	4/25	25
Beaver Cr > Sandy R	71545	14	14	3/2	1	1	1	1	14
Boulder Cr > Salmon R	71546	30	30	20/10	8	5/4	3	3/30	30
Camp Cr > ZigZag R	71547	25	25	20	20	15	15	15/25	25
Cedar Cr > Sandy R	71548	60	60	40/20	10	10	10/20	40	60
Cheney Cr > Salmon R	71549	35	35	20/10	8	5/4	3	3/35	35
Clear Fork > Sandy R	71550	25	25	20/15	12	8	8	8/25	25
Gordon Cr > Sandy R	71552	50	50	30/20	15	15	15	20/50	50
Henry Cr > ZigZag R	71553	18	18	10/7	4/3	2	2	2/18	18
Lost Cr > Sandy R.	71555	20	20	15	15/12	12	12	12/20	20
S Fk Salmon > Salmon R	71560	35	35	20/10	8	5	5/8	15/35	35
Salmon R > Sandy R	71557	250	250	250	150/125	100/80	80/250	250	250
Salmon R > Sandy R	71558	150	150	150	120/90	60	60/100	150	150
Sandy R > Columbia R	71480	1,900	2,000	1,400	850	400	500	650	1,500
Sandy R > Columbia R	71559	250	250	250	150/100	100	100/250	250	250
Still Cr > ZigZag R	71561	60	60	50/40	30/25	25	25/60	60	60
Trout C > Sandy R	71562	35	35	20/5	4/3	3	3	5/20	35
ZigZag R > Sandy R	71563	200	200	150	100	75	75/200	200	200

Note: CFS data entered as 15/10 means that the in-stream water right is 15 cfs for the first half of the month and 10 cfs for the latter half of the month

Agricultural Practices

Agriculture in the Sandy Subbasin consists primarily of nursery stock production based largely on the plateaus of the lower watershed east and north of Gresham and south of Troutdale. Beaver Creek is a medium-sized tributary to the lower subbasin that is greatly affected by agricultural practices in these areas. Beaver Creek is typically turbid following even light rainfall, and sediment deposits are evident in low gradient areas in the lower subbasin near Troutdale (general observations, Tom Murtagh, ODFW, 1994 and 1995).

Some land is also used for agricultural purposes in the hills on the north shore of the Sandy River. Activities associated with agricultural practices that are of concern are land clearing, tilling, ditching, draining of wetlands, road building, heavy machinery use and applications of fertilizers and herbicides that can leach into streams. Also, vegetation along some tributary streams may be removed to gain access to streams or increase the production potential of the land.

Urbanization

The human population of the Sandy Subbasin has been growing ever since settlers following the Oregon Trail began arriving in the 1840s. Incorporated cities in the subbasin include Rhododendron, Zig Zag, Government Camp and Sandy. Portions of the cities of Gresham and Troutdale lie within the lower part of the subbasin. The 2000 Census shows growth in the subbasin continued at a rapid pace during the 1990s. The City of Troutdale increased by 75% to 13,777 while Gresham grew by 32% to 90,205 and Sandy grew to 5,385, or a 29% increase. Additional growth is expected in the coming decade and will put further demands on the subbasin's natural resources. The probable impacts on fisheries related to urbanization include the following:

- Direct loss of stream and riparian habitat to road building and residential and commercial construction.
- Loss or partial obstruction of upstream and/or downstream fish migration by culverts and bridges.
- Increased winter streamflows and reduced summer streamflows caused by increased impervious surfaces, stormwater runoff, and diversions.
- Reduced water quality from elevated stream temperatures, chemical contamination, and increased sediment loading and deposition.
- Increased disturbance, harassment, and poaching of adult salmonid spawners.
- Increased disturbance by pets and livestock.
- Increased potential for toxic spills.
- Cumulative negative effects on the biotic and ecological integrity of the aquatic environment and consequent associated impacts on fish.
- Filling of wetlands and reduction of aquifer storage, which may impact downstream areas by overloading channels with water during storms.

Mining

Mining of minerals, rock or sand within the active channels of the watershed is currently not a great concern. Many miles of both the upper Sandy River and Bull Run River watersheds are protected by wilderness or municipal water use status. Twelve miles of the lower mainstem Sandy River, from Dodge Park (RM 18.5) downstream to Dabney State Park (RM 6) is also protected by both State Scenic Waterway and Wild and Scenic River status. Homeowners control significant miles of shoreline both above and below these boundaries. It should be noted that sand and gravel were historically extracted from the beds within the active channels of the lower subbasin near Gordon Creek and Troutdale for commercial and domestic use, however it is unknown if pursuit of this kind of venture in the lower subbasin will be renewed.

Grazing

Livestock grazing in the watershed is considered to be light and is not thought to greatly affect overall fish habitat quality in the subbasin. The horse and cattle grazing activities that do occur are generally located on the plateau above the river corridor.

Impoundments and Irrigation Projects

Irrigation is not extensive in the subbasin. Only about 3,000 acres are irrigated which occurs mostly along the lower portion of the Sandy River, downstream from the City of Sandy (SRBWC 1999a). There are impoundments in the subbasin associated with hydropower production and municipal water use as described in the following paragraphs.

Bull Run Watershed

The Bull Run River watershed, located in the 95,382-acre Bull Run Watershed Management Unit, is managed primarily as the City of Portland's domestic water supply [under Public Law (PL) 95-200]. Efforts to divert water from the Bull Run River were initiated about 1891, and in 1892 President Benjamin Harrison, established the Bull Run Reserve to insure the continued supply of high quality potable drinking water for Portland. In 1904, federal legislation closed the watershed to public entry. Fishing, hunting, and other recreational uses have not been allowed in the Reserve since that time.

The first conduit and water diversion was constructed in 1891 at the site of the present Headworks Dam, located approximately 6 miles above the mouth of the confluence with the Sandy River (Whitt 1975). Records are poor regarding the general description of this facility, and consequently it is unknown if fish were able to pass around the structure or were blocked from upstream migration. However, in 1922 the Headworks Dam was built 22 feet high, and no fish passage was provided. About 28 miles of stream habitat, once used by large runs of coho, winter steelhead, spring and fall chinook, and migratory trout have been blocked for nearly 75 years. The habitat loss represents a significant proportion of the in-stream habitat in the entire subbasin once available to migratory fish. Important populations of rainbow, cutthroat, whitefish and other fish species thrive in the reservoirs and tributaries above these dams, however.

Water management in the watershed has also significantly altered the hydrological profile of the 6-mile reach below the Headworks Dam, and has greatly impacted the spawning and rearing potential for fish in this area. In accordance with a 1984 agreement between ODFW and Portland, Portland compensates for the loss of natural fish production in the Bull Run River by funding the production of 32,000 pounds of hatchery smolts (presently 160,000 spring chinook and 60,000 winter steelhead).

The Ben Morrow Dam, referred to as Bull Run Dam No. 1, was built in 1929 near the confluence of Bear Creek and the Bull Run River. The structure is about 200 feet high, and maximum surface elevation of the reservoir is 1,045 feet. The storage capacity of the reservoir is 10 billion gallons. During the years 1958-1963, Bull Run Dam No. 2 was constructed at RM 6.2, just upstream of the Headworks Dam. This dam is 118 feet high and the spillway is located on an arm of the reservoir downstream of the dam. Maximum surface elevation is at 860 feet and the storage capacity is 7 billion gallons.

Bull Run Lake, a naturally formed body of water, is located in the headwaters of the Bull Run watershed. In 1915, a 10 foot high rock and log crib structure was built at the outlet of the lake to raise its storage capacity. The maximum surface elevation of the lake is 3,178 feet, and the storage capacity is about 4 billion gallons. The lake is a backup water reserve to the lower elevation reservoirs during dry spells. An important population of wild cutthroat trout exists in the lake and spawn in small tributary streams that enter the lake. The USFS, in cooperation with the City of Portland, ODFW and other stakeholders, developed the Bull Run Lake Special Use Authorization and Lake Level Management Plan. Under guidelines defined in the plan, the USFS issued a long-term (20 year) Special Use Authorization that continues to allow the Portland Water Bureau to manage their existing facilities at Bull Run Lake. Actions defined in the USFS management plan address conservation of trout in the lake, and are largely aimed at maintaining access into small spawning streams by sustaining an adequate lake level needed to facilitate trout migrations during spawning timing, and providing floating cover during excessive drawdown periods.

A small reservoir was once located in the North Fork of the Bull Run River near its headwaters. The impoundment was called Boody Lake, and stored about 0.4 billion gallons. The reservoir currently does not store water for municipal use. Also, other sites in the Bull Run Watershed have been under review by the Portland Water Bureau for additional storage under the Regional Water Supply Plan. Bull Run Dam No. 1 and No. 2 were originally designed to produce hydropower, but were not retrofitted to produce power until the early 1980s. Since 1958, Portland has also sold water to PGE, which is diverted to Roslyn Lake for additional power production.

Marmot Dam and the Little Sandy Diversion Dam

Hydropower development in the Sandy Subbasin was initiated in 1906 by the Mt. Hood Railway and Power Company, an electric utility that later merged with a PGE predecessor (PGE TAC Meeting, April 1994). Construction of the Bull Run Powerhouse on the lower Bull Run River (RM 2) and the Little Sandy Diversion Dam, located at RM 1.7 on the Little Sandy River, were completed by 1912 (PGE 1991). The Little Sandy Dam is about 16 feet high, and diverts water through a 17,000-foot long flume to Roslyn Lake. This lake is a 140-acre impoundment and is the forebay for the Bull Run Powerhouse.

Construction of Marmot Dam on the mainstem Sandy River (RM 30) was finished in 1913 to provide additional water for power production. Marmot Dam was originally a wood crib dam, but was rebuilt with concrete in 1989 under Federal Energy Regulatory Commission (FERC) requirements, as structural failure was feared. The dam is 30 feet high, and diverts water from the Sandy River to the Little Sandy River via a network of canals and a 4,690-foot long tunnel excavated under a mountain ridge that divides the two basins. The diversion canal has a flow capacity of 600 cfs. Sandy River water combines with the Little Sandy River and is then diverted to Roslyn Lake through a wood-box flume that parallels the Little Sandy along its south bank. The flow capacity of the diversion canal between the Little Sandy Diversion and Roslyn Lake is 800 cfs. Generally, all water from the Little Sandy River is diverted, and water diverted from the Sandy River makes up the additional quantity needed to maximize flow in the canal. However, flow capacity in the canal may not be reached during low flow periods, usually in summer, because PGE is required to meet minimum flow requirements, established in 1975, for fish passage below Marmot Dam (Table 3). If flows in the Sandy River at Marmot Dam drop below minimum flow agreements, then water is not diverted from the mainstem Sandy River.

Table 3. Minimum flow agreements with PGE for flows below Marmot Dam

Dates	Minimum Flows
June 16 through October 15	200 cfs
October 16 through October 31	400 cfs
November 1 through June 15	460 cfs

Portland General Electric operates Marmot Dam and the Little Sandy River diversion project under FERC hydroelectric license #477, which was issued in 1980 and will expire in 2004. When the project comes up for re-licensing in 2004, a number of fish issues will be raised including minimum flows in the Sandy River below Marmot Dam and in the Little Sandy River below the diversion dam, upstream and downstream fish passage, and hatchery compensation.

Water is impounded in Roslyn Lake, which has a gross capacity of 2,000 acre-feet. Water flows down to the PGE powerhouse through two 1,400-foot long penstocks extending from the northern edge of the reservoir. Water drives four horizontal turbine generators, each with a nameplate rating of 5,250 kW, for a total of 21,000 kW.

Portland General Electric operates under FERC license #477, and is required to maintain the fish ladder at Marmot Dam for upstream fish passage. The fish ladder, located on the south bank, was rebuilt in 1983. Upstream fish passage in the ladder is believed to be adequate. They are also required to maintain a fish counter at the facility to provide ODFW and the public with reliable daily fish counts. The counter was upgraded in 1996 because the previous counter was unreliable.

The FERC license #477 also requires that PGE maintain rotating diversion screens and a downstream juvenile bypass facility in the Marmot Dam diversion canal. The canal was unscreened until 1951, and prior to this date, it is believed that large numbers of fish naturally produced in the watershed above the dam were diverted into the canal and to Roslyn Lake. Several studies have been conducted on the juvenile bypass system that review how the system works and what modifications have occurred at the facility to improve juvenile bypass efficiency (Wagner 1959, Leonards 1960, and Cramer 1993).

The rotating screens and juvenile downstream bypass facility are located in the diversion canal 700 feet downstream of Marmot Dam. The canal leading to the bypass facility is trapezoidal in cross section, with the top and bottom dimensions 27 and 13.5 feet, respectively (Cramer 1993). The depth is 9.5 feet and the gradient in this section is 0.1% (Cramer 1993).

The rotating screens are composed of three traveling screen units, set side by side at a 90-degree angle to flow (Cramer 1993). Each unit consists of 26 screen panels, composed of wire mesh with 1/8-inch openings. Electric motors drive the screens at a rate of 8 feet per minute (Cramer 1993). There are 10 vertically-aligned fish collection ports to divert fish back to the river. Three ports are located on each sidewall of the canal, and two ports are located on each vertical column separating the screen section (Cramer 1993). Fry caught on the rotating screens are flushed by water from spray nozzles into a trough located in front of the screens. These fish are then flushed into the bypass transport pipe and deposited into a holding pond near the shore of the Sandy River. Fish then swim volitionally into the river at this point. A juvenile trap also exists at the pond site, and has been used to capture experimental fish.

The FERC license #477 required that PGE study the Marmot canal fish screen and bypass with cooperation and concurrence of the fisheries agencies (Cramer 1993). Numerous modifications have been made to the screen and bypass since that time, and major changes reported by Cramer (1993) include:

- Increasing the number of bypass ports in use from 3 to 10.
- Changing the 24-inch bypass culvert to a 36-inch fiberglass lined conduit increasing the bypass flow to 60 cfs.
- Reducing the screen openings from 3/16 inch to 1/8 inch.
- Adding a second set of screen nozzles to the screen wash system.
- Adding a second set of baffles approximately 20 feet upstream of the screens to provide a more even flow.

In addition, Cramer (1993) reports the following operating criteria have been established pursuant to fish migrant studies to maximize fish survival at the rotating screens and downstream juvenile bypass facility at Marmot Dam:

- The fish bypass operates whenever water is diverted into the canal.
- The canal screens are run continuously from March 1 through May 31 when fry are present.
- The screen wash water spray pressure is maintained at 30 psi from March 1 through May 31.
- Flow in the bypass is maintained at approximately 60 cfs to keep velocities entering ports at 2 feet per second.
- When large numbers of smolts are observed in front of the screens, water level in the canal is dropped so fish can be flushed through the bypass and back to the river.

In summary, based on evaluation of the downstream juvenile migrant bypass facility at Marmot Dam, Cramer (1993) concluded that though the proportion of downstream migrants diverted into the canal is unknown, an estimated 95.4% of the fry bypassed survived. In addition, an estimated 97.3% of hatchery steelhead test smolts and 95% hatchery spring chinook test smolts survived the bypass system (Cramer 1993).

Though the rotating screens and bypass facility have undergone improvements since 1981, the ODFW has the following concerns in regards to the bypass facility:

- The rotating screens designed to divert salmonid fry are perpendicular to the flow and do not provide an acceptable sweeping velocity to prevent impingement.
- Fry survival and bypass is highest when canal surface water elevation is between 2.7 to 4.0 feet, probably because the top fish diversion port openings are at surface elevation 2.67 to 4.2 feet.
- Spray pressure from the screen wash water affects fry survival and a spray psi of 30 seems to provide the best survival over the ranges tested;
- Some delays to smolt and fry migration may occur.
- The spray wash system is presently not operated year round and should be operated year round to ensure adequate passage is provided all year.

The ODFW has concluded that the screens and bypass system at Marmot Dam currently fall below agency operational criteria and that the facility should be redesigned as a condition of a new license when the existing license expires. The ODFW also has the following fish management concerns in regards to PGE hydropower impacts on the fish resource of the subbasin:

- Lost anadromous fish habitat above the Little Sandy River diversion dam, and reduced flows in the 1.7-mile reach below the diversion dam.
- Spill may occur at the Little Sandy diversion dam during high water events, and attract migratory fish up to the diversion dam. When flows abate, fish attracted upstream in the Little Sandy River may become stranded and die when the channel below the diversion waters.
- Mitigation agreements for lost habitat in the Little Sandy River; Portland General Electric presently compensates the production of 12,000 pounds of hatchery fish (presently 100,000 spring chinook smolts).
- Changes in the hydrological profile in the 11-mile reach below Marmot Dam.
- Temperature differences that may exist during summer in the Sandy and Bull Run Rivers at the point of confluence as a result of flow manipulations.
- Water leaving the Bull Run River is mixed with water diverted from the Sandy River, and this may promote straying of wild and hatchery fish into the Bull Run watershed where spawning and rearing habitat has been severely degraded.

Mitigation Agreements and FERC License Requirements

The City of Portland and PGE presently compensate for lost fish production caused by in-stream habitat losses or impacts resulting from hydropower and municipal water supply development in the Sandy Subbasin. A large portion of the winter steelhead and spring chinook hatchery production destined for release in the Sandy River are tied to FERC license requirements. Presently, Portland funds the production of 60,000 hatchery winter steelhead smolts (12,000 pounds) and 160,000 spring chinook smolts (20,000 pounds) as compensation for lost habitat caused by the development of hydroelectric production facilities in the Bull Run River. Provisions for compensation are stipulated in Portland's FERC license #2821 for these projects (expires in 2029). The agreement between Portland and ODFW pertaining to this requirement was signed in 1984 and only provides for lost annual natural production since that time. However, this agreement resolved all "past claim" disputes. It should be noted that the requirements in the FERC license did not address migratory trout or other migratory fish species.

Unfortunately, no comprehensive records exist that accurately quantify the numbers of fish that historically returned to the Bull Run River. In order to determine the lost natural fish production potential of the Bull Run River due to municipal water supply and hydroelectric power development, the ODFW evaluated old hatchery egg take records from the early 1900s of fish intercepted at the Salmon River Hatchery to estimate the size of the potential fish runs in the Bull Run River prior to dam construction. It was assumed that because of geomorphological and hydrological similarities between the Bull Run River and the Salmon River, that runs returning to these basins may have also been similar. It was estimated that potential annual production of wild fish from Salmon River was at least 1,530-spring chinook, 725 steelhead, and 1,050 coho, or a total of 3,505 anadromous fish. Compensation for lost natural production in the Bull Run River was agreed to be 60,000 hatchery winter steelhead smolts and 20,000 pounds of hatchery spring chinook smolts (160,000). These hatchery smolts are released in the Sandy River below Marmot Dam, primarily to support sport and commercial fisheries interests.

Similarly, PGE funds the production of 100,000 hatchery spring chinook smolts (about 12,000 pounds) for lost salmonid habitat in the Little Sandy River. It should be noted that lost natural production of coho and winter steelhead in the Little Sandy River was used to calculate the compensation of equal pounds in hatchery produced spring chinook. The ODFW decided that funding for lost natural production of coho and winter steelhead should be used for production of hatchery spring chinook. Coho and winter steelhead programs at that time were already federally funded, and it was thought that greater benefits would be realized by enhancing the spring chinook program. From various records it was determined that the Little Sandy River could once have naturally produced as many as 846 adult coho and 706 adult steelhead (ODFW intradepartmental memo from Lou Fredd, October 4, 1979).

The agreement between ODFW and PGE was signed in 1983 and is incorporated as a requirement of FERC license #477. The compensation requirements did not address lost fish production prior to the signing of the agreement, nor did it address lost habitat for migratory trout or other migratory and non-game fish species. In addition, the Little Sandy diversion dam is not screened, and downstream migrant trout naturally produced in the basin upstream are probably diverted into Roslyn Lake. The re-licensing period for PGE's Little Sandy River diversion is 2004.

Protected Areas

Nearly 60 river miles in the Sandy Subbasin are protected by Wild and Scenic River status. In 1968, Congress passed the National Wild and Scenic Rivers Act (P.L. 90-542), which was intended to create a system of outstanding free-flowing rivers in the United States. In 1988, the Omnibus Oregon Wild and Scenic Rivers Act (P.L. 100-557) amended the 1968

Act, designating the following reaches: 1) the Sandy River from Dabney State Park (RM 6) upstream to Dodge Park at RM 18.5 (Lewis 1993), 2) the Salmon River in its entirety from its headwaters on Mount Hood downstream to its confluence with the Sandy River at RM 38, and 3) the upper Sandy River from its headwaters on Mount Hood downstream 12.4 miles to the USFS Boundary near RM 44. Reaches within each Wild and Scenic segment are classified and managed as wild, scenic, or recreational depending on the level of development and access present at the time of the designation.

Relation to Federal Columbia River Power System

While no hydropower dam and reservoir complex is operated by a federal agency in the Sandy Subbasin, there are private facilities licensed through FERC and numerous powerlines and infrastructure which are operated in conjunction with the Federal Columbia River Power System (FCRPS) to provide power to the Northwest power grid system. In addition, the Sandy River Delta and lower subbasin areas were directly affected by the construction and the operation of the FCRPS, especially nearby Bonneville Dam. Therefore, the impacts from these FCRPS activities on subbasin fish and wildlife resources form the core of information around which this Subbasin Summary is developed.

Fish and Wildlife Resources

Fish and Wildlife Status

Fish

The Sandy Subbasin is home to 19 native and 14 introduced fish species. Prior to the 1800s, anadromous and resident fish populations flourished in the subbasin's pristine environment full of shallow gravel beds, deep pools, and cool mountain stream flows (Taylor, 1998). Native anadromous fish species included winter and summer steelhead trout, fall and spring chinook salmon, and coho salmon. Historically, it has been estimated that fish runs as high as 15,000 coho, 20,000 winter steelhead, 10,000 fall chinook, and 8,000-10,000 spring chinook once returned each year to spawn in the subbasin (Taylor, 1998). Large populations of cutthroat trout (resident and migratory forms), bull trout, rainbow trout, mountain whitefish, pacific lamprey, and other resident fish also were found in the subbasin.

By the late 1800s, development within the subbasin also began to affect fish production. Widespread timber harvest, driving logs down river to mills, road building, agricultural production, and other development, especially in the lower basin, damaged pristine habitat areas. In 1887, hatchery egg-take operations on the Salmon and Sandy rivers captured many fish returning to upper basin spawning grounds (Taylor, 1998). Also, the building and operating of several dams in the basin during the early 1900s also seriously affected fish habitat and production. On the Little Sandy River, salmon and steelhead lost access to about 6.5 miles of spawning and rearing habitat after construction of the diversion dam. The Headworks Dam built on the Bull Run River blocked salmon and steelhead from about 37 miles of habitat in the upper drainage. Flow diversions at both dams restricted fish production in the lower river sections. Marmot Dam, constructed in 1913, hindered the upstream and downstream migration of fish and flow diversions often left little water in the Sandy River below the dam, which limited fish production.

Today, the subbasin's anadromous fish runs have fallen far below historic levels. Comparisons of old hatchery records and recent spawning surveys suggest that current adult returns are only 10% to 25% of 1890 levels, and hatchery-reared fish now dominate the runs (Taylor, 1998). Many of the salmonid populations in the subbasin are currently under stress (Table 4).

Table 4. Federally Listed and Candidate Fish Species in the Sandy Subbasin

Fish Species	Status	Federal Register
Chinook Salmon (*Oncorhynchus tshawytscha)*		
Lower Columbia ESU	Threatened	64 FR 14308; March 24, 1999
Steelhead (*Oncorhynchus mykiss)*		
Lower Columbia ESU	Threatened	63 FR 13347; March 19, 1998
Coho Salmon *(Oncorhynchus kisutch)*		
Lower Columbia/SW Washington ESU	Candidate	60 FR 38011; July 25, 1995

Spring Chinook Salmon

Figure 4 shows the distribution of spring chinook salmon (*Oncorhynchus tshawytscha*) in the Sandy Subbasin. Historically, strong healthy runs of native spring chinook salmon ascended the Sandy River and its tributaries. Mattson (1955) reported that between 8,000 and 10,000 wild spring chinook may once have returned to the watershed (5,000 to the Bull Run River and 3,000-5,000 to the upper subbasin). However, municipal water supply development in the Bull Run River and water diversions from the mainstem Sandy at Marmot Dam beginning in the early 1900s severely impacted natural production capability of spring chinook in the subbasin. In addition, adult spring chinook were trapped at Marmot Dam in many years up through the 1950s for artificial propagation. The Marmot Dam diversion canal was not screened until 1952, and at the time, fisheries managers felt that it was not justifiable to allow adult salmon to spawn above the dam only to have a large proportion of out-migrating juveniles diverted from the mainstem and into Roslyn Lake.

In addition, ocean and Columbia River commercial and sport fisheries also impacted the run. Passage of wild spring chinook at Marmot Dam dwindled to near zero during some run years in the 1950s as a result of these cumulative effects. However, based on District reports from anonymous authors in the 1950s, small numbers of spring chinook continued to spawn in the lower basin below Marmot Dam based on old survey records.

Hatchery spring chinook have been released in the Sandy River since the early 1900s. Though mostly fry and presmolts of Sandy origin were released up through 1969, a more focused hatchery program was initiated in the early 1970s to supplement the depleted native run with Willamette stock spring chinook. However, Carson stock (Washington) was used in 1977 and 1978. Presently, about 460,000 hatchery spring chinook smolts, Willamette stock from the Clackamas Hatchery, are released annually into the Sandy River. Since the early 1980s, Portland and PGE have provided funding to support the production of 260,000 of these smolts under FERC requirements to mitigate for lost fish production in the Bull Run and Little Sandy watershed (see Hatchery section). The spring chinook return has increased markedly over the past 15 years (Table 5; Figure 5) largely in response to hatchery releases in the watershed (see Abundance section for rationale). The estimated five year average return for run years 1990-94 was 5,118 (Table 5; Figure 5).

Though it is believed that most spring chinook returning to the subbasin are of hatchery origin, natural production continues to occur primarily above Marmot Dam in the larger clear water tributaries and is believed to be making a contribution to the spring chinook run in the Sandy River. Many miles of spawning and rearing habitat are in reaches of the watershed that are under "Wilderness" or "Wild and Scenic River" status, and also exist above areas that are heavily influenced by flow manipulations. Spring chinook adults and redds are counted each year in Still Creek by USFS personnel from the Zigzag Ranger District and spawning activity is documented in other neighboring streams.

Naturally produced juvenile spring chinook out-migrants, both 0+ and 1+ fish, have also been trapped annually in Still Creek by the USFS since 1986. Naturally produced juvenile spring chinook have also been observed by snorkel surveys in Still Creek and the Salmon River during the summer. However, the proportion of the spring chinook spawning escapement that originates from natural production or directly from hatchery returns is unknown as only a small percent of the hatchery spring chinook smolts originating from the Clackamas Hatchery are marked (about 5% in some years).

Though a significant amount of spawning activity is observed in the upper subbasin each year, genetic introgression between any remnant returns of native Sandy spring chinook and the large numbers of hatchery Willamette stock spring chinook has probably occurred. It is unknown if the indigenous stock of Sandy River spring chinook has sustained itself as a separate subpopulation from the introduced Willamette stock.

The ODFW presently list spring chinook that return to the Sandy Subbasin in the Willamette spring chinook Gene Conservation Group, which also includes populations that return to the McKenzie, Santiam, Molalla and Clackamas rivers, all major tributaries to the Willamette River. Willamette stock spring chinook are now managed in the Sandy Subbasin for both hatchery and natural production. It is probable that Willamette stock spring chinook have become adapted to the Sandy Subbasin and a portion of the run is now represented by naturally produced Willamette spring chinook.

The importance of sustaining a naturally produced population of Willamette stock spring chinook in the Sandy River has emerged because wild runs in the Willamette Basin are declining. All hatchery spring chinook smolts have been released in the lower subbasin below Marmot Dam since 1994 to reduce competition with the naturally producing component of the run in important spawning and rearing areas in the upper subbasin.

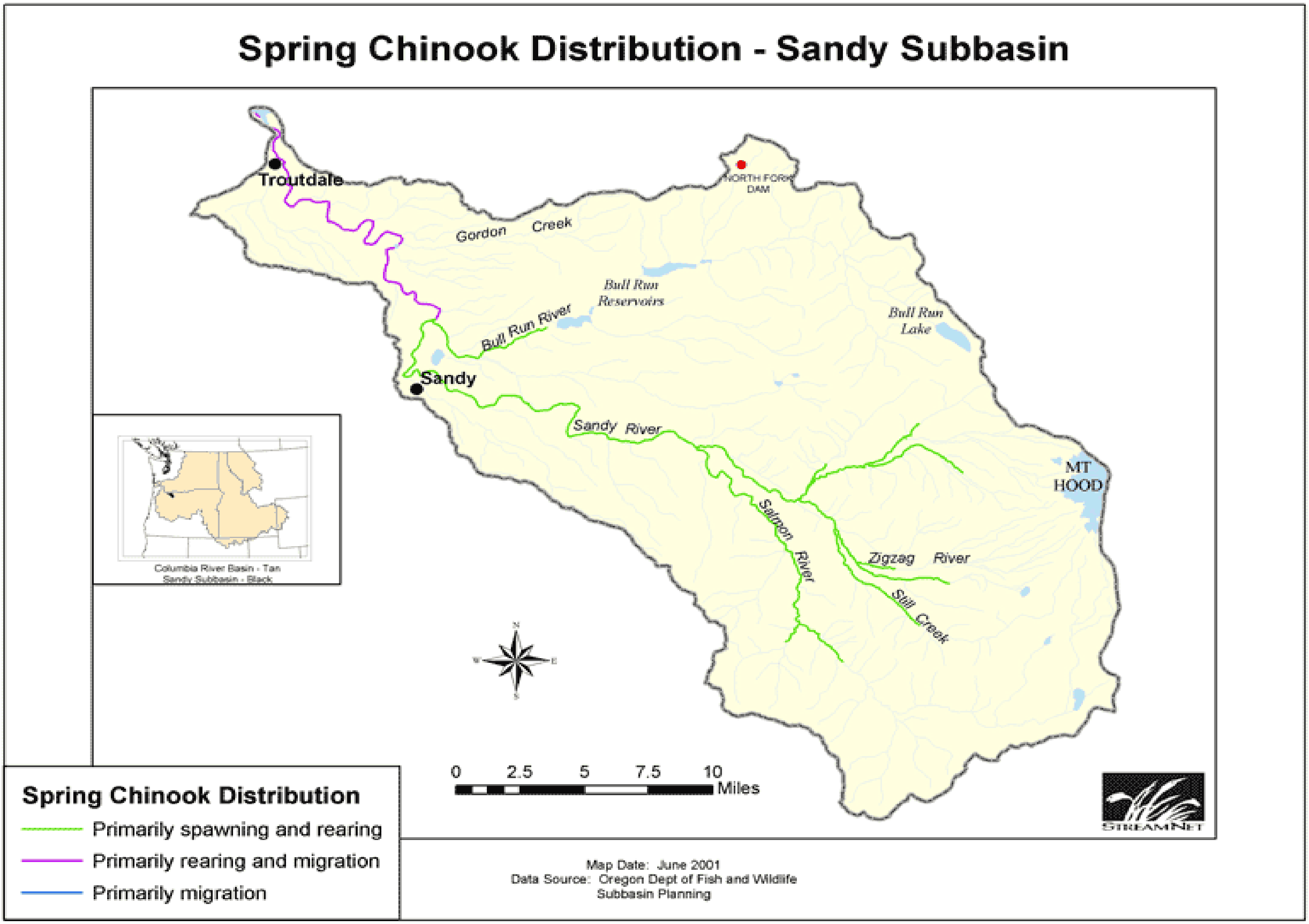

Figure 4. Distribution of spring chinook salmon in the Sandy Subbasin

Table 5. Spring chinook run components in the Sandy Subbasin

Year	Marmot Counts[2]	Sport Catch[1] Bull Run River	Sport Catch[1] Sandy River (below Marmot)[3]	Sport Catch[1] Sandy River (above Marmot)[4]	Minimum Run Estimate	Harvest Rate (%)	Estimated Spawning Escapement
1954	400	--	--	--	--	--	--
1955	5	--	--	--	--	--	--
1956	0	--	354	--	354	--	--
1957	10	--	156	--	166	--	--
1958	78	--	246	--	324	--	--
1959	304	--	383	--	687	--	--
1960	23	--	126	--	149	--	--
1961	37	--	33	--	70	--	--
1962	65	--	32	--	97	--	--
1963	124	--	67	--	191	--	--
1964	660	--	29	--	689	--	--
1965	13	--	38	--	51	--	--
1966	63	--	29	--	92	--	--
1967	51	--	35	--	86	--	--
1968	61	--	28	--	89	--	--
1969	81	--	83	--	164	--	--
1970	137	--	112	--	249	--	--
1971	--	--	60	--	--	--	---
1972	--	--	37	--	--	--	--
1973	--	--	89	--	--	--	--
1974	--	--	36	--	--	--	--
1975	--	--	274	--	--	--	--
1976	--	--	159	--	--	--	--
1977	--	--	275	--	--	--	--
1978	607	12	116	--	735	--	556
1979	267	15	597	--	879	--	245
1980	553	9	1,260	--	1,822	--	506
1981	1,087	15	1,739	--	2,841	--	996
1982	525	3	854	--	1,382	--	481
1983	561	44	1,259	--	1,864	--	514
1984	1,212	38	1,124	--	2,374	--	1,110
1985	566	8	875	--	1,449	--	518
1987	1,421	0	932	--	2,353	--	1,302
1988	1,947	12	972	50	2,931	35	1,897
1989	1,413	4	587	63	2,004	33	1,350
1990	1,614	16	1,897	145	3,527	58	1,469
1991	1,904	9	1,739	202	3,652	60	1,702
1992	7,011	3	1,537	683	8,551	26	6,328
1993	4,389	12	1,968	436	6,369	38	3,953
1994	2,319	3	1,176	143	3,498	38	2,176
1995	1,503	--	--	--	--	--	--

1. Counter not in operation from 1971 through 1977.
2. Counter failed June 1992; count is estimated based on average June return for previous years.
3. Problems with installation of new camera system during spring and summer 1996; counts are estimates based on proportions of fish counted by the electronic counter.
4. Counts from 1960-70 were estimated from trapping efforts conducted by ODFW.

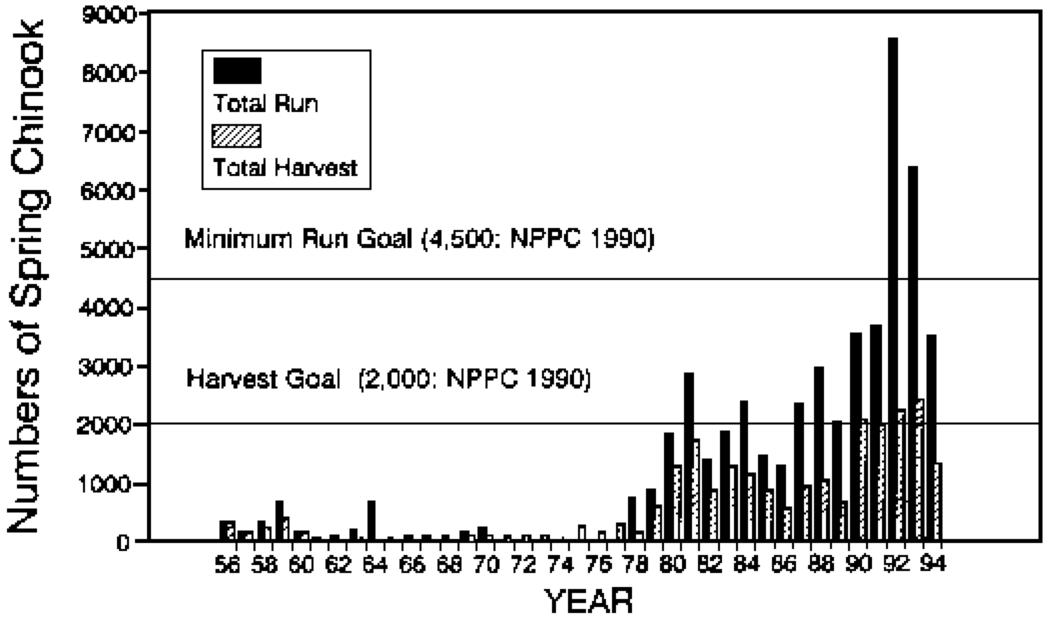

Figure 5. Trends in run size and harvest of spring chinook in the Sandy Subbasin

Run Timing and Spawning Distribution

Spring chinook may enter the Sandy River as early as February, but peak movement into the subbasin typically occurs in April and May according to angler reports (see Angling section). Willamette stock spring chinook have been harvested in the Willamette River below Willamette Falls as early as January in some years (personal communication, Curt Melcher, ODFW, 1996), and possibly some bright “winter” chinook reported in January and February by anglers on the Sandy River may be early returning spring chinook.

Spring chinook typically migrate into the upper subbasin above Marmot Dam from May to early October (Figure 6); however, some migrants are observed as early as April and as late as November. It may be that chinook counted in late October and November are actually late maturing fall chinook that are attracted into the upper basin when flows permit (see Fall Chinook section). Peak migration over Marmot Dam generally occurs in June, and for run years 1980 to 1995, 30% of the spring chinook count occurred in this month (Figure 6). Passage at Marmot Dam then decreases in summer, probably in response to drops in flow and increases in water temperature. A second but smaller peak often occurs in September as water temperatures again decrease. For run years 1980-1995, 15% of the spring chinook count at Marmot Dam occurred in September, and an additional 5% of the run occurred in October (Figure 6). This is a concern because cumulatively, about 20% of the spring chinook run that pass Marmot Dam is holding in the lower subbasin for most of the summer in areas that are greatly influenced by flow manipulations and temperature differences, which may affect survival.

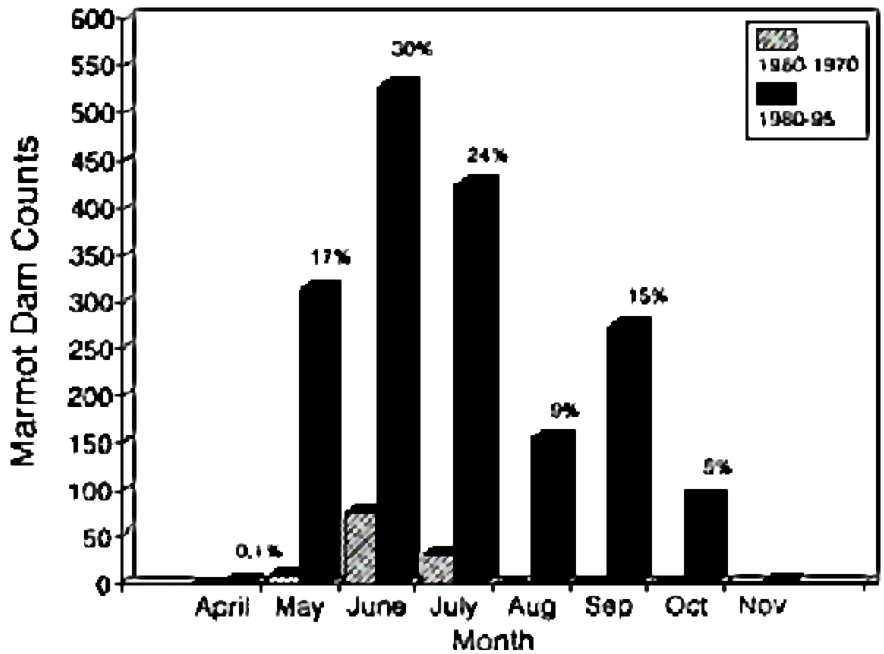

Figure 6. Comparison of average monthly spring chinook escapement over Marmot Dam for years 1960-1970 and 1980-1995

Historical migratory run patterns of spring chinook in the Sandy Subbasin are unknown; however, during run years 1960-1970, spring chinook passed Marmot Dam primarily in May, June and July. Peak counts were in June and accounted for about 63% of the upstream migrants during the period. Very few fish were counted at Marmot Dam after July (Figure 6), a migratory response caused by water diversions at Marmot Dam and subsequent dewatering of the 11-mile reach below the dam.

Interestingly, run timing of Willamette stock spring chinook into upstream spawning reaches varies by watershed (Figure 7), though spawning timing is about the same. Peak passage of spring chinook into the upper Sandy Subbasin occurred in June during run years 1991-1995 (30% of total upstream migrants), but the peak migration in the Clackamas River, (measured at North Fork Dam RM 30), occurred in September for the same time period and accounted for 41% of the total upstream migrants (Figure 7). It is believed that a combination of both hatchery practices at Clackamas Hatchery, located just downstream from the dams, and hesitance of adult spring chinook to enter the ladder at River Mill Dam during spring and summer strongly influence migratory behavior of spring chinook in the Clackamas Basin (personal communication, Jay Massey, ODFW, 1996). Peak spawning of spring chinook typically occurs in September and early October in the Clackamas River, and brood fish that hold and mature below the dams may become incited to move upstream to spawn with the onset of fall. The Clackamas Hatchery also closes the adult trap in September and spring chinook are no longer attracted into the facility.

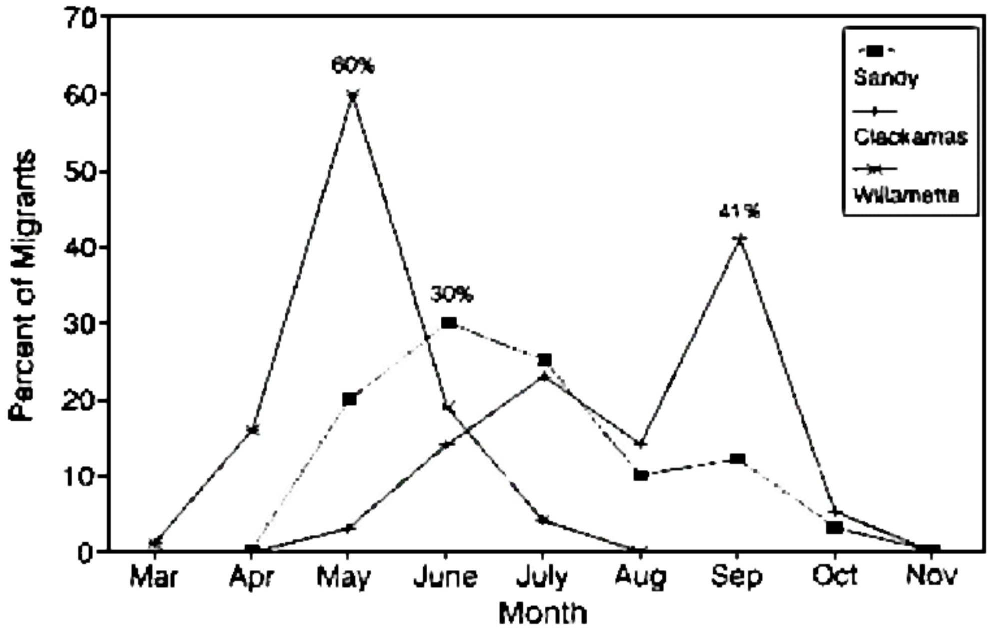

Figure 7. Comparison of Willamette stock spring chinook migratory patterns in the Sandy, Clackamas, and Willamette Rivers

Upstream migration of Willamette stock spring chinook at Willamette Falls generally begins in March, and for run years 1991-1995, 60% of the run moved above the falls in May. Most of the run is usually complete by July (Figure 7). Migration of Willamette stock spring chinook in the Willamette River is strongly influenced by flow and water temperatures that often rise above 70°F in July (personal communication, Craig Foster, ODFW, 1996). Spring chinook in the Willamette River also must travel longer distances to their respective spawning areas.

Primary spring chinook spawning areas in the subbasin are presently located in the upper watershed above Marmot Dam. Most spawning occurs in the Salmon River up to Final Falls and in Still Creek primarily from its confluence upstream about 3 miles (personal communication, Jeff Uebel, Zigzag Ranger District). However, a significant amount of spawning activity is also documented in the ZigZag River, upper Sandy River and in the lower reaches of several tributary streams when flows permit. Spring chinook may also use the mainstem and side channels for spawning and rearing. Spawning and rearing distribution in the upper subbasin is moderated to some extent by natural inputs of glacial sediments in the Muddy Fork of the Sandy, the upper Sandy, and the ZigZag Rivers. Though turbidity in some reaches may locally depress production potential, these tributaries are important conduits to habitat in nearby clearwater tributaries.

Historically, Sandy spring chinook were documented to migrate into the Bull Run River (Mattson 1955). Since the early 1900s, the City of Portland's municipal water supply has prevented passage into approximately 17 miles of spawning and rearing habitat. An additional 6 miles of the lower Bull Run River below the dams continue to be impacted by severe flow reductions from late spring to fall, the period of spring chinook migration and spawning. Poor spawning gravel and winter habitat complexity in this reach also limits natural production capability of spring chinook. However, variable levels of straying into the Bull Run River occurs annually. Sandy River water is diverted into the Bull Run basin for power production, mixes with Bull Run water, and attracts adult spring chinook migrants and other salmonids as well. Stray spring chinook may ascend the river above the PGE powerhouse (RM 1.5) in the spring or early summer when accretion flows or spill provide adequate water for migration. These fish may then become trapped in isolated mainstem pools below the Headworks Dam when flows decrease as a result of water storage in upstream reservoirs. It is believed that these spring chinook are subject to high mortality due to predation, or increased temperatures and poor water quality caused by reduced flows. Total annual losses of spring chinook due to these impacts are unknown.

Abundance

Historically, between 8,000 and 10,000 wild spring chinook may once have returned to the watershed, 5,000 to the Bull Run River and 3,000-5,000 to the upper Sandy Subbasin (Mattson 1955). Mattson (1955) reported from accounts of residents on the river that “prior to the construction of the Marmot Dam (1912) these fish were quite abundant in the main river and the Salmon and ZigZag rivers.”

Presently, trends in run strength and timing of migration of spring chinook in the Sandy Subbasin are estimated from harvest in the lower basin and from fish counts made at Marmot Dam fish ladder/trap. The trapping facility is operated and maintained by PGE and provides a reasonable estimate of spring chinook escapement and spawning timing into the upper basin. A trap was monitored at the dam from 1953-1970 to assess anadromous salmonid migrations, and provides information on escapement during that time period. From 1971-1977, fish counts were not made at the dam and escapement estimates are unknown. However, anglers continued to catch spring chinook in the lower subbasin during the time period (Table 5) and it is likely some escapement above the dam also occurred. From 1977-1998, fish counts were made by an electronic and photographic counter. In November 1998, a trap at the top of the fish ladder was installed and also allowed sorting of fish. Only unmarked fish were allowed passage above Marmot Dam.

The estimated minimum escapement of spring chinook to the Sandy River in the 1950s, prior to large hatchery spring chinook releases, averaged about 336 fish annually). The estimate is based on harvest in the lower subbasin and escapement at Marmot Dam. However, adult spring chinook sometimes spawned in the lower subbasin, based on old survey records, probably because water diversions at Marmot Dam significantly reduced flows by late spring and early summer, thereby preventing passage upstream to the dam in some years. Those spring chinook forced to spawn in the lower subbasin, or in the lower Bull Run River (Mattson 1955), were not accounted for in escapement estimates. Marmot counts dropped to an average of 168 in the 1960s (Table 5).

Hatchery releases of Willamette stock spring chinook smolts began in earnest in the early 1970s in conjunction with increased flows below Marmot Dam in summer and fall, and greatly improved spring chinook returns to the Sandy Subbasin. The estimated annual return to the subbasin averaged 2,056 for run years 1980-1984, 2,005 for run years 1985-1989, and 5,118 for run years 1990-1994 (Figure 8). Note that large returns in 1992 and

1993 significantly increase the average for the 5-year period and variation between years is relatively large (Table 5). It is believed that most spring chinook returning to the Sandy River originate from hatchery releases or are the progeny of naturally producing hatchery fish in the basin. The hatchery and natural produced components are unknown.

The total run goal of 4,500 spring chinook set in the Northwest Power Planning Council's (NWPPC) *Sandy Fish Management Plan* (1990) was exceeded, on the average, for the 1990-1994 time period. In addition, both the in-basin harvest goals of 2,000 spring chinook and the spawning escapement goals of 2,500 spring chinook were also met, on the average, during these run years. However, it should be noted that the spawning escapement goal was only met in 2 of the 5 years.

Preliminary analysis of spring chinook returns to the Sandy River since 1982 suggests that although spring chinook naturally reproduce in the watershed, spring chinook run strength has grown largely in response to increased releases of hatchery smolts in the subbasin (Table 6). Analysis of age composition and brood year survival for annual hatchery spring chinook smolt releases provides a rough sketch of what may be driving spring chinook run trends in the subbasin.

Age composition of the annual spring chinook return to the Sandy River was estimated for return years 1982-1995 (Table 6) using age composition tables for spring chinook caught in the Clackamas River sport fishery (provided in Bennett 1995). Willamette stock spring chinook smolts released in both the Sandy and Clackamas Rivers are produced at the Clackamas Hatchery, and it is assumed that the age composition for each population at return is similar. However, certain factors may affect age at return between basins and are considered in the following text.

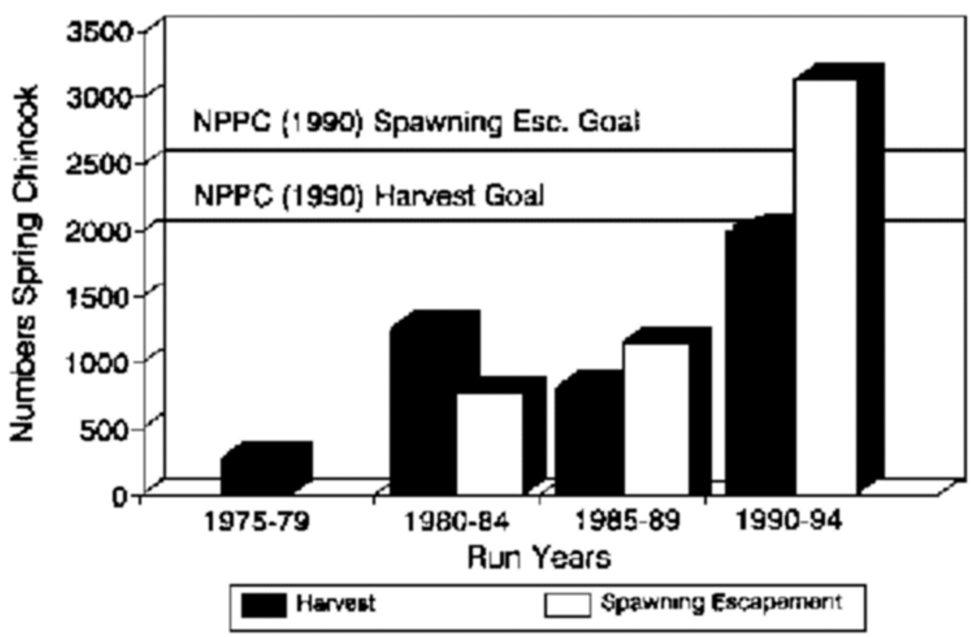

Figure 8. Trends in spring chinook run strength, harvest and spawner escapement in the Sandy Subbasin for three 5-year time periods

Table 6. Hatchery spring chinook smolts released in the Sandy Subbasin representing brood years 1979-1990, adult return for each age class, and brood year survival (adult return divided by representative smolt release)

Brood Year	Hatchery Smolts Released[a] Fall Sub-Yearling	Spring Yearling	Total Rel. Annually	Age Class Return[b] 3	4	5	6	Total	Brood Year Survival Rate
1979	200,393	0	200,393	94	1,317	855	10	2,276	1.14%
1980	200,400	0	200,400	102	1,410	394	7	1,913	0.95%
1981	199,899	0	199,899	95	996	287	0	1,378	0.69%
1982	208,674	0	208,674	49	921	565	11	1,546	0.74%
1983	199,925	0	199,925	71	1,708	1,706	8	3,493	1.75%
1984	200,305	0	200,305	80	1,202	958	0	2,240	1.12%
1985	418,774	0	418,774	12	806	633	24	1,475	0.35%
1986	200,548	153,102	353,650	232	2,809	2,022	111	5,174	1.46%
1987	199,045	260,773	459,818	86	1,544	5,591	119	7,340	1.60%
1988	99,651	361,784	461,435	62	2,676	4,015	19	6,772	1.47%
1989	0	460,181	460,181	166	1,812	1,137	21	3,136	0.68%
1990	0	458,743	458,743	423	2,275	717[c]	--	3415[c]	0.74%

Average for 1979-84: Smolts - 201599 Brood Year Returns: 2141
Average for 1985-90: Smolts - 43534 Brood Year Returns: 4552

Note: Commercial and sport harvest occurring outside the Sandy Subbasin during the period varied annually and is not accounted for in this analysis.

a. Hatchery spring chinook presmolts and fry were also released in some years. Though presmolt and fry releases were significant in some years, survival to adult return was believed to be poor and was therefore not included in the analysis.
b. Numbers of spring chinook returning by age to the Sandy River for each brood year release are calculated using respective proportions of each age class in the Clackamas River sport fishery as reported in Bennett (1995) and shown in Appendix Table C. Age composition of spring chinook returning to the Sandy River are assumed to be similar to returns in the Clackamas River because both populations are largely represented by Willamette stock spring chinook originating from the Clackamas Hatchery. However, smolt release strategies for each basin differ which could affect age at return (see text).
c. Age 5 return reflects only counts of spring chinook at Marmot Dam. Harvest in 1995 is not yet available and therefore, is not accounted for in the figure. Actual figure is higher and will increase overall brood year survival rate.
d. Six year average brood year survival success for each time period, 1979-1984 and 1985-1990, is expressed as an average of total brood year age class returns divided by the representative number of spring chinook smolts released.

Hatchery spring chinook smolt releases averaged about 200,000 for brood years 1979-1984, and subsequent adult year class returns to the subbasin from these releases averaged 2,141 for return years 1982-1990 (Table 6). The average annual spring chinook smolt releases in the Sandy River more than doubled to 435,434 for brood years 1985-1990 (release years 1986-1992) due to mitigation negotiations with Portland and PGE in the early 1980s. Subsequent adult returns from these brood year releases more than doubled to an estimated average of 4,552 in return years 1988-1995 (note that age-6 adults from brood year 1990 return in 1996 and are not accounted for). In addition, the estimated average brood year survival rate for the two six year periods remained about the same: 1.06% for brood years 1979-1985 and 1.05% for brood years 1986-1990 (Table 6). Brood year survival rate for each six year period (1979-1984 and 1985-1990) is expressed as the average total spring chinook escapement to the Sandy River by year class for the period divided by the representative number of spring chinook smolts released. These figures do not represent total survival, as a significant number of fish are harvested in commercial and sport fisheries outside the subbasin.

Natural Production

Spring chinook returning to the Sandy River typically spawn from August to early October, and spawning activity is generally complete by mid-October based on spawning ground surveys conducted by the USFS in Still Creek and Salmon River (see October entries in Table 5). During run years 1989-1995, surveyors counted 38 spring chinook adults/mile/year and 37 redds/mile/year in the lower three miles of Still Creek (Table 7).

In the Salmon River, during run years 1991-1995, surveyors counted 59 spring chinook adults/mile/year and 37 redds/mile/year in a two mile reach in the upper Salmon River below Final Falls (RM 10-12). Additional surveys have also been conducted in a 1/4 mile braided reach of the Salmon River near the Salmon River Golf Course (RM 6). During run years 1994 and 1995 surveyors counted an average of 92 spawners/mile/year and 52 redds/mile/year. Factors affecting the difference in counts per mile in each tributary stream are: 1) Still Creek is a smaller order tributary than Salmon River, 2) Final Falls is a barrier to salmon migration and adult spring chinook may “keg up” in this upper reach and though redds/mile are the same as in Still Creek, spawners/mile were greater in the Salmon River survey, 3) the braided side channel near the Golf Course on the Salmon River may have a higher proportion of quality spawning gravel than the neighboring mainstem and may attract and concentrate spawners, and 4) the data set is limited and natural variability in abundance of spawners in specific areas may occur between years. Fecundity for naturally producing spring chinook in the Sandy River is unknown.

Juvenile spring chinook rearing distribution is not well documented in the subbasin. However, studies conducted by the USFS in Still Creek suggest that spring chinook fry emerge in mid to late winter and begin to drift downstream, probably to rear in larger mainstem areas of the watershed. Few juvenile spring chinook are observed in Still Creek by snorkeling or electrofishing efforts later in the summer (personal communication, Jeff Uebel, Zigzag Ranger District, 1995). This life history pattern is also consistent with spring chinook freshwater rearing strategies in Fish Creek, a large tributary to the neighboring Clackamas River. Everest et al. (1986) reported that though spring chinook spawned in Fish Creek when flows allowed, most of the progeny descended into the mainstem Clackamas River prior to attaining smolt status. Some spring chinook yearling smolts are trapped annually at the Still Creek smolt trap, but it is unknown if these fish departed as fry and moved back into Still Creek to overwinter or spent a full year rearing within Still Creek. More information regarding seasonal migratory patterns and rearing needs of naturally produced juvenile spring chinook is needed to better evaluate habitat related factors that may limit survival within mainstem rearing areas.

Table 7. Spring chinook spawner and redd counts in Still Creek and the Salmon River during return years 1989-1995

Year	Date	Number Redds	Live Adults	Dead Adults	Total Count
Still Creek (3 miles)[a]					
1989	25-Sep	81	34	29	63
1990	19-Sep	94	121	3	124
1991	25-Sep	113	95	20	115
1992	05-Oct	117	20	120	140
1993	28-Sep	113	52	76	128
1994	27-Sep	112	41	57	98
1995	28-Sep	143	64	66	130
Average		110	61	53	114
Average Number Miles/Year:		37 redds/miles/yr.		38 spawners/mile	
Salmon River (2 miles)[b]					
1991	23-Sep	64	62	22	88
1992	06-Oct	79	16	127	143
1993	29-Sep	62	34	67	101
1994	20-Sep	105	104	19	123
1995	26-Sep	58	58	79	137
Average		74	55	63	118
Average Number Miles/Year:		37 redds/miles/yr.		38 spawners/mile	
Salmon River (1/4 mile)[c]					
1994	22-Sep	13	12	12	24
1995	26-Sep	12	11	10	21
Average		13	12	11	23
Average Number Miles/Year:		52 redds/mile/yr.		92 spawners/mile	

a. Still Creek survey starts at mouth and ends 3 miles upstream at confluence with Cool Creek. Flows in Still Creek often effect spawner distribution (i.e. in 1994 the stream was low and spring chinook spawners were congregated mostly in the lower reach, whereas in 1995 flows were higher and spawners were more distributed throughout the survey reach (personal communication, Chris Brigham, Zigzag, 1995).
b. The USFS conducts two surveys in Salmon River: this survey is in the Fly Angling only zone and begins at the USFS Bridge (about RM 10) and ends 2 miles upstream.
c. This is a short survey conducted in a 1/4 mile reach located near the Salmon River Golf Course near RM 6. This reach is braided and these side channel areas are also surveyed.

Naturally produced juvenile spring chinook typically outmigrate to the Columbia River in the spring of their second year as yearling (1+) smolts. Some juvenile spring chinook may outmigrate in the fall as sub-yearlings, however. Information on size at outmigration for naturally produced spring chinook in the subbasin is limited. However, in the spring of 1994 eight yearling spring chinook smolts were sampled in the Still Creek trap and ranged between 86 mm and 116 mm, with an average length of 106 mm and an average weight of 12.2 grams (USFS, unpublished data, 1994). Age at return, sex ratios and weight for naturally produced spring chinook is unknown for the subbasin.

Hatchery Production

Spring chinook were trapped and propagated at various facilities in the Sandy Subbasin since the late 1890s. The first hatchery in the subbasin was located near the mouth of Boulder Creek, a tributary to the Salmon River (Craig and Suomela 1940). This facility trapped and propagated spring chinook on and off through 1912. The greatest egg take at this facility occurred in 1903, with about 3,551,000 eggs collected. Although progeny from these egg collections were generally released back into the Salmon River (Wallis 1966), some eggs were transferred out to other facilities (Craig and Suomela 1940).

Following the construction of Marmot Dam in 1912, hatchery operations moved downstream to a site immediately below the dam. Spring chinook and other salmonids were trapped here for artificial propagation because the Marmot diversion canal was not screened until 1951, and managers at the time felt that a significant proportion of juvenile migrants produced above Marmot Dam would be diverted out of the river and into Roslyn Lake. A rack was built below Marmot Dam that spanned the channel to trap spring chinook, coho and winter steelhead. Spring chinook were trapped here from 1913 to 1925 and 1938 to 1955, and egg takes at this site varied from a low of 10,280 in 1955 to a high of about 2.7 million in 1913. Egg takes at this site may not accurately reflect run size to the subbasin because severely reduced flows below Marmot Dam often prevented fish from reaching the dam.

Spring chinook were produced intermittently at Sandy Hatchery following commission in 1952 through the mid 1960s. Mostly Sandy stock spring chinook were used. The program was marginally successful as spring chinook spawning migration timing did not coincide with adequate flows in Cedar Creek and it was difficult to get adults back to the hatchery for production.

A more aggressive spring chinook hatchery program got underway in the early 1970s to supplement natural production and support commercial and sport fisheries (NWPPC 1990). Minimum stream flows below Marmot Dam were agreed upon by PGE to provide salmonids with the necessary flows for upstream migration. The spring chinook hatchery program in the subbasin has been supported almost exclusively with Willamette stock spring chinook. However, Carson Hatchery stock (Washington) was released in the subbasin in 1977 and 1978.

Hatchery releases averaged 199,526 smolts for years 1977-1985 and increased to an annual average of 420,985 for years 1986-1996. Significant numbers of presmolts and fry have also been released in some years. The ODFW STEP program has also provided Willamette stock spring chinook eggs to interested parties for development and release as unfed fry into the subbasin since 1985. However, egg distribution has been relatively low and ranged from 9,537 eggs in 1989 to a high of 91,405 in 1990. The focus of STEP has changed, and presently only a few thousand spring chinook eggs are distributed annually, primarily to local grade schools for educational purposes. Any remaining STEP releases of hatchery spring chinook are also made below Marmot Dam.

Under FERC license #2821, the City of Portland agreed in 1984 to compensate the production of about 160,000 hatchery spring chinook smolts to mitigate for lost natural production in the Bull Run watershed. Similarly under FERC license #477, PGE compensates the production of 100,00 spring chinook smolts to mitigate for lost natural fish production in the Little Sandy River due to the hydropower projects there.

Hatchery spring chinook are generally released in spring as yearling smolts at about 8-10 pounds. During the 1980s, most hatchery spring chinook were released in the fall as studies conducted at Dexter and South Santiam hatcheries indicated that fall releases of spring chinook smolts produced more and larger spring chinook adults at return (Smith and Zakel 1980). However, more recent results concluded that a greater survival to adult return is realized by releasing smolts in spring (Smith et al. 1987).

Additional information collected on Willamette spring chinook stocks returning from 1988 and 1989 brood year releases in the Clackamas River showed that spring releases survived at a higher rate than fall releases (personal communication, Mark Lewis, ODFW, Corvallis, 1996). Also, prior to 1989, a broad apron existed at the bottom of Marmot Dam, and because of reduced spill at the dam in early fall, it was feared that fall hatchery spring chinook releases in the upper basin might be impacted while dropping over the dam (personal communication, Jay Massey, ODFW, Clackamas, 1996).

All Willamette stock spring chinook smolts released into the Sandy River are currently produced at Clackamas Hatchery, located in McIver State Park on the Clackamas River just downstream from the River Mill Dam. This hatchery was built in 1980 with funds provided by National Marine Fisheries Service (NMFS) and PGE, and is operated by ODFW. Production of spring chinook at Clackamas Hatchery originated primarily from Willamette stock spring chinook from the upper Willamette River. In the 2002 production year, adult unmarked Sandy River spring chinook will be collected for brood. All subsequent smolt production for the Sandy River will be from this local stock.

Angling and Harvest

Spring chinook returns to the Sandy Subbasin support a substantial angling opportunity in the region. Both boat and bank angling are popular for spring chinook. Angling effort occurs primarily below Marmot Dam particularly in the lower river from Oxbow Park downstream to Troutdale, where boat and bank access is good and large deep resting pools are available. However, significant numbers of fish are also taken by bank anglers in both the Wild and Scenic section from Dodge Park to Oxbow Park, and in the gorge area from Marmot Dam downstream to Revenue Bridge. About 83% of the harvest during run years 1988-1994 occurred below Marmot Dam (Table 5). Anglers harvested an estimated average of 1,994 spring chinook annually for run years 1990-1994, a harvest rate of about 39% (Table 5). Though harvest of spring chinook in the subbasin varied annually during the period, the estimated annual average sport harvest of spring chinook met the NWPPC (1990) harvest goal of 2,000 fish.

Fall Chinook Salmon

Figure 9 shows the distribution of fall chinook salmon (*Oncorhynchus tshawytscha*) in the Sandy Subbasin. Fall chinook are indigenous to the Sandy River. The ODFW presently describes two run components: early maturing tule, and later maturing Sandy stock fall chinook that is the dominant fall chinook stock in the subbasin. The two groups are separated based on certain genetic differences and maturation schedules.

Additionally, recent studies show that the late maturing stock has similar run timing and genetic characteristics to wild stocks in the Lewis and Cowlitz Rivers in Washington (personal communication, Kathryn Kostow, ODFW, 1995; Anne Marshall, Washington Department of Fish and Wildlife, 1993). These three lower Columbia River tributary populations are collectively described as the Lower River Wild stock (LRW; ODFW 1995a) for fisheries management. For conservation management, the late maturing Sandy fall chinook population is also recognized as a separate Gene Conservation Group, independent of the earlier returning tule group, which is in the Lower Columbia Gene Conservation Group. Lower Columbia River fall chinook stocks, including all wild Sandy stocks, are presently listed as a Sensitive Species under Oregon's listing criteria.

Until recently, the late maturing population of fall chinook (LRW) in the Sandy River was separated into two stocks or run components: the group that returns from October to early December with peak spawning in early November, and a late-returning group that returns from December to early February, sometimes referred to as "winter" chinook (ODFW 1995b).

Prior to 1995, and according to ODFW's 1995 *Biennial Report on the Status of Wild Fish in Oregon*, the late-returning "winter" chinook were described separately from other fall chinook, but are now considered as a late run component of the LRW population. This decision was made to facilitate management, and because genetic evidence does not currently exist to confirm stock differences.

However, much is unknown about the "winter" chinook in the subbasin. Records show chinook salmon spawning activity in both Gordon and Trout Creeks from late December to February since the early 1950s, and spawning ground surveyors in the 1970s reported morphological differences in size, shape and color as compared to fall chinook observed in October and November (personal communication, Paul Hirose, ODFW, Clackamas, 1995). Anglers also occasionally report catching "bright" chinook in the Sandy River from mid-December to early February. It is unknown if this component of the fall chinook run is genetically distinct from other fall chinook stocks, or is simply a much later returning segment of the run with different morphological characteristics. Though it is believed that abundance of the late run component was never large, abundance has declined to near zero since the early 1980s based on spawning ground counts, and genetic information cannot be collected to resolve the issue.

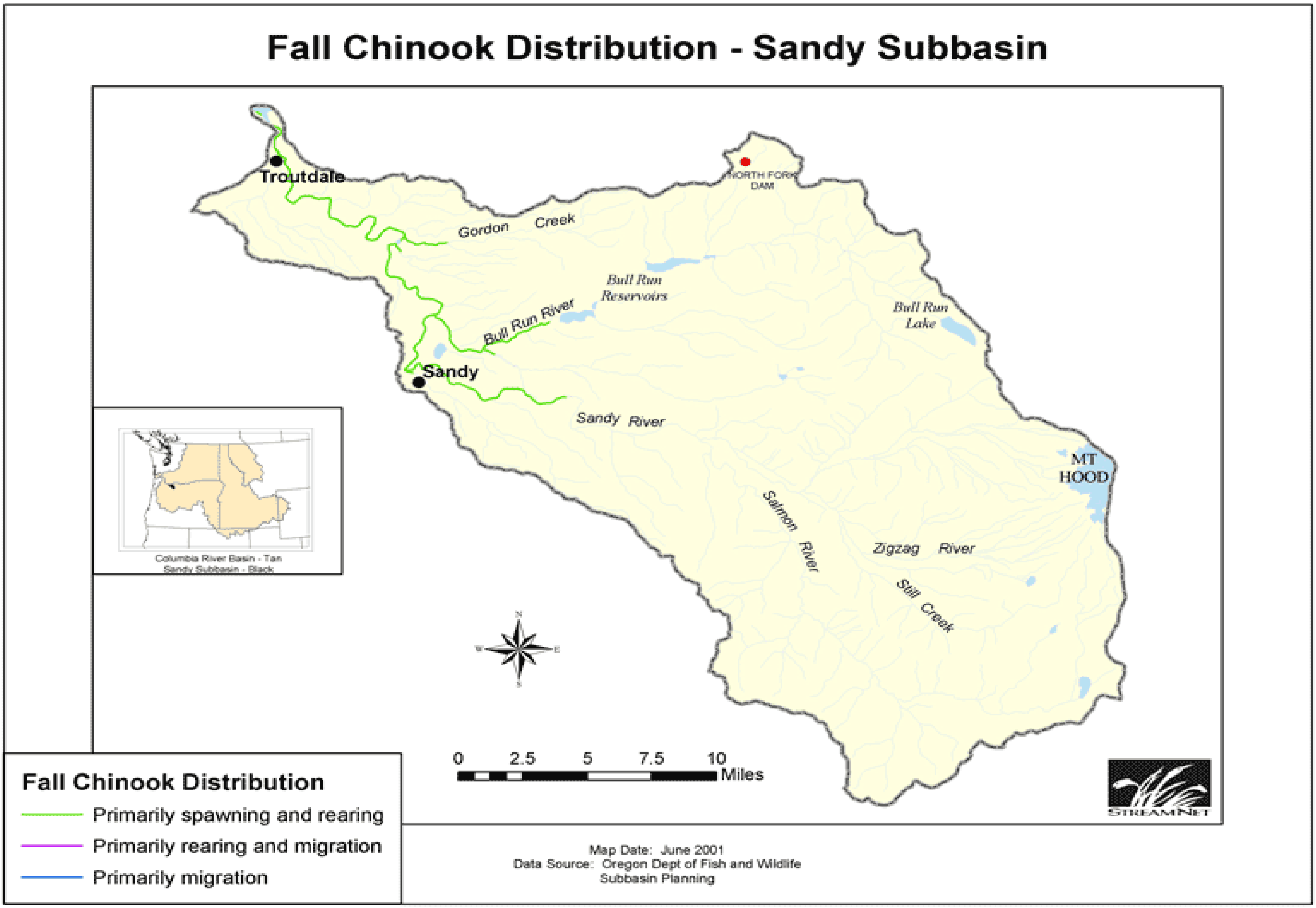

Figure 9. Distribution of fall chinook salmon in the Sandy Subbasin

Most of the early-maturing tule fall chinook that presently return to the Sandy River are believed to be a mix of: 1) naturally produced fish which originated from hatchery releases made in the Sandy River prior to 1977 (see Hatchery section), 2) the progeny of successful spawning stray hatchery fall chinook, and to a lesser extent 3) stray hatchery fall chinook adults originating from hatcheries in both Washington and Oregon (personal communication, Paul Hirose, ODFW, Clackamas, 1994). Collectively, the early-returning group is also considered to be part of the Lower Columbia River Hatchery stock (LRH; ODFW 1995a). Early maturing tules enter the Sandy River in August and September based on harvest records. Peak spawning usually occurs in early October, which follows the maturation schedule of LRH returns to neighboring hatcheries (Howell 1985). Hatchery straying is confirmed from coded-wire-tags collected from carcasses during spawning ground surveys in the fall, and scale samples describe the naturally produced component. Straying of hatchery fall chinook in the Sandy River is not significant in most years based on the low incidence of coded wire tag recoveries (personal communication, Paul Hirose, ODFW, Clackamas, 1994). It is possible the stray rate of early-run hatchery fall chinook is moderated to some degree by low flows and relatively warm water in the lower Sandy River during August and September, and because the broad shallow conditions that exist at the confluence with the Columbia River during this period may deter entry (personal communication, Paul Hirose, ODFW, Clackamas, 1994).

Early-run fall chinook (tule) may have historically returned to the Sandy Subbasin. The information available on early-run fall chinook in the Sandy River leaves the question unanswered. Genetic information is not available to distinguish fall chinook returning to the basin prior to 1990, and until recently fall chinook returning to the Sandy River from August to November were described as components of the same run. In addition, pre-1950 records describing fall chinook runs in the Sandy River are sketchy and do not provide conclusive evidence of strong returns of early-returning wild fall chinook (August-September). However, many other tributary rivers in the lower Columbia River historically supported robust runs of wild tule fall chinook, and straying or wandering from these populations may have occurred. Hatchery fall chinook originating from stock both inside and outside the subbasin have also been released intermittently into the Sandy River up to 1977. Annual average returns of early fall chinook to the Sandy River presently range from a few hundred to several hundred.

Run Timing and Spawning Distribution

Early maturing tule fall chinook enter the Columbia River as early as July and may enter the Sandy River sometime in August based on in-basin harvest data (see Angling section). Tule fall chinook generally spawn from late September to mid-October (Figure 10) and distribution in the basin is limited by low flow conditions typical of the Sandy River at this time. Spawning generally occurs in the mainstem from Lewis and Clark State Park to the upstream boundary of Oxbow Park. Spawning activity is usually highest near Oxbow Park where there are large deep resting pools and wide gravel bars. Spawning may occur in some lower system tributaries if early season rain events are significant enough to raise stream flows. Increased flows also improve spawning opportunities in side channels.

Wild Sandy fall chinook typically migrate into the Columbia River in August and September and enter the Sandy River in early October. Adult migrants usually hold in large pools and mature, and spawning generally occurs from late October through December (Figure 10). Peak spawning usually occurs in early November (personal communication, Paul Hirose, ODFW, 1995).

Spawning distribution of fall chinook appears to be controlled by flow conditions in the subbasin. When low flows persist into November, spawning usually occurs in the same mainstem areas as the earlier returning tules. If autumn rains are significant, increased flows in the basin allow fall chinook spawners to spread out into side channels and neighboring tributary streams. Gordon and Trout Creeks are important lower basin tributaries used by fall chinook when flows increase. These tributaries, which enter the Sandy River near RM 14, may act as important refuge areas for adult fall chinook during severe flow events, and could be critical to between-year spawning success during high flow years when the lower mainstem remains too high for successful spawning. In addition, the lower mainstem channels are loosely composed of alluvial cobble, gravel and sand deposits. Survival of incubating eggs in mainstem redds, built prior to severe flow events, may be reduced if sediment loads increase or spawning beds scour out.

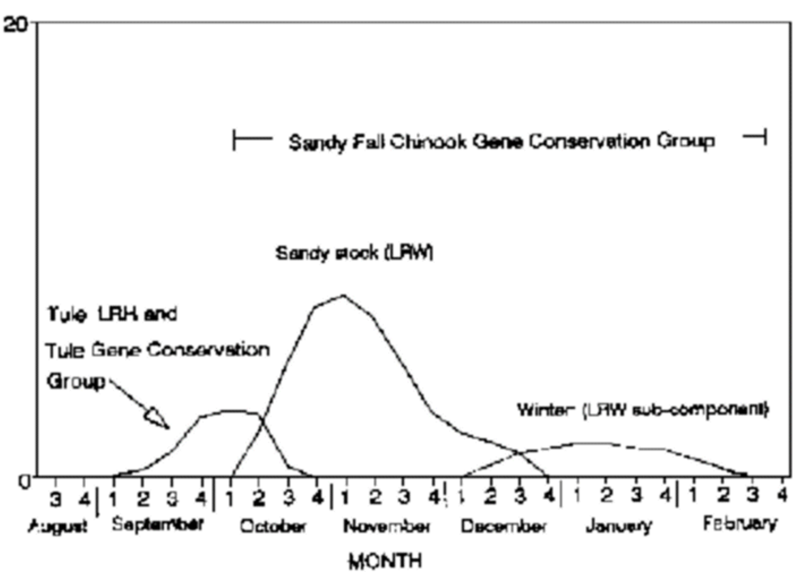

Figure 10. General spawning time distribution for Sandy fall chinook populations

Though the bulk of spawning for fall chinook presently occurs in the mainstem and tributaries of the lower basin near Oxbow Park, historical spawning distribution is documented to have occurred both in the Bull Run River and in large tributary streams above Marmot Dam. Prior to municipal water supply development in the Bull Run River near the turn of the century, fall chinook would have had access to almost 20 miles of additional habitat given good flow conditions (based on assessment of information in Whitt 1975). According to Mattson (1955) some of the better spawning areas in the Bull Run River were above the Headworks Dam (RM 6). Mattson (1955) also reported that several hundred fall chinook were observed spawning in the Bull Run River below the PGE powerhouse (RM 2) in some years. Additionally, Pirtle (1953) reported, "On November 20, 1952, a check of the river from the Bull Run Bridge (RM 1.5) to the mouth of the Little Sandy River revealed 125 dead chinook, 29 live jack chinook and 22 other live chinook." This information implies that peak spawning may have occurred and is consistent with current spawning timing of LRW stock fall chinook today. Reduced flows from the Bull Run watershed also reduces flows downstream in the Sandy River where fall chinook presently spawn, and in drier periods may limit spawning opportunities.

Historical escapement of fall chinook into the upper subbasin (above Marmot Dam) is documented by fall chinook egg-take records from the hatchery facility located on the confluence with Boulder Creek and the lower Salmon River near the turn of the century (Wallis 1966). Some question remains regarding stock distinction as spring chinook were also trapped and spawned at this location (see Spring Chinook section). However, Mattson (1955) reported that several hundred fall chinook were observed in some years below the hatchery weir on the Salmon River prior to the construction of Marmot Dam. More recently, USFS and the Bureau of Land Management (BLM) surveyors observed chinook spawning activity in Sixes Creek, a tributary to the lower Salmon River, in early November of 1994 and 1995. These observations occurred several weeks after spring chinook spawning activities in the area ended, and scale samples taken in 1994 showed distinct fall chinook patterns (personal communication, Doug Case, ODFW, Clackamas, 1995). Also, some chinook migrating over Marmot Dam in October and November have shown morphological similarities to fall chinook according to pictures taken at the counting facility (personal communication, Doug Cramer, PGE, 1994).

"Winter" chinook typically return to spawn from December to February based on spawning ground surveys, angler reports, and harvest records (Figure 10; see also Angling section). Though flows are adequate for migration during this time, spawning distribution appears to be limited to the lower mainstem near Oxbow Park and larger tributary streams like Gordon and Trout Creeks. Chinook have not been observed at the Marmot Dam counter after November, and chinook caught in January and February, have only been reported by anglers fishing in areas below Dodge Park. Historic distribution of "winter" chinook in the Bull Run River is also unknown.

Adult Escapement

The late maturing Sandy Stock fall chinook (LRW) is believed to be depressed but stable. The average annual minimum run estimate for returns to the Sandy River is 1,503 for run years 1984-1994 (Table 8). Note that this is a minimum run estimate as some spawning occurs outside the standard survey areas in the lower basin and a high degree of variability exists in the harvest estimate. Actual spawning escapement for the entire subbasin is believed to be higher in most years.

Tule fall chinook (LRH) escapement in the subbasin is poorly documented, but it is believed that in most years escapement is generally low. However, surveyors counted 828 redds and 920 fish on October 10, 1988, which indicates that in some years tule escapement may be high. By applying the constant of 2.5/redd, the estimated spawning escapement of tules to the survey reach is 2,070 for 1988 which is higher than the estimated 1988 spawning escapement of 1,675 for the later returning stock (LRW). Since tule fall chinook spawning timing may overlap with the later maturing LRW stock, more information is needed to better assess the stock components in the Sandy River.

Tule fall chinook are produced in 12 lower Columbia River hatcheries (ODFW 1995a) and straying of returning hatchery adults into the Sandy River occurs in some years, but appears to be low based on the relatively small number of CWT's found on carcasses on the spawning grounds. However, actual stray estimates based on tagging rates at respective hatcheries and the ratio of marked to unmarked fall chinook on the spawning grounds in the Sandy River were not calculated for this document. Most stray fall chinook entering the subbasin were produced and released at Washougal Hatchery located on the Washougal River, a Washington tributary that enters the Columbia River just across from the mouth of the Sandy River.

The late returning "winter" chinook is severely depressed based on declining spawner counts in Gordon and Trout Creeks and was listed as "at high risk of extinction" by Nehlsen et al. (1991). However, spawner abundance in these lower basin tributaries has always been relatively low and in some years no chinook were observed after early December. It is possible that spawning activity was missed in some run years as surveys were often intermittent.

Low tributary flows during the time of some surveys may have also forced adult chinook to spawn in the mainstem, or the streams remained unsurveyable due to high flows. Survey information dating back to the 1950s shows that bright fish were present in these lower subbasin tributaries in both December and January, but are rarely observed there today. Anglers, however, continue to report catching an occasional "bright" chinook in the Sandy River in December and January. One lone chinook was observed on a redd in Trout Creek on December 29, 1995. Much remains unknown about this unique stock of fall chinook, and more information is needed to evaluate stock status in the subbasin.

Natural Production

Natural production potential of fall chinook stocks in the Sandy River and subsequent brood year success depends upon the population dynamics of each stock including 1) age at maturation, 2) fecundity, 3) male-to-female ratios, 4) egg-to-smolt survival, 5) ocean survival, and 6) oceanic distribution and harvest rates that affect adult returns. Understanding fall chinook spawning behavior and habitat requirements is also an important consideration. All stocks of fall chinook returning to the Sandy River generally spawn in the lower mainstem reaches of the watershed, but will also use large tributaries and side channels when flows permit.

Table 8. Run size estimate of Sandy fall chinook (LWR)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Sport Catch																
Bull Run River	6	3	6	6	24	14	19	16	4	3	9	3	4	0	--	--
Sandy River (below Marmot)	255	344	155	388	185	305	735	481	549	291	420	244	394	28	--	--
Sandy River (above Marmot)	--	--	--	--	--	--	--	23	0	29	21	34	8	0	--	--
Total[b]	261	347	161	394	209	319	754	520	553	323	450	281	406	28	--	--
Spawning Escapement Estimate																
Redd Count[c]	--	--	--	320	201	274	882	670	824		283	403	552	233	422	
Spawner Estimate[d]	1,000	1,000	1,000	800	503	685	2,205	1,675	2,060	500[e]	708	1,008	1,380	786[f]	1,055	
Minimum Run Size Estimate																
Basin[g]	1,261	1,347	1,161	1,194	712	1,004	2,959	2,195	2,613	823	1,158	1,289	1,786	814	--	--

a. The mainstem was listed under one stream code prior to 1988.
b. Sport catch may include both early run tules and the later returning LRW stock.
c. Fall chinook spawning escapement in the Sandy River is estimated by multiplying the redd count by a constant of 5. In most years redds are only counted in the reach of the lower Sandy River from Dabney State Park (RM 6) upstream to the upper end of Metro's Oxbow Regional Park (RM 13). During high flow years many more fall chinook may spawn in neighboring tributaries or in reaches above the RM 13.
d. Standard index surveys were not conducted until 1984. ODFW assumed a 1,000 fish escapement for run years 1981-83 to be applied in a predictive model used by the Washington Department of Fisheries. (See also footnote c).
e. River high and turbid. Redds not counted. Spawning escapement of 500 is a rough estimate.
f. The observed number of fall chinook (786) is used as the spawning escapement figure because it exceeds the estimate based on redd counts (2.5 x 233 = 583).
g. The estimate is a minimum run size estimate used in trend analysis. It does not include escapement in the mainstem upstream of Oxbow Park, lower basin tributaries, or passage at Marmot Dam. Escapement estimates are affected by several factors including water clarity, surveyor bias, date, and length of survey. Harvest may be a composite of both tules and LRW stocks and is subject to statistical error.

Fecundity is unknown for native Sandy stock fall chinook (LRW). Estimating sex and age composition of each fall chinook stock may help in predicting subsequent brood year success. The male-to-female ratio for wild Sandy Fall chinook (LRW) varies annually (Table 9). The proportion of females in the LRW population ranged from 32% in 1987 to 66% in 1990 based on carcass inspections. Sex ratios for tule and "winter" chinook are unknown for the subbasin. Hatching and emergence timing of fall chinook is unknown for the Sandy River but is primarily dependent on spawning timing and water temperature. Also, much is unknown about early life history characteristics of fall chinook stocks indigenous to the river.

Size at Adult Return

Size at return for Sandy LRW and tule (LRH) fall chinook varies by age, sex and between years, and significant overlap exists between the range in lengths for both sexes. Based on a simple review of these tables, LRW fall chinook returning at Age-2 are almost exclusively males and Age-3 fish are predominantly males. Females represented a higher proportion of the 4 and 5 year old age classes; however, males tended to be larger on the average for these ages. Few females fell in the 100-109 cm length range (fork length), and all fall chinook exceeding 110 cm were males.

Table 9. Sex composition for Sandy stock (LRW) fall chinook for run years 1984-1995 based on data from spawning ground survey

Year	% Male	% Female
1984	54	46
1985	65	35
1986	72	28
1987	68	32
1988	50	50
1989	35	65
1990	34	66
1991	48	52
1992	42	58
1993	52	48
1994	57	43
1995	38	62

a. Jacks not included in estimate.

Hatchery Production

Fall chinook were trapped intermittently over the years for hatchery production and egg transfers since the turn of the century (Wallis 1966). The first hatchery in the Sandy Subbasin was constructed and operated by the U.S. Commission of Fish and Fisheries in 1896 at the confluence of Boulder Creek and the Salmon River (Craig and Suomela 1940). Ownership of this facility was transferred to the Oregon Fish Commission in 1898. The hatchery primarily cultured spring chinook, winter steelhead and coho; however, records show that fall chinook eggs were taken between 1903 and 1912 from adults returning to the hatchery or trapped in lower river areas and then transferred to the hatchery for rearing (Craig and Suomela 1940). Some speculation remains regarding stock separation between spring and fall chinook though, and it is believed that some mixing of stocks may have occurred at this facility. Following construction of Marmot Dam in 1912, hatchery operations were moved to a station just downstream of the diversion dam. In 1913, nearly 1.5 million fall chinook eggs were taken from fish trapped at a rack located 3 miles upstream of Troutdale (Craig and Suomela 1940). Fall chinook also were trapped at racks in the lower Bull Run River from 1954-1958 and on Cedar Creek during some years in the 1950s to support fall chinook production at the Sandy Hatchery on Cedar Creek. In addition, 16,457 eggs were taken from a few fall chinook captured in Gordon Creek in 1960 (Wallis 1966).

Wallis (1966) also reported intermittent fall chinook egg transfers to facilities in the subbasin from both Bonneville and Oxbow hatcheries from 1931-1960, and in 1959 the USFWS transferred 2,939,233 fall chinook eggs to the Sandy Hatchery for development. However, it is unknown if fingerlings from these egg transfers were released in the subbasin or retransferred to off-station release sites in other basins. Wallis (1966) reported that fall chinook fry or fingerlings were transferred from “other Oregon Fish Commission Hatcheries” for release in the Sandy in some years. About 100,000 fall chinook fingerlings were released in Gordon Creek in 1938; 4.5 million juveniles were released into the mainstem Sandy River in 1950 and about 2 million were released in 1951.

The Sandy Hatchery produced Sandy stock fall chinook from 1954 up through 1976 for release into the subbasin and to support other fall chinook programs outside the basin (Wallis 1966). In-basin releases of fall chinook propagated at Sandy Hatchery generally occurred in Cedar Creek or the lower mainstem Sandy River. However, some juveniles were also intermittently released in Gordon Creek. Since 1977 Sandy hatchery has produced only coho. The last release of fall chinook in the subbasin occurred in 1977 from production of 1976 brood year returns.

Angling and Harvest

Angling interest for fall chinook in the Sandy River is limited because generally by the time adults enter the Sandy River body condition and meat quality have deteriorated. Conversely, “winter” chinook are reported to return to the Sandy River in good physical condition, but angling regulations are now set to protect this stock as run size of this component is severely depressed. Harvest of fall chinook generally occurs in the lower Sandy River where they concentrate in large deep holding pools prior to spawning. Although some harvest also occurs in the Bull Run River and the Sandy above Marmot Dam, most chinook caught in the upper river are believed to be spring chinook (personal communication, Jay Massey, ODFW, Clackamas). Harvest in the Sandy River has averaged 383 annually for run years 1985-1994 based on salmon tag returns that are corrected for non-response bias (Table 8). The estimated in-basin sport harvest rate for the 10-year period averaged about 25%. Sport harvest between years does not appear to vary greatly (Figure 11), and is probably affected by run size, run timing, flows and turbidity. Sport harvest data from angler punch cards may contain significant statistical error, which may account for variability in the estimate between years (personal communication, Charles Corrarino, ODFW, Portland, 1995).

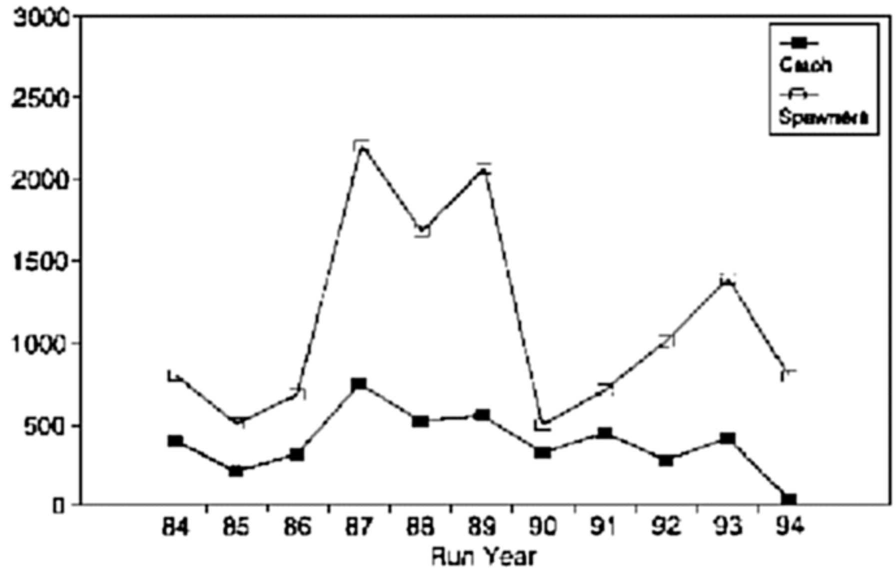

Figure 11. Comparison of fall chinook sport harvest trends in the Sandy subbasin, and spawning escapement for run years 1984-1994 based on redd count expansions

Winter Steelhead

Figure 12 shows the distribution of winter steelhead (*Oncorhynchus mykiss*) in the Sandy Subbasin. Winter steelhead are indigenous to the Sandy River, and are considered to be one of the most prized game fish in the subbasin. Wild Sandy River winter steelhead are widely distributed, and spawn and rear in many tributaries and mainstem reaches throughout the subbasin below barriers to anadromous fish. Sandy winter steelhead are recognized by the NMFS as a subpopulation within the Lower Columbia River steelhead ESU. Though native winter steelhead runs to the subbasin historically were healthy and abundant, recent declines in the Lower Columbia ESU, including the Sandy stock, prompted NMFS to list this ESU as threatened in March 1998.

Historically, wild winter steelhead typically migrated past Marmot Dam after late February with the majority of the fish passing the dam in April and May. Though straying of hatchery winter steelhead into upper subbasin streams is believed to be low, many winter steelhead continue to be counted at Marmot Dam from December to February, which may be due to hatchery influence. Recently, the late returning component of the run appears to have declined, most significantly since the late 1980s.

According to various reports and anecdotal information, the Sandy River once supported a robust population of native winter steelhead. Mattson (1955) researched old accounts and evaluated historic production potential of tributary streams including the Bull Run watershed, and concluded that as many as “20,000” adult winter steelhead may once have ascended the river. More recently, the estimated average annual run size for winter steelhead was 10,179 for run years 1987-1988 to 1991-1992, but is a composite of both hatchery and wild fish. The estimate is a summation of harvest in the lower river and escapement over Marmot Dam. For the same time period, an average of 2,616 adult winter steelhead escaped the fishery annually to spawn above Marmot Dam. For run year 1995-1996, only 537 winter steelhead were counted at Marmot Dam. However, this is only a partial count as the counter malfunctioned.

Spawning and Rearing Distribution

Historically, native Sandy winter steelhead spawned and reared in most of the accessible reaches of the subbasin and its tributaries. Presently, most of the spawning and rearing habitat for winter steelhead lies above Marmot Dam, primarily in the Salmon River and its tributaries below Final Falls, and in Still Creek. However, many other smaller tributaries in the upper subbasin are important to natural production of winter steelhead. To a lesser degree, winter steelhead also spawn and rear in the mainstem and side channels. Spawning and rearing distribution is moderated to some extent by natural inputs of glacial sediments in the Muddy Fork of the Sandy River, the upper Sandy River, and the ZigZag River. Though turbidity in some reaches may locally depress production potential, these tributaries are important conduits to habitat in nearby clear-water tributaries.

Below Marmot Dam, natural production of winter steelhead has been significantly reduced by passage problems and water quality conditions in several historically important tributaries. Municipal water supply development began in the Bull Run watershed near the turn of the century and blocked off many miles of high quality mainstem and tributary habitat for winter steelhead.

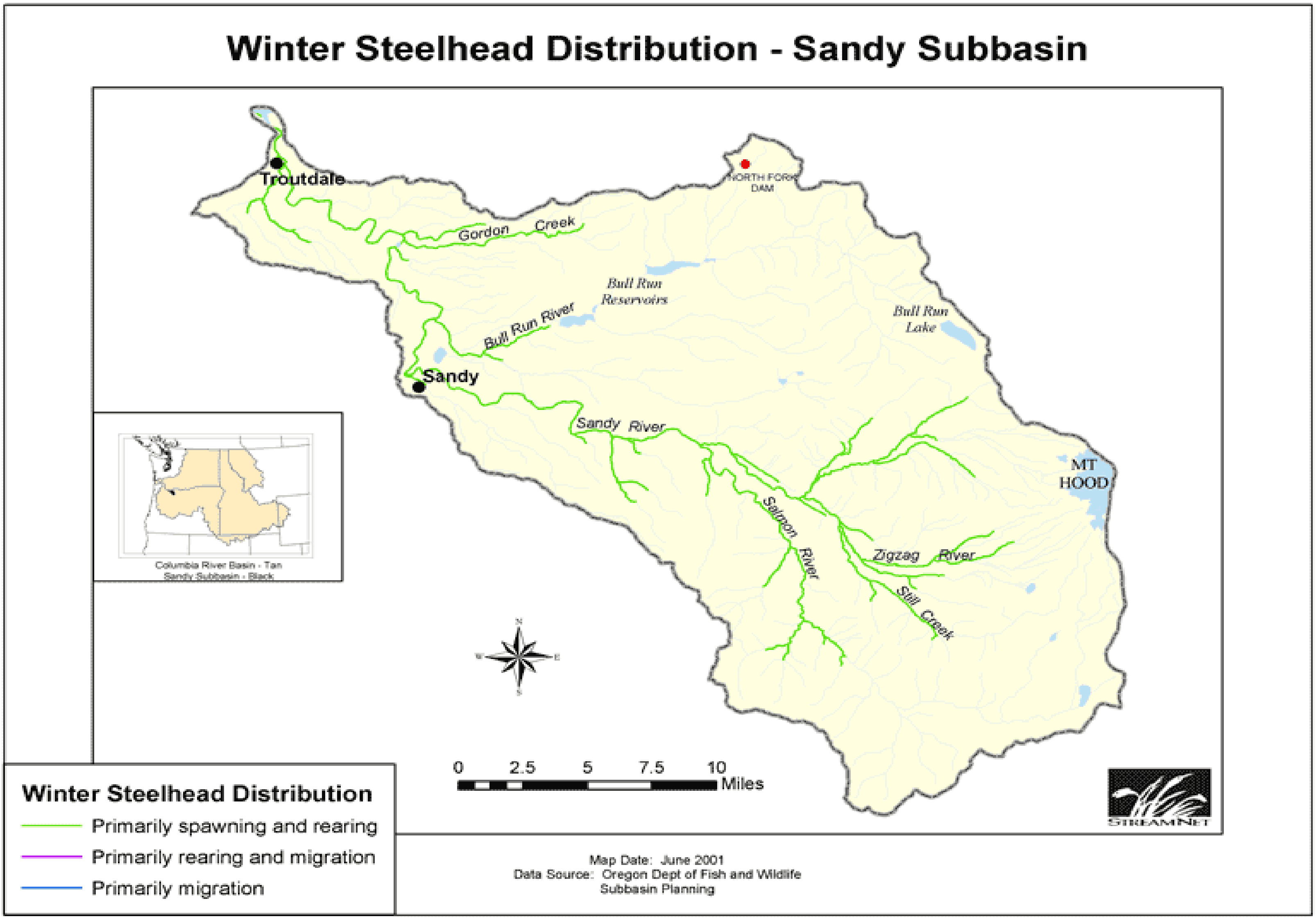

Figure 12. Distribution of winter steelhead in the Sandy Subbasin

Six miles of free flowing river remain between the Headworks Dam downstream to the confluence with the Sandy River, but production potential there is poor due to lack of spawning gravel, severely reduced flows in summer, and reduced in-stream winter habitat complexity. It is improbable that future passage will be provided for migratory salmonids in the Bull Run River beyond RM 6. However, the City of Portland is required by FERC license #2821 to compensate for salmonid fish loss in the Bull Run River by funding the production of 60,000 winter steelhead (12,000 pounds) and 160,000 spring chinook smolts (20,000 pounds). This hatchery production is allocated for release into other areas of the Sandy Subbasin.

Natural production of winter steelhead in the Little Sandy River has been curtailed by PGE's Little Sandy Diversion Dam (RM 1.7) since 1912. About 6.5 miles of suitable winter steelhead habitat lies above the dam upstream to a natural barrier falls (Collins 1974), but remains inaccessible, and water diversions also affect production potential in the 1.7 mile reach from the dam downstream to the confluence with the Bull Run River. However, under provisions of FERC license #477, PGE compensates for the loss of winter steelhead and coho production in the Little Sandy River by funding the production and release of 100,000 spring chinook smolts (12,000 pounds) in the Sandy Subbasin. The ODFW opted to trade equal pounds of hatchery coho and winter steelhead production for hatchery spring chinook because hatchery programs for these stocks were already in place. The re-licensing date for the Little Sandy diversion facility is November 2004.

Run Timing and Abundance

Run timing and abundance of winter steelhead in the subbasin are estimated from harvest in the lower river and from fish counts made at Marmot Dam. The estimated minimum annual return of winter steelhead to the subbasin has averaged 10,179 for run years 1987-1988 to 1991-1992 (Figure 13). During the time period, anglers caught an estimated average of about 7,563 winter steelhead, which includes harvest above Marmot Dam. It is estimated that an annual average of 2,616 escaped to spawn annually during the period.

Run time distribution and peak returns are stock dependent. Presently, early returning hatchery winter steelhead usually begin entering the Sandy River in November, with the majority entering the river in December and January based on harvest records. The hatchery component of the run may continue into March.

Historically, during the period of time of no or little hatchery winter steelhead influence (mid 1950s to early 1960s), the spawning migration of native Sandy River winter steelhead at Marmot Dam began in late February, and peaked in April or May (Figure 14; Figure 15; Table 10; Phillips 1957).

The run timing of winter steelhead in the subbasin may have shifted over the past 40 years. By evaluating historic wild winter steelhead migration timing at Marmot Dam prior to the initiation of the hatchery steelhead program in 1955, it is possible to track run timing changes and abundance trends in wild spawner escapement. For years 1954-1956, when all steelhead returning to the Sandy River were wild, the majority passed Marmot Dam after February with a peak usually occurring in April (Figure 14; Phillips 1957).

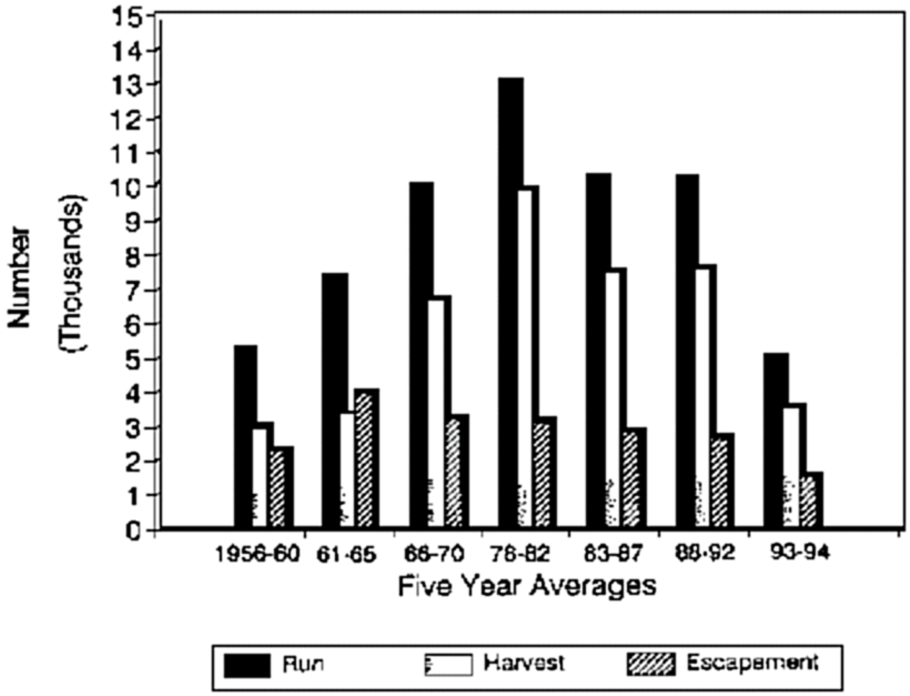

Figure 13. Trends in winter steelhead run strength, harvest, and escapement above Marmot Dam displayed in 5-year averages since 1956 (average escapement for run years 1993-94 is included for comparison)

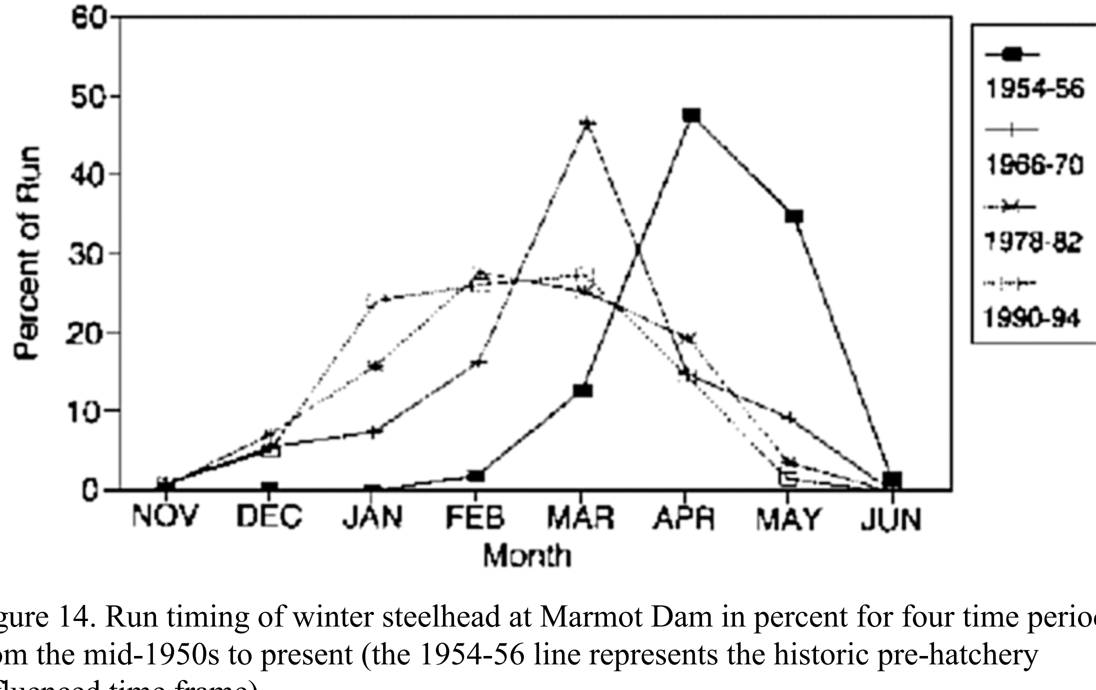

Figure 14. Run timing of winter steelhead at Marmot Dam in percent for four time periods from the mid-1950s to present (the 1954-56 line represents the historic pre-hatchery influenced time frame)

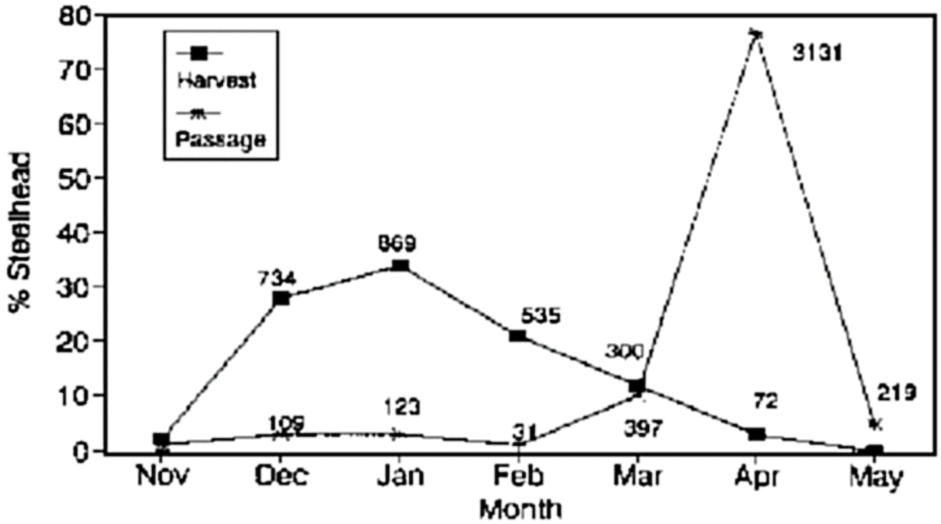

Figure 15. Distribution of angler catch and passage of adult winter steelhead at Marmot Dam by month during the 1961-62 run year

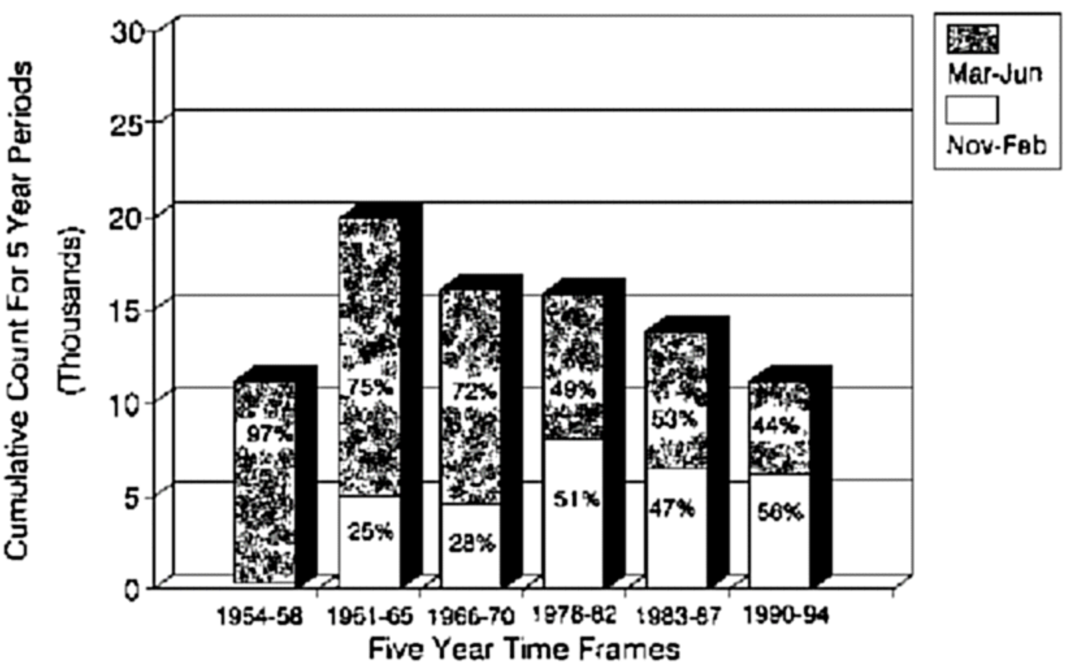

Figure 16. Cumulative numbers of winter steelhead passing Marmot Dam for six 5-year time frames (lower portion of bar shows cumulative returns from November through February, upper portion represents March through June)

Table 10. Monthly passage of Sandy River winter steelhead at Marmot Dam

	Month									
Run Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total[b]
1953-54	0	0	0	0	95	180	1,460	450	15	2200[c]
1954-55	0	0	0	0	5	280	325	941	50	1581[c]
1955-56	0	0	0	0	1	345	1,100	740	40	2240[c]
1956-60 run years not available.										
1960-61	0	2	111	451	1,092	214	785	462	7	3,124
1961-62	0	35	109	123	31	397	3,131	219	0	4,045
1962-63	1	9	159	49	938	229	1,659	281	0	3,325
1963-64	9	13	209	356	261	944	1,922	166	0	3,880
1964-65	1	31	337	33	659	2,494	1,825	149	0	5,529
1965-66	0	50	25	330	345	1,444	720	652	18	3,584
1966-67	1	180	313	438	510	1,515	575	544	0	4,076
1967-68	2	16	30	302	710	1,379	382	113	4	2,938
1968-69	10	28	25	67	419	2,302	231	91	3	3,176
1969-70	5	4	25	75	677	915	535	154	0	2,390
1971-77 runs years not available. Counting facility not in operation.										
1977-78	0	0	192	765	1,772	836	343	163	0	4,071
1978-79	0	3	60	17	576	723	429	192	0	2,000
1979-80	0	0	49	140	669	542	1,429	186	0	3,015
1980-81	0	0	735	1,010	995	1,045	293	0	0	4,078
1981-82	0	30	91	586	380	897	611	83	11	2,689
1982-83	0	0	43	619	931	242	491	123	0	2,449
1983-84	0	0	0	362	694	667	398	111	0	2,232
1984-85	0	0	36	54	1,192	450	937	117	1	2,841
1985-86	0	0	9	338	410	1,322	618	54	1	2,752
1986-87	0	3	111	995	781	825	900	59	1	3,675
1987-88	0	40	192	1,105	702	693	690	18	0	3,440
1988-89	0	30	390	944	273	842	469	44	1	2,993
1989-90	0	24	87	944	572	911	507	19	1	3,065
1990-91	0	33	138	347	770	263	337	107	0	1,995
1991-92	0	0	92	650	1,220	736	189	31	0	2,918
1992-93	0	0	153	332	143	694	311	3	0	1,636
1993-94	0	0	86	444	235	461	312	29	0	1,567
1994-95	0	52	194	527	254	265	368	20	0	1,680
1995-96[d]	0	0	53	166	97	220	1	0	0	537

a. Steelhead counted in October during the 1960s may have been stray summer steelhead.
b. Total count at Marmot Dam in this table may differ slightly, particularly for run years 1960-70, because of discrepancies in data from District reports; differences are small.
c. Monthly totals for winter steelhead passage for 1954-56 were derived from a graph in Phillips, 1957.
d. PGE photographic fish counter at Marmot Dam failed from April 1 to May 21, 1996, and passage of winter steelhead was not estimated for the period.

Wild winter steelhead escapement above Marmot Dam varies between years, but the late returning component (March to June) has declined based on interpretation of cumulative escapement numbers for several five-year time frames (Figure 16; Table 10).

From 1954 to 1958, the 5-year cumulative escapement of winter steelhead passing Marmot Dam from March to June was 11,241, of which 10,913 (97%) were determined to be wild (hatchery steelhead from smolt releases first returned in 1957-1958).

Numerical figures defining passage by month at Marmot Dam for the time period are not available, but based on analysis of graphs and information provided in annual District reports (Phillips 1957), roughly 97% of winter steelhead escaped into the upper basin after February for the time period (Figure 15). From 1961 to 1965, the 5-year cumulative escapement of winter steelhead passing Marmot Dam was 19,903, of which 14,884 (75%) migrated after the end of February (Figure 16; Table 10). Though the hatchery influenced early returning component of the escapement had made a significant contribution to the total number of migrants for this time period, the cumulative late returning component also increased by 3,971 over the 5-year cumulative figure registered between 1954 and 1958.

After 1965, the abundance of wild winter steelhead passing Marmot Dam from March to June decreased. This could have occurred in response to the severe effects of the 1964 flood, or more likely by the aggressive channelization efforts that followed in several tributaries of the upper basin aimed at reducing the impacts of future floods.

From 1990 to 1994, the 5-year cumulative escapement of winter steelhead passing Marmot Dam was 11,181, of which only 4,910 (44%) migrated after the end of February (Table 10; Figure 16). This reduction in escapement of late returning winter steelhead from 1990 to 1994 above Marmot Dam also occurred after implementation of the catch-and-release regulation, initiated in 1990.

Natural Production

Spawning of wild winter steelhead generally occurs from April to June. Adults usually spawn in second to fourth order tributaries, and often higher in respective drainages than either coho or chinook. Long term trends in male to female ratios of native winter steelhead are unknown for the Sandy River. However, Stout (1962) reported that the percent of the run composed of females for return years 1960, 1961, and 1962 was 55%, 56%, and 50% respectively. For the same time period, the study also determined that the average weight for adult steelhead was about seven pounds.

Winter water temperatures vary at different elevations in the subbasin and are generally cooler in headwater areas. Thus, incubation timing of eggs in redds in lower elevation tributaries may develop faster than eggs developing in redds at higher elevations. Later returning winter steelhead bound for the upper basin may encounter warmer water temperatures than early migrating fish. However, early wild winter steelhead migrants may enter the lower Sandy River and remain below Marmot Dam until water temperatures rise in late winter or early spring.

Wild winter steelhead smolts migrate downstream to the ocean typically as age 2+ smolts in spring, but 3+ smolts are not uncommon. Of 194 scale samples collected from naturally produced winter steelhead harvested in the subbasin in the 1986-1988 run years, 79% had outmigrated as smolts following two years of freshwater residence, and 21%

smolted following three years of residence (NWPPC 1990). Age 1+ and 4+ smolts have been observed in other Oregon rivers but appear to be uncommon in the Sandy River.

Information defining outmigration timing and size for native Sandy winter steelhead juveniles is limited. However, studies conducted in the subbasin show that the majority of 2+ and older juveniles depart the upper basin prior to the trout opener in late May, and at size less than 8 inches (minimum harvestable size for trout in the mainstem Sandy River from RM 0.0 to the Brightwood Bridge, RM 38, beginning in 1997).

It is believed that Sandy wild winter steelhead juveniles follow similar outmigration and ocean distribution patterns as other Columbia River stocks. Typically, winter steelhead smolts depart natal tributary streams and enter the Columbia River in late spring or early summer, and then descend to the ocean. Upon ocean entrance, young steelhead will generally move directly offshore and migrate to feeding grounds in the Gulf of Alaska and south of the Aleutian Islands (Burgner et al. 1992). Information describing ocean distribution is very limited.

Sandy Subbasin winter steelhead usually spend two summers in the ocean before returning to spawn. Age at return is variable both between and within brood years. Size at return for adult winter steelhead is dependent on age at return and may also vary between years because of trends in ocean productivity. Lengths were also taken from the sport caught steelhead sampled above. The average length for the 2-salt fish was 26 inches (range 22 to 32 inches), and the 3-salt steelhead averaged 31 inches for the time period (range 28-35; Wagner 1965).

Hatchery Production

Hatchery practices involving winter steelhead in the subbasin have occurred since the turn of the century. Historically, winter steelhead were trapped at various locations in the subbasin for egg take operations. Winter steelhead eggs were collected at a hatchery on Boulder Creek, a tributary to the lower Salmon River, from 1896 to 1913 (Collins 1974). A rack was also built in the Salmon River to direct fish into the Boulder Creek Hatchery. Winter steelhead eggs were sometimes shipped out of the subbasin to support other hatchery programs (Craig and Suomela 1940), but tables presented by Wallis (1966) indicate many were raised to fingerling size and released back into the Sandy drainage.

Following the construction of Marmot Dam in 1912, the Oregon Fish Commission moved hatchery operations to a site below Marmot Dam from 1913 to 1954, and trapped winter steelhead here for egg takes on and off through 1945. Fish were trapped here because the Marmot diversion canal was unscreened until 1951, and many smolts were being diverted out of the river and lost in the turbines at the PGE powerhouse on the Bull Run River. The largest egg take was 1,378,000 in 1941.

Presently the ODFW releases about 160,000 hatchery winter steelhead smolts annually into the Sandy River to support a popular winter steelhead fishery. Native Sandy River stock is used. Both Big Creek and Eagle Creek winter steelhead stocks were released up to the 2002 stocking season. Previous stocking levels were targeted at 230,000 smolts annually, but due to hatchery spatial constraints associated with switching to native Sandy stock, the smolt release target was reduced to 110,000 to 160,000. All smolts are marked for identification in the sport fishery. Beginning in 1989, all smolts have been released below Marmot Dam to reduce competition with native stocks and concentrate the consumptive angling opportunities in downstream reaches of the subbasin.

Mitigation Agreements

A large portion of the winter steelhead and spring chinook hatchery production destined for release in the Sandy River are tied to legally binding mitigation agreements. Presently, the City of Portland funds the production of 60,000 hatchery winter steelhead smolts (12,000 pounds) and 200,000 spring chinook smolts (20,000 pounds) as mitigation for lost habitat caused by the development of Portland's municipal water supply in the Bull Run watershed. Provisions for mitigation are requirements stipulated in the City of Portland's FERC license #2821 for these projects. The agreement between the City of Portland and ODFW was signed in 1984 and only provides for lost annual natural production since that time. This agreement is effective until 2029.

Angling and Harvest

The Sandy River consistently rates as one of Oregon's top ten winter steelhead producers and provides the region a popular recreational fishery from November through May. Most of the angling occurs in the lower river below Marmot Dam and opportunities for both boat and bank angling are available. Certain stretches of the river are only accessible by trail, and for those anglers willing to make the effort, the Sandy River offers many miles of secluded fishable water.

The intent of the hatchery winter steelhead program on the Sandy River is to concentrate angling effort in the basin below Marmot Dam, and maintain a high harvest rate on hatchery winter steelhead, while protecting native winter steelhead through catch-and-release regulations. All hatchery winter steelhead smolts are marked and have been released below Marmot Dam since 1989 to promote homing of adults back to areas of high angling intensity. This strategy may also reduce competition effects on native juvenile steelhead rearing in the upper subbasin.

Harvest of winter steelhead in the subbasin averaged 7,425 for run years 1983-1984 to 1992-1993, and according to punch card estimates, 96% of the catch for run years 1988-1993 occurred below Marmot Dam. The harvest estimate includes an unknown number of wild steelhead as catch-and-release regulations did not go into effect until 1990.

The hatchery winter steelhead program has greatly increased the run of winter steelhead to the subbasin, and consequently catch of winter steelhead has also improved, particularly in December and January (Figure 17). During the period of little hatchery winter steelhead influence (run years 1956-1960), estimated steelhead harvest during months November to June averaged about 2,946, most of which were wild. As hatchery winter steelhead releases increased and smolt-to-adult survival improved with increased size at release, the return to the basin also increased (Wagner 1967). In-basin sport harvest for months November to June increased to an annual average of 6,783 for run years 1966-1970, peaked at 8,456 in run years 1976-1980, and averaged about 8,189 during the decade of the 1980s. Since 1965, harvest of winter steelhead ranged from a low of 1,181 in 1993-

1994 to a high of 13,000 in 1979-1980. It is believed that wild winter steelhead made a significant contribution to the harvest up until 1990, but estimates are unknown.

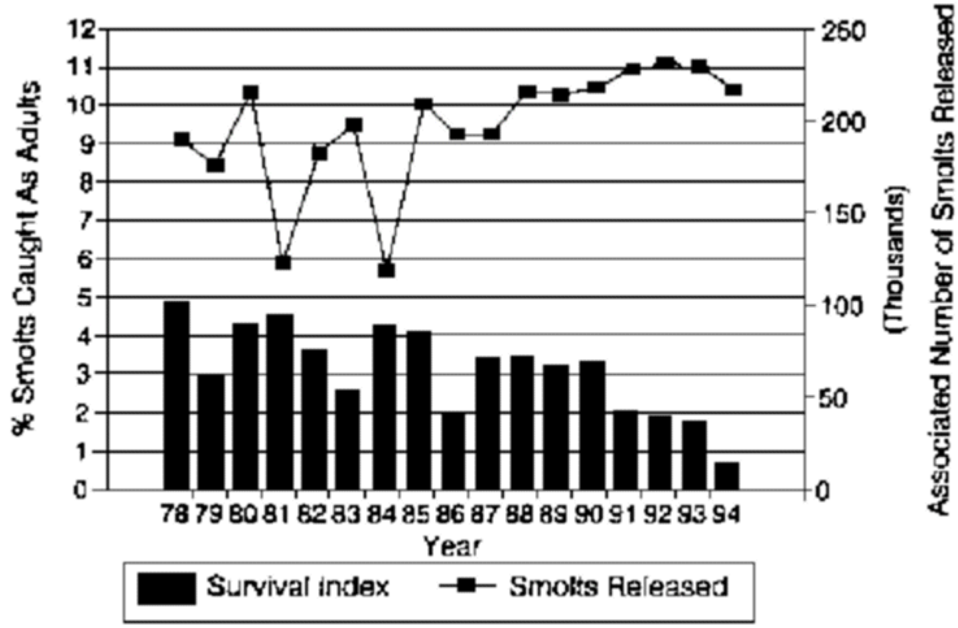

Figure 17. Sandy winter steelhead catch by month for pre-hatchery run years (1958-1962) and during more recent years of hatchery influence (1985-1989)

Summer Steelhead

Figure 18 shows the distribution of summer steelhead in the Sandy Subbasin. Hatchery summer steelhead were introduced into the subbasin in 1975 to enhance angling opportunities. Through 1997, smolts were released into large tributaries located in the upper subbasin including the Salmon and ZigZag Rivers where a very popular fishery developed. Hatchery smolts were also released into Still Creek, a tributary of the ZigZag River, until 1996, but due to growing conservation concerns for wild winter steelhead, these releases were discontinued. In addition, because of continued low native winter steelhead returns, and because the Lower Columbia River ESU, which includes the native Sandy stock, was listed as threatened in March of 1998, the ODFW decided to move all hatchery summer steelhead releases below Marmot Dam. This action was taken to greatly reduce competitive impacts between hatchery summer steelhead and listed wild winter steelhead in important spawning and rearing areas located in the upper subbasin, while retaining a more limited summer steelhead fishery exclusively in the lower river.

Foster/Skamania (South Santiam) stock summer steelhead (#24) is the hatchery stock used. The stock was developed from eggs obtained from the Skamania Hatchery on the Washougal River in southwest Washington (ODFW 1986) from 1967-1973, and transferred to South Santiam Hatchery for rearing. Since 1974, most eggs have been taken from adults returning to South Santiam Hatchery.

The debate continues over whether the Sandy Subbasin once supported a wild population of summer steelhead. If the subbasin supported a summer race of steelhead, it is believed the run was small.

Life History and Population Characteristics

Distribution of hatchery summer steelhead is influenced by the location of smolt releases. Smolts have been released in the ZigZag River, Salmon River and Still Creek, and consequently most adults have been harvested in these tributaries. Upriver distribution in the Salmon River is constrained by Final Falls in the Salmon Huckleberry Wilderness. In the ZigZag River, gradient increases and the channel width decreases upstream of the confluence with Still Creek which may constrain migration during low flow periods. Still Creek is a relatively smaller low gradient tributary, and therefore, summer steelhead escapement is probably controlled by seasonal flows. However, smolt releases were discontinued in Still Creek in 1996 to reduce hatchery fish competition with wild fish. Summer steelhead may also migrate into the upper Sandy River above the confluence with the ZigZag River, but smolts are not released there and escapement is considered low.

In November of 1998, ODFW began the operation of a fish trap at Marmot Dam. All adipose-clipped adult summer steelhead returning to the trap are recycled downstream or stocked into Roslyn Lake. All unmarked adult summer steelhead returning to the trap are allowed to pass into the upper subbasin. Spawning timing of summer steelhead in the subbasin is believed to follow maturation schedules of adult returns to South Santiam Hatchery (hatchery of origin), which is generally December through mid-February. Although this assumption needs confirmation, if true then it is likely that interbreeding between hatchery summer steelhead and native winter steelhead is low because native winter steelhead generally spawn from late March into early June. However, concern persists regarding intra-specific competition between progeny of successfully spawning hatchery summer steelhead and the native winter population.

Variable levels of straying into the Bull Run River occurs annually, and is influenced by Sandy River water diversions into the Bull Run River for power production. Some steelhead ascend the river above the PGE powerhouse at RM 1.5 in the spring. These fish may be trapped in isolated mainstem pools below the Headworks Dam when flows decrease as a result of water storage in upstream reservoirs. It is believed that these steelhead are subject to high mortality due to predation, and increased temperatures and poor water quality caused by reduced flows.

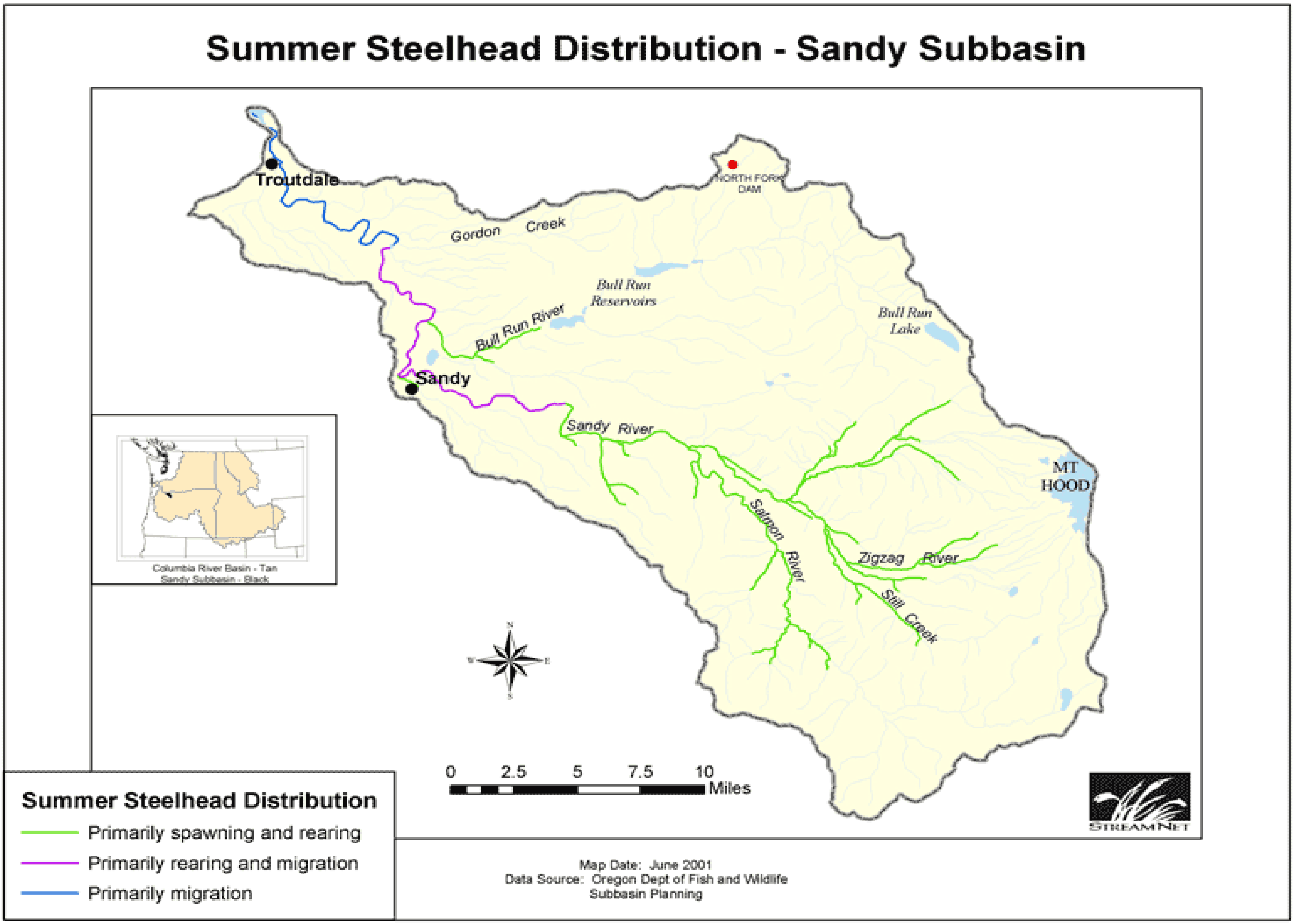

Figure 18. Distribution of summer steelhead in the Sandy Subbasin

Run Size and Timing

Summer steelhead may first enter the Sandy River as early as February and begin migrating past Marmot Dam in March or April (Table 11; Figure 19). The migration generally peaks in June, and averaged 33% of the run for return years 1984-1993. Total summer steelhead returns to the Sandy River are estimated from punch card data and dam counts. For a recent 5-year average, in run years 1989-1990 to 1993-1994, the estimate averaged 4,544 and ranged between 3,142 in 1993-1994 and 6,994 in 1992-1993. Over 10,000 summer steelhead were harvested in 1984; however, the total run estimate is difficult to determine, as prior to 1988 the mainstem was listed under one stream code which prevented accurate run assessment. Summer steelhead return to the Sandy River as reproductively immature adults and will not reach maturation until about mid winter of the following year. Natural reproduction of hatchery summer steelhead is not desired, but is known to occur. In 1999, 20 unmarked adult summer steelhead were passed above Marmot Dam and in 2000, 115 unmarked adult summer steelhead were passed above the dam.

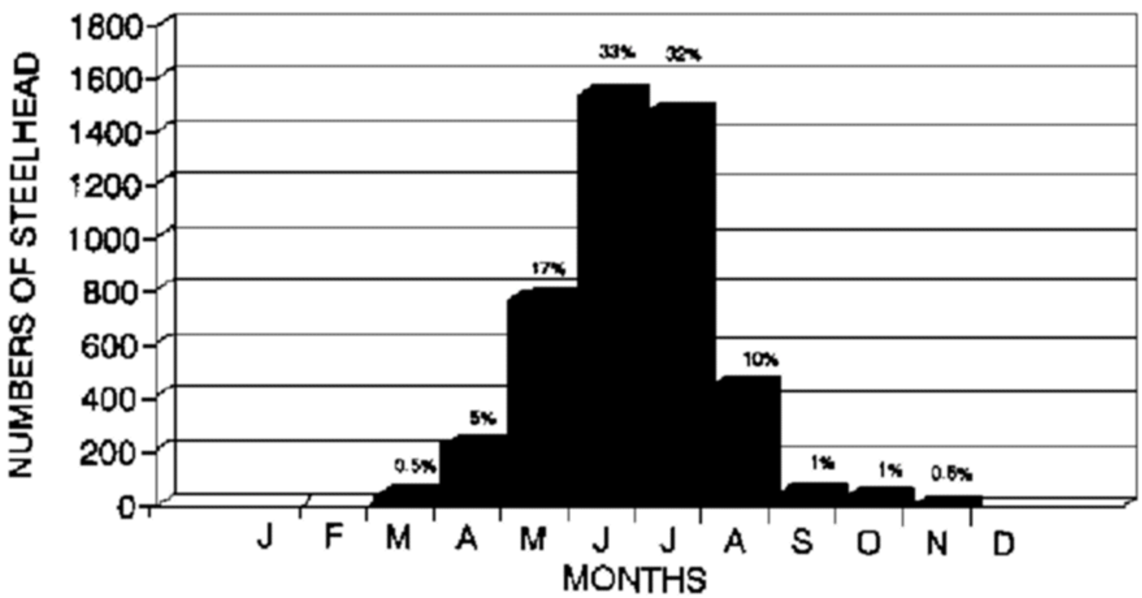

Figure 19. Average summer steelhead passage at Marmot Dam by month during run years 1984-1993

Hatchery Production

Summer steelhead in the Sandy Subbasin are presently managed for hatchery production only. Though summer steelhead were released in small numbers into the subbasin in 1968 and again in 1971 (Collins 1974), the current program began in earnest in 1975. Currently the ODFW releases 60,000 Skamania/Foster stock summer steelhead smolts into the subbasin. Smolts are acclimated and released at Sandy Hatchery. Foster/Skamania stock summer steelhead (#24) is the hatchery stock used because it is a high quality game fish. It is also resistant to *Ceratomyxa shasta*, and survival is usually excellent. Smolts are released in late March or early April at about 5/pound. In 1998, all releases of hatchery summer steelhead were moved downstream of Marmot Dam. This was done to eliminate hatchery fish competition with wild fish in the upper subbasin.

Hatchery summer steelhead smolts migrate to the ocean by early summer and are assumed to follow similar migration routes as other Columbia River steelhead stocks to feeding grounds in the Gulf of Alaska or in the North Pacific Ocean south of the Aleutian Islands (Burgner etal. 1992). Most smolts will remain at sea for two summers prior to returning as adults (that is, smolts released in the spring of 1992 generally returned as 2-salt adults in the spring and summer of 1994). Age composition of adult Skamania summer steelhead is unknown for the Sandy River.

Angling and Harvest

Summer steelhead angling is very popular in the Sandy River. Summer steelhead first enter the Sandy River in late February or March, with the bulk of the run arriving in the lower river in May and June. Peak catch is in May. Since 1998, all releases of hatchery summer steelhead have been from Sandy Hatchery. Harvest data is not yet available for 1998 to the present. All angling for summer steelhead occurs below Marmot Dam.

Before 1998, summer steelhead were released into the upper subbasin above Marmot Dam. Releases were targeted to small, clear water tributaries that are unaffected by glacial sediment. Summer steelhead angling in the upper subbasin was unique as it offered anglers the challenge of pursuing large fish in relatively small fast flowing streams in close proximity to the Portland metropolitan area. In addition, angler access to the river in the upper subbasin is generally good.

Potential Spawning Escapement

Natural reproduction of Skamania summer steelhead is undesirable in the Sandy River but is occurring at varying low levels between run years. Spawning escapement in the upper subbasin is determined by the number of unmarked adult summer steelhead passed at Marmot Dam. In 1999, 20 unmarked adult summer steelhead were passed above Marmot Dam. In 2000, 115 unmarked adult summer steelhead were passed.

Coho Salmon

Figure 20 shows the distribution of coho salmon (*Oncorhynchus kisutch*) in the Sandy Subbasin. Coho salmon are indigenous to the Sandy River. Historically, as many as 10,000 to 15,000 wild coho returned to the Sandy Subbasin to spawn (Mattson 1955). Presently, the subbasin supports both an early-run hatchery and a wild run of coho salmon. The native wild stock is referred to as a late-returning stock.

Historically, wild coho migrated into the Sandy River from October to February, and spawning usually occurred from November to February. During the early 1960s, peak coho counts at Marmot Dam usually occurred in November. However, run timing has shifted, and today most coho escape above Marmot Dam in September and October. Though natural reproduction continues to occur in the lower subbasin below Marmot Dam, primary spawning and rearing areas are currently located in the clearwater tributaries above Marmot Dam. Coho counts at Marmot Dam have averaged 1,201 (adults and jacks) annually for the 10-year period 1985-1994 (Table 12). However, estimated coho escapement at Marmot Dam declined to an annual average of 784 for the five-year period 1991-1995, and ranged from a high of 1,492 in 1991 and a low of 220 in 1993 (Table 12).

Table 11. Monthly counts by PGE of adult summer steelhead at Marmot Dam for run years 1977-1997

Year	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1977	0	0	0	245	593	205	43	0	0	0	1,086
1978	0	0	0	329	323	1,126	133	37	0	0	948
1979	0	0	0	621	678	220	119	110	7	0	1,755
1980	0	0	168	689	1,466	583	331	119	86	0	3,442
1981	0	0	535	0[a]	1,361	74	43	24	0	0	2,037
1982	0	89	621	1,079	703	151	29	11	3	0	2,686
1983	0	22	174	414	242	364	104	3	0	0	1,323
1984	0	29	540	2,243	3,191	1,139	233	142	81	0	7,598
1985	0	168	461	1,694	1,432	657	142	67	18	1	4,640
1986	0	115	1,353	1,846	1,445	341	79	13	9	0	5,201
1987	0	353	660	1,761	2,077	544	32	12	30	0	5,469
1988	0	351	925	1,904	2,299	432	70	88	40	0	6,109
1989	0	186	291	792	992	259	11	63	31	0	2,625
1990	118	229	810	1,947	813	256	43	40	10	0	4,266
1991	4	162	195	406	976	359	16	9	0	0	2,127
1992[b]	247	501	2,075	2,165	863	455	31	25	6	0	6,368
1993	0	188	513	738	747	168	14	45	11	0	2,424
1994	0	118	475	741	675	76	6	6	0	0	2,097
1995[c]	0	38	161	338	604	187	6	17	0	0	1,351
1996[d]	0	0	19	448	469	122	59	39	8	0	1,164
1997	0	95	333	754	582	149	29	12	12	0	1,966
1998	0	12	53	--	--	--	--	--	--	--	--
Average (82-94)	28	193	699	1,364	1,266	400	62	40	18	0	4,071
% Run	1	5	17	31	10	10	2	1	1	0	

a. Data unavailable. No estimate calculated.
b. Marmot counter failed in June 1992. The figure 2,165 was calculated using the ratio of June to total passage for run years 1985-91 and 1993.
c. Camera malfunctioned during most of summer steelhead run for 1995. Counts are estimates based on proportions of fish counted by the electronic counter.
d. Problems with installation of new camera system developed during spring and summer of 1996 while bugs were being worked out. Counts are estimates based on proportions of fish counted electronically.

More recently, coho escapement further declined to 180 and 116 for run years 1996 and 1997, respectively. Coho counts at Marmot Dam for 1998, 1999, and 2000 were 261, 178, and 732 unmarked adults, respectively. Though the population was considered stable but depressed as recently as 1995, recent declines in 1996 and 1997 are a significant management concern.

Life History and Population Characteristics

Historically, native Sandy stock coho spawned and reared in most of the accessible reaches of the subbasin and its tributaries. Presently, most of the spawning and rearing habitat for coho lies above Marmot Dam, primarily in the Salmon River and its tributaries below Final Falls, and in Still Creek. However, many other smaller tributaries in the upper subbasin are important to natural production of coho. Spawning and rearing distribution in the upper subbasin is moderated to some extent by natural inputs of glacial sediments in the Muddy Fork of the Sandy River, the upper Sandy River, and the ZigZag River. Though turbidity in some reaches may locally depress production potential, these tributaries are important conduits to habitat in nearby clearwater tributaries.

Below Marmot Dam, natural production of coho has been significantly reduced by passage problems and water quality conditions in several historically important tributaries. Natural production opportunities for coho in the lower subbasin have been substantially reduced to a limited number of tributary streams and to some mainstem side channels. Currently, the primary tributary streams used by coho in the lower subbasin are Gordon Creek (6.5 miles), Trout Creek (0.5 miles), and Buck Creek (possibly 2-3 miles).

Abundance

Abundance and run timing of coho in the Sandy Subbasin are estimated from sport harvest, hatchery returns, and from fish counts made at Marmot Dam (Table 12; Figure 21). The estimated minimum annual return of coho to the subbasin averaged 14,473 for run years 1985-1994, and ranged between a low of 511 in 1993 and a high of 29,537 in 1986, the highest return on record (Table 12; Figure 21). A large proportion of the coho run returning to the Sandy River is composed of hatchery fish, however. For the period 1985-1994, an estimated annual average of 12,306, or 85% of the run escaped to Sandy Hatchery. An estimated annual average of 1,202 coho, or 8.3% of the run, escaped to spawning areas above Marmot Dam during the period.

Though most of the coho that return to the subbasin are of hatchery origin, most of those coho that previously migrate upstream above Marmot Dam were of naturally produced origin. Since November 1998, with the installation of the fish trap at Marmot Dam, only unmarked coho salmon have been passed into the upper basin. The watershed above Marmot Dam has many miles of suitable spawning and rearing habitat. Many reaches are in Wild and Scenic segments of the subbasin and/or are bounded by wilderness areas that remain intact from resource extraction activities.

Though it is thought that most coho that historically migrated above Marmot Dam were of naturally produced or wild origin, conversely, many of the coho migrating into lower subbasin tributaries below Marmot Dam are believed to be strays from Sandy Hatchery.

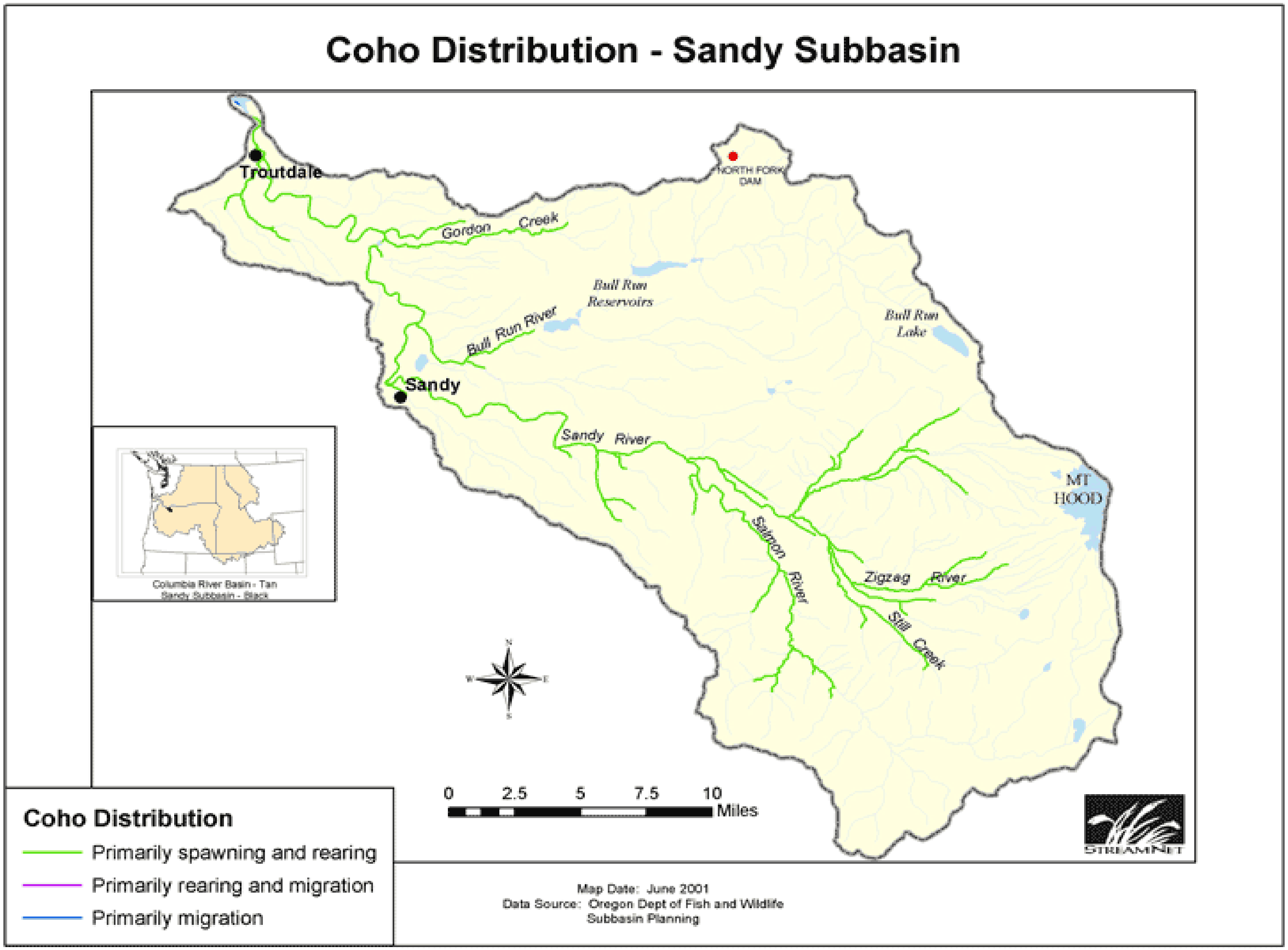

Figure 20. Distribution of coho salmon in the Sandy Subbasin

Table 12. Hatchery returns, Marmot Dam counts, sport catch, and total run estimates of coho in the Sandy Subbasin

Run Year	Hatchery Return Adults	Hatchery Return Jacks	Hatchery Return Total	Marmot Dam Counts Adults	Marmot Dam Counts Jacks	Marmot Dam Counts Total	Sport Catch Bull Run River	Sport Catch Below Marmot Dam	Sport Catch Above Marmot Dam	Total Catch
1953	118			--	--		--	--	--	--
1954	493	91	584	--	--		--	--	--	--
1955	402	144	546	--	--		--	--	--	--
1956	990	2,138	3,128	--	--		--	--	--	--
1957	854	1,942	2,796	42	222	264	--	--	--	--
1958	962	910	1,872	83	247	330	--	--	--	--
1959	2,112	916	3,028	34	34	68	--	--	--	--
1960	587	2,956	3,543	1,102	568	1,670	--	--	--	--
1961	--	--	--	1,525	208	1,733	--	--	--	--
1962	--	--	--	1,006	452	1,458	--	--	--	--
1963	--	--	--	1,056	1,143	2,199	--	--	--	--
1964	--	--	--	749	377	1,126	--	--	--	--
1965	--	--	--	677	341	1,018	--	--	--	--
1966	--	--	--	162	67	229	--	--	--	--
1967	--	--	--	386	283	669	--	--	--	--
1968	--	--	--	841	440	1,281	--	--	--	--
1969	--	--	--	411	305	716	--	--	--	--
1970-1974	--	--	--	--	--	--	--	--	--	--
1975	5,695	2,504	8,199	--	--	--	--	--	--	1,115
1976	8,409	2,186	10,595	--	--	--	--	--	--	1,801
1977	5,359	1,276	6,635	--	--	--	--	--	--	962
1978	8,751	324	9,075	411	15	426	--	--	--	1,967
1979	8,692	590	9,282	680	2	682	--	--	--	1,130
1980	9,500	204	9,704	632	13	645	--	--	--	831
1981	6,884	265	7,149	620	14	634	3	1,011	--	
1982	13,944	1,234	15,178	722	20	742	7	2,252	--	
1983	4,756	705	5,461	--	--	496	0	398	--	
1984	12,290	279	12,569	798	8	806	0	1,884	--	
1985	8,145	3,024	11,169	1,445	27	1,472	0	730	--	
1986	25,872	833	26,705	1,546	48	1,594	0	1,238	--	
1987	5,467	3,727	9,194	1,205	198	1,403	0	524	--	
1988	10,297	2,373	12,670	1,506	84	1,590	0	1,440	8	
1989	21,348	1,194	22,542	2,182	113	2,295	0	1,293	7	
1990	6,131	460	6,591	376	80	456	0	948	3	
1991	11,534	413	11,947	1,491	1	1,492	0	2,200	27	
1992	13,277	652	13,929	790	55	845	0	1,176	10	
1993	231	11	242	193	27	220	0	49	4	
1994	7,947	125	8,072	601	47	648	0	22	0	
1995	3,264	38	3,302	697	19	716	--	--	--	
1996	328	314	179	179	1	180				
1997			116	116	0	116				

Table 12 Key:

a. Sport harvest data for coho in the subbasin is unavailable prior to the mid-1970s, as catch records classify coho and chinook collectively as "salmon."
b. Minimum run estimates for coho are unavailable prior to 1978 as fish were not counted at Marmot Dam from 1970 to 1977, and coho are not distinguished in the catch records prior to the mid-1970s.
c. Coho counts were not made at Marmot Dam in 1983, so escapement above the Dam for 1983 was determined from an estimate of the average annual proportion of the run that escaped above Marmot Dam for the 5-year periods 1978-82 and 1984-88.

The population of coho destined for spawning areas above Marmot Dam was considered depressed but stable up through 1995 but more recently has declined (Table 12). Coho counts at Marmot Dam averaged 1,201 (adults and jacks) for the ten year period 1985-94, but declined to an annual average of 784 for the five-year period 1991-1995, and ranged from a high of 1,492 in 1991 and a low of 220 in 1993. Coho escapement at Marmot Dam further declined to 180 and 116 for run years 1996 and 1997, respectively.

Historically, as many as 10,000 to 15,000 wild coho returned to the subbasin to spawn naturally (Mattson 1955). However, many factors have combined over the past century to cause the decline of wild coho abundance in the subbasin.

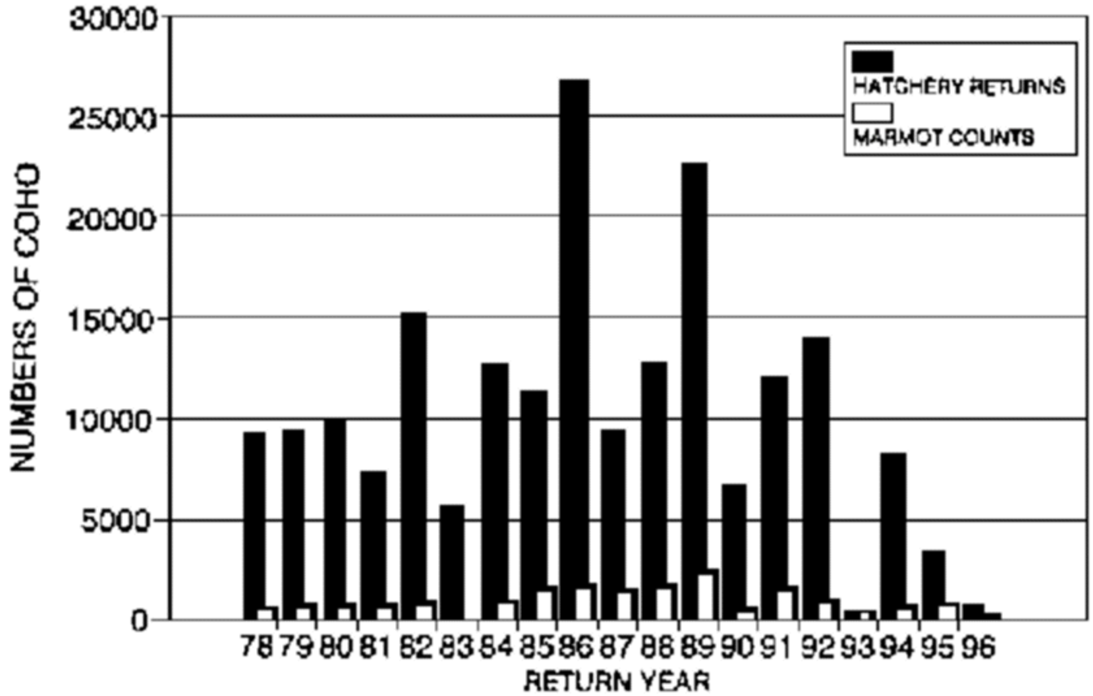

Figure 21. Estimated annual coho spawner escapement at Marmot Dam and hatchery coho returns to Sandy Hatchery for run years 1978-1996

Run Timing

Historically, coho generally returned to the Sandy River from September until early February, and spawning generally occurred from November through February. During run years 1960-1966, a period when influences of hatchery coho supplementation practices above Marmot Dam were thought to be insignificant, peak migration at Marmot Dam usually occurred in November. During the period, November counts averaged 48% of the run (Table 13). However, peak run timing for these run years is variable as nearly 65% of the run passed Marmot Dam in October in both 1960 and 1961. Recently (1990-1994 run years), peak run timing has shifted more consistently to October with about 40% of the run passing Marmot Dam in this month. The late portion of the run which returns after November has also declined since 1960. For run years 1960-1966 an average of about 11%

of the run passed Marmot Dam after November, whereas for run years 1990-1994 only 1% of the run escaped after November (Table 13). In 1994 and 1995, no coho were observed passing Marmot Dam in December.

Table 13. Monthly passage of coho at Marmot Dam for run years 1960-1997

				Month				
Run Year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total
1960	0	38	1,091	252	288	1	0	1,670
1961	0	10	1,107	436	158	20	2	1,733
1962	0	16	399	990	50	3	0	1,458
1963	0	43	993	1,135	28	0	0	2,199
1964	0	14	83	759	2	0	0	1,126
1965	0	0	0	801	213	4	0	1,018
1966	0	0	96	132	1	0	0	229
1967	0	343	234	71	21	0	0	669
1968	0	108	855	236	67	15	0	1,281
1969	0	122	363	148	82	0	1	715
1971-77 years counting facility not in operation.								
1978	0	0	111	308	3	3	1	426
1979[a]	0	102	241	2	20	7	310[b]	682
1980	0	0	219	373	27	23	3	645
1981	0	170	393	57	0	0	0	634
1982	1	493	197	11	35	0	0	742
1983[b]	--	--	--	--	--	--	--	--
1984	0	40	586	143	7	0	0	806
1985	0	404	922	133	1	12	0	1,472
1986	0	202	952	403	37	0	0	1,594
1987	0	357	308	732	5	1	0	1,403
1988	5	563	703	316	3	0	0	31,590
1989	0	281	896	1,061	57	0	0	2,295
1990	0	165	189	102	0	0	0	456
1991	0	742	272	478	0	0	0	1,492
1993	0	87	94	21	18	0	0	220
1994	3	204	396	45	0	0	0	648
1995	0	347	319	50	0	0	0	716
1996	0	73	81	26	0	0	0	180
1997	0	92	19	5	0	0	0	116

a. The estimated coho escapement of 310 in February 1979 is an anomaly, but was confirmed through discussion with Doug Cramer, PGE, November 1, 1996.
b. Trap and counter did not function from early October 1983 through December 1983.

Natural Production

Coho historically spawned in the Sandy Subbasin from late October to February. Presently, most spawning takes place in late October through November with very few fish observed spawning naturally after December. Long-term trends in male-to-female ratios of native coho are unknown for the Sandy River. Spawner survey data is presently limited. The jack component of the run is estimated from counts taken at Marmot Dam, and averaged about 67 annually for run years 1986-1995. However, annual average jack counts for the period 1957-1966 was 366. More importantly, the proportion of jacks in the coho run passing

Marmot Dam has declined from an annual average of 36% for the earlier period 1957-1966, to less than 6% for the period 1986-1995 (Table 12).

Emergence from the gravels takes place following the “button-up” phase, which in the subbasin is believed to occur about three months after spawning, or February to April (NWPPC 1990). Winter water temperatures vary at different elevations in the basin and are generally cooler in headwater areas. Thus, incubation timing of eggs in redds in lower elevation tributaries may develop faster than eggs developing in redds at higher elevations. Later returning coho bound for the upper subbasin may encounter colder water temperatures than earlier migrating fish. Emergent coho fry have been identified at Marmot Dam as late as June 1 (NWPPC 1990).

Juvenile coho typically migrate from the Sandy Subbasin at about 12 to 14 months of age, and are referred to as age 1+ smolts. Some juvenile coho may drop out of a respective watershed prior to winter as a presmolt, but adult returns from these young outmigrants is generally considered to be poor. Coho smolts from headwater tributaries further from salt water generally migrate earlier than those from streams closer to salt water (NWPPC 1990). Actual time and size of ocean entry for naturally produced Sandy stock coho is unknown.

The upper subbasin presently contains the majority of the viable coho spawning and rearing habitat. Using current knowledge of coho spawning and rearing distribution, it is estimated that over 75% of the available coho spawning and rearing habitat in the entire subbasin is now located above Marmot Dam.

Hatchery Operations and Production

Coho have been trapped and produced at various hatchery sites in the Sandy Subbasin since 1898 (NWPPC 1990; Wallis 1966). The first hatchery to operate in the subbasin was at Boulder Creek, a small tributary to the lower Salmon River. The hatchery was used to trap and produce coho as well as spring chinook and winter steelhead. Operations at this facility was discontinued following the construction of Marmot Dam in 1912, and hatchery production resumed at a new hatchery that was built just downstream from Marmot Dam. Coho were trapped and spawned at this facility intermittently from 1913 through 1945. The river was often racked and coho were intercepted for hatchery production. This practice was implemented because fish managers felt that many of the coho smolts and fry produced in the watershed above Marmot Dam were being diverted into the Marmot Diversion canal and transported to Roslyn Lake. Records provided by Collins (1974) show numbers of coho eggs taken at this facility declined steadily from 500,000 in 1939 to less than 15,000 in 1945. The hatchery below Marmot Dam continued to operate until 1955, primarily as an egg taking facility for the Sandy Hatchery on Cedar Creek, which began operations in 1951 under the Columbia River Fisheries Development Program (CRFDP). The practice of racking the river ended soon after screens were installed in the Marmot Diversion Canal in 1951.

The Sandy Hatchery began as a state funded hatchery and was converted to a CRFD program in 1959, and funded by the NMFS as part of the federal governments responsibility through the Mitchell Act. Though fall chinook, spring chinook and steelhead were produced at Sandy Hatchery in earlier years, presently only early-run Sandy stock coho are produced. All production comes from adults returning to the facility each fall.

Hatchery production grew from an initial 1950 brood year release of 250,000 yearling smolts into Cedar Creek. Releases fluctuated from about 500,000 to about 800,000 and then remained stable at about 1,000,000 for a number of years. However, beginning in 1995, coho smolt releases into the subbasin from the Sandy Hatchery were reduced to 700,000, when 300,000 smolts were earmarked for release into Youngs Bay to enhance harvest opportunities in the lower Columbia River. All coho smolts produced at Sandy Hatchery are now marked (adipose-clipped) prior to release as a conservation measure aimed at protecting wild coho in all fisheries. This program began with the 1996 release year (brood year 1994, return year 1997).

The 10-year hatchery coho return to the Sandy Hatchery for return years 1986-1995 averaged 11,519, but ranged widely from only 242 in 1993 to a high of 26,705 in 1986 the highest return on record (Table 12; jack coho returns are included in the average). The low hatchery return in 1993 occurred due to high mortality on smolt production released in June of 1992. Higher smolt survival from a smaller release in May of 1992 accounted for nearly 100% of the coho return to Sandy Hatchery in 1993. Naturally produced coho returns at Marmot Dam were also poor in 1993 (Table 12). Smolt survival of hatchery coho produced and released at Sandy Hatchery varies greatly both between years and between groups released at different times in the same release year.

Hatchery Supplementation History

Following dismal coho returns after passage at Marmot Dam was reopened in the early 1950s, fisheries managers began a hatchery coho supplementation campaign in 1961 to rebuild the coho run in the upper watershed. Hatchery fry, presmolt, and adult releases began in earnest in 1965, and, with the exception of 1975-1979, continued annually until 1988 when supplementation was discontinued because of concerns regarding impacts to the wild run component. A study conducted on coastal streams in the early 1980s demonstrated that surviving hatchery adults from large hatchery coho presmolt (age 0+) releases returned earlier to their release streams than the wild run component, and that survival of progeny produced from hatchery adults spawning in the wild was lower than wild spawners (ODFW 1997). The study also concluded that releasing hatchery presmolts did not significantly increase sport and commercial harvest in ocean fisheries.

Though most hatchery coho releases into the Sandy River have consisted of Sandy stock coho produced at the Sandy Hatchery, Lower Columbia early stock was also used intermittently from 1980-1987. Coho smolts (age 1+) were never released above Marmot Dam. From 1988 to 1991, an average of 92,000 Sandy stock STEP fry continued to be released in some tributaries above Marmot Dam. The STEP fish were released as unfed fry and survival was considered to be minimal.

Since the turn of the century coho salmon have been trapped and spawned in hatcheries on the Sandy River, with intermittent releases of coho fry into various locations in the subbasin. Though it is believed that the wild coho population in the Sandy River has been significantly impacted by long-term hatchery practices in the subbasin, significant numbers of coho continue to spawn and reproduce naturally, primarily above Marmot Dam. Straying of hatchery coho into upper basin reaches appears to be minimal, and it is hoped that the wild component of the run can reestablish traditional late run timing and spawning patterns.

Angling and Harvest

Sport angling and harvest of Sandy coho occurs both inside and outside the Sandy River. Significant numbers of Sandy Hatchery produced coho are harvested in ocean and Columbia River fisheries (Table 14). In the Sandy River, most of the angling for coho occurs in the lower river below Marmot Dam. According to analysis of in-river sport harvest data (Table 12), sport anglers caught an estimated average 1,263 coho annually in the Sandy River for the 12-year period 1981-1992. The harvest accounted for about 8.2% of the average estimated minimum coho return to the Sandy River. However, many coho produced at Sandy Hatchery are also harvested in fisheries outside the subbasin (Table 14).

Prior to the 1993 run year, commercial fisheries operating both in the ocean and in the Columbia River intercepted significant numbers of Sandy Hatchery coho (Table 14). For the 12-year period 1981-1992, total ocean commercial harvest of Sandy Hatchery coho is estimated to have averaged 19,170 annually, and accounted for about 43.5% of the total Sandy Hatchery coho available.

Table 14. Sport angling and harvest of Sandy coho

Brood Year	Return Year	Oregon Ocean Sport	Oregon Ocean Comm.	Non-OR Ocean Comm.	Non-OR Ocean Sport	Frshwtr & Est. Sport	Frshwtr & Est. Comm.	Sandy Sport Harvest[a]	Hatchery Returns (jacks included)	Total Accounted For
1978	1981	2,712	11,127	3,496	2,642	0	354	1,014	7,088	29,433
1979	1982	2,707	8,025	3,599	1,991	444	380	2,259	14,209	33,614
1980	1983	3,507	8,653	3,532	3,333	96	188	398	5,990	25,697
1981	1984	3,585	189	2,319	4,126	1,802	14,793	1,884	12,995	41,693
1982	1985	2,349	745	566	2,175	327	3,521	730	8,424	18,837
1983	1986	4,082	9,026	3,052	3,585	3,453	30,124	1,238	29,896	84,456
1984	1987	4,381	10,416	1,674	3,077	779	8,572	524	6,300	35,723
1985	1988	6,414	18,042	1,983	5,126	1,976	10,286	1,440	14,024	59,291
1986	1989	11,102	19,751	5,997	8,147	1,000	20,540	1,293	23,721	91,551
1987	1990	5,108	3,704	3,526	5,181	137	1,246	948	7,325	27,175
1988	1991	5,538	6,856	2,037	7,264	2,464	5,244	2,200	11,994	43,597
1989	1992	10,475	3,438	515	5,401	1,850	2,521	1,176	13,690	39,066
1990[c]	1993	83	0	47	27	27	68	0	883	1,335

a. Estimated from punch card returns. This data also assumes that all sport caught fish in the Sandy are of hatchery origin. Wild coho were not factored in and subtracted from total sport catch; however, wild fish destined for the upper subbasin represent a low percentage of the entire coho run returning.
b. Jack returns from the prior year were used to reflect brood year survival and success (i.e. jacks returning in 1980 were added to adults returning in 1981).
c. Returns were extremely low which compared similarly to other Columbia River Basin hatcheries.

Several management strategies have been implemented to improve the wild run component of coho in the Sandy Subbasin. No hatchery coho have been released in the upper basin since 1988, except for some small STEP fry releases. Beginning in November

1998 with the installation of a trap at the Marmot Dam fish ladder, only unmarked fish are allowed passage into the upper subbasin. Salmon angling is closed in the Sandy River from November 15 until January 31 to protect late returning spawners. Habitat restoration projects have been completed and are still underway in many upper basin tributaries. The headwaters of many important coho spawning and rearing streams in the upper subbasin are protected to some level by Wild and Scenic River or Wilderness status. The USFS has conducted Watershed Analysis for the Salmon, ZigZag, and upper Sandy Rivers. Goals and objectives outlined in these documents are aimed, in part, at improving both in-stream and riparian habitat in these subwatersheds. Seasonal minimum stream flows were established below Marmot Dam in the early 1970s to improve upstream fish passage. Flow requirements for migrating salmon and steelhead below Marmot Dam will be revisited during the next FERC application process in 2004. In addition, all releases of Willamette hatchery stock spring chinook and hatchery winter steelhead are now made below Marmot Dam, which will reduce interspecific competition.

Cutthroat Trout

Cutthroat trout (*Oncorhyncus clarki clarki*) are indigenous to the Sandy Subbasin and are found throughout most of the watershed, including the Bull Run River and its tributaries. Cutthroat trout are the most common trout species in the subbasin. Presently, Sandy cutthroat trout are considered to be a subpopulation of a much larger complex of Coastal cutthroat trout distributed throughout western Oregon, and exhibit similar diverse life history patterns. Both anadromous and resident forms exist in the subbasin.

Cutthroat trout are distributed from the mouth near the Columbia River upstream into most headwater tributaries, both above and below migratory barriers. Four life history types are found: 1) resident cutthroat trout that remain relatively close to their area of emergence in small order headwater streams above and below barriers, 2) fluvial cutthroat trout that reside in the larger channels of the mainstem river and migrate upstream into tributaries to spawn, 3) adfluvial cutthroat trout which reside in lakes and use small feeder tributaries to spawn, and 4) anadromous cutthroat trout that spawn in freshwater, rear as juveniles, and move into the Columbia River estuary or the ocean to grow. A genetically important population of adfluvial cutthroat trout exists in Bull Run Lake.

Anadromous (sea run) cutthroat trout abundance in the subbasin is presently very low, as it is for other lower Columbia River tributaries and coastal basins as well. Historically, anglers reported good sea run migrations into the subbasin. Sea run cutthroat have also been documented to enter the adult salmon trap at the Sandy hatchery on Cedar Creek up until the early 1970s, but presently, this rarely occurs. Anadromous coastal cutthroat trout in the lower Columbia Basin, which includes the population in the Sandy River, are considered to be a Sensitive Species by ODFW. The populations associated with coastal and lower Columbia tributaries are also listed as at “moderate risk of extinction” by the American Fisheries Society (Nehlsen et al. 1991).

Distribution

Cutthroat trout are widely distributed in the subbasin, in most tributaries and mainstem reaches downstream to the Columbia River. Distribution in the basin and within habitat types is dependent on life history type (i.e. sea run, or resident), age, season, habitat quality and availability, and presence of other salmonids.

Important isolated subpopulations of resident cutthroat trout also exist above many barrier falls throughout the watershed (Table 15). Isolated populations represent a valuable genetic resource both individually and as representatives of the entire subbasin population. Recent genetics studies conducted cooperatively by ODFW and the USFS have shown that samples from isolated cutthroat trout populations both in Bull Run Lake and in a relatively short reach of the Bull Run River (about 3 miles) between the lake and a high barrier falls are "substantially different" from samples of cutthroat trout populations in the downstream Bull Run Reservoirs (memorandum from Fred Allendorf, Division of Biological Sciences, University of Montana, July 1995; personal communication, Kathryn Kostow, Oregon Department of Fish and Wildlife, Portland, August 1995).

Some cutthroat trout populations, which historically were not isolated, are now segregated from downstream populations by dams and weirs constructed in the last century. Cutthroat trout are now isolated above dams in the Bull Run River (RM 6-1922), Little Sandy River (RM 1.7-1911), and in Cedar Creek above the Hatchery weir (RM 0.5-1950). Some downstream movement may occur during high seasonal flows when water breaches the spillways, but no passage exists for upstream movement.

Anadromous cutthroat trout distribution in the basin is poorly understood. Historically, sea runs were documented to migrate into the Sandy River from late summer through fall and escaped into tributary streams to spawn. It is unknown how far upstream sea runs were able to migrate given the geomorphological conformation of the Sandy Subbasin prior to hydropower and water supply development. It is believed that sea runs were capable of ascending the main Sandy River into the upper watershed. In the Bull Run River there is a significant cascade at RM 4 that may have prevented passage beyond this point; however, larger anadromous salmonids like steelhead, coho, and chinook could bypass this obstruction.

Abundance

Information is limited on cutthroat trout abundance in the Sandy Subbasin.

Angling and Harvest

Angling for cutthroat trout is allowed throughout the subbasin from late May through the end of October. There is no current survey information on cutthroat trout angling in the subbasin. Angling opportunities for cutthroat trout abound in remote areas of the subbasin. Many tributary streams both in the lower and upper subbasin are only accessible by hiking. Sea run cutthroat trout once provided a significant fishery in the Sandy River according to old angler reports, but returns have declined and run status is currently depressed.

Rainbow Trout

Resident rainbow trout are the non-anadromous form of *Oncorhynchus mykiss*, and are indigenous to the Sandy Subbasin and other lower Columbia River tributaries as well. Resident rainbow trout are found in the mainstem and many of the larger tributary streams throughout the subbasin including the Bull Run River. In general, resident rainbow trout live below anadromous barriers, but are documented to exist in some tributaries above barriers (Table 15).

Table 15. Confirmed isolated cutthroat and rainbow trout populations existing above barriers in the Sandy Subbasin

Watershed	Confirmed Species	WFMP Compliance	Pop. > 300	Comment
Sandy River < Marmot	Rb	Yes	Unknown	Above natural barrier.
Big Creek	Rb/Ct	Yes	Unknown	Above natural barrier.
Gordon Creek	Ct/Rb	Yes	Unknown	Above natural barrier.
Trout Creek	Ct	Yes	Unknown	Above natural barrier.
Cedar Creek	Ct	Yes	Unknown	Above natural barrier.
Badger Creek				
Sandy River > Marmot				
Whiskey Creek	Ct	Yes	Unknown	Above natural barrier.
Alder Creek	Ct	Yes	Unknown	Above natural barrier.
Wildcat Creek	Ct	Yes	Unknown	Above natural barrier.
Upper Sandy River				
Lost Creek	Ct/Rb	Yes	Unknown	Above natural barrier.
Cast Creek	Ct/Rb	Yes	Unknown	Above natural barrier.
Clear Creek	Ct/Rb	Yes	Unknown	Above natural barrier.
Clear Fork				
Salmon River				
Boulder Creek	Ct/Rb	Yes	Unknown	Above natural barrier.
South Fork Salmon River	Ct	Yes	Unknown	Above natural barrier.
Mack Hall Creek	Ct/Bt	Yes	Unknown	Above natural barrier.
Mud Creek	Ct/Bt	Yes	Unknown	
Salmon River > Final Falls	Ct	Yes	Unknown	Above natural barrier: Rb stocked in Trillium may enter Salmon River via Mud Creek. Brook trout also present in Ghost Creek & Salmon River Meadows
ZigZag River				
Still Creek	Ct	Yes	Unknown	Above natural barrier.
Henry Creek	Ct	Yes	Unknown	Above natural barrier.
Camp Creek	Ct	Yes	Unknown	Above natural barrier.
Bull Run River	Ct/Rb	Yes	Unknown	Above Headworks Dam (RM 6): populations isolated by dams since 1920s.
Camp Creek	Ct	Yes	Unknown	Tributary to reservoir #2: assumed healthy.
S. Fork Bull Run River	Ct	Yes	Unknown	Tributary to reservoir #2: assumed healthy.
N. Fork Bull Run River	Ct	Yes	Unknown	Above natural barrier: tributary to reservoir #1. Brook trout may be present.
Fir Creek	Ct/Rb	Yes	Unknown	Above natural barrier: tributary to reservoir #1; assumed healthy.
Log Creek	Ct	Yes	Unknown	Above natural barrier: above reservoir #1; assumed healthy.
Blazed Alder Creek	Ct/Rb	Yes	Unknown	Above natural barrier: above reservoir #1; assumed healthy.
Little Sandy River	Rb	Yes	Unknown	Above natural barrier: assumed healthy. Brook trout present 1982 (Cain and Smith 1982)

Life history associations may exist between resident rainbow trout and migratory steelhead in the subbasin. However, this association is unclear for steelhead and resident rainbow populations in the subbasin. Resident rainbow are also known to occasionally hybridize with coastal cutthroat trout. A cooperative genetics study on resident cutthroat and rainbow trout conducted by ODFW and the USFS in the subbasin in 1994 and 1995 found evidence that of hybridization between resident cutthroat and rainbow trout occurred in some tributaries of the upper subbasin.

Hatchery rainbow have also been released in several tributaries and various high mountain lakes to support angling opportunities in the subbasin. The Cape Cod stock is the primary stock used. The "catchable" rainbow program for flowing reaches of the subbasin was discontinued after 1994 because of budget cuts and the impacts on wild fish.

Life History and Population Characteristics

There is much unknown about life history and population characteristics of native rainbow trout populations in the Sandy Subbasin. No known studies in the subbasin have been aimed specifically at resident rainbow trout.

Distribution

Information on distribution and abundance of resident rainbow in the Sandy Subbasin is limited. Surveys conducted by the USFS and ODFW have documented rainbow trout in many low elevation tributaries to both the Bull Run River and the Sandy River.

Important populations of rainbow trout are documented to exist above anadromous barriers in both the Little Sandy River, a tributary to the Bull Run River, and in upper Gordon Creek (Table 15). Presently, native rainbow trout have not been documented in the Salmon River above Final Falls or above the falls in the Bull Run River at about RM 21.

Rainbow trout have also been observed in the Little Sandy River above the diversion dam at RM 1.7 but below the anadromous barrier at about RM 7. This population exists in sympatry with resident cutthroat trout. Similarly, populations of rainbow exist in sympatry with cutthroat trout above the dams in the Bull Run watershed, both in the reservoirs and in the lower reaches of tributaries draining into the reservoirs.

Abundance

No information exists to confirm historic abundance of naturally produced native rainbow trout in the subbasin.

Hatchery Production

Hatchery rainbow trout were annually released into some upper Sandy tributaries through 1994 to provide popular consumptive angling opportunities within accessible flowing reaches of the subbasin (Table 16). In recent years, Cape Cod stock was used as they tend to remain near their release sites.

According to some ODFW reports, rainbow trout of catchable size were released into several of the large upper subbasin tributary streams as far back as the 1940s. From about the mid 1960s until 1978, catchable rainbow trout from Oak Springs and Roaring River hatcheries were released during late spring and summer into Still Creek, Lost Creek, Camp Creek, Salmon River, and the upper Sandy River. Hatchery rainbow trout releases were discontinued in Still Creek and the mainstem Sandy River beginning in 1979. The catchable trout program in Sandy tributary streams was discontinued due to budget cuts and impacts on wild fish.

Table 16. Catchable rainbow trout stocking in the Sandy Subbasin, 1987-1994

Stocking Site	1987	1988	1989	1990	1991	1992	1993	1994
Streams								
Salmon River	7,016	6,778	4,998	7,069	7,024	7,218	6,919	4,981
Lost Creek	3,499	3,243	2,505	3,502	3,557	3,584	3,497	2,523
Camp Creek	3,486	3,243	3,256	3,535	3,526	3,584	3,497	2,523
Lakes								
Trillium Lake	16,648	16,012	15,972	14,738	15,995	14,775	16,073	15,600
Roslyn Lake	23,043	19,952	17,971	19,430	20,035	22,106	27,159	20,078
Collins Lake	1,998	1,684	1,750	1,752	1,785	1,796	1,750	1,793
Mt. Hood College Pond	1,974	2,009	3,788	3,010	3,031	3,028	4,050	3,029

Note: The hatchery trout stocking program was discontinued in flowing waters of the Sandy Subbasin after 1994.

Angling and Harvest

Angling for trout in the Sandy Subbasin is popular with many anglers. Until 1995, the trout fishery within the river and its tributaries was supported by both wild cutthroat and rainbow trout, and releases of hatchery rainbow trout in designated reaches of the subbasin. However, the catchable rainbow trout program was discontinued beginning in 1995. Presently, and in the future, trout angling opportunities in the flowing reaches of the subbasin may rely completely on natural production of wild cutthroat and rainbow trout.

Brook Trout

Brook trout (*Salvelinus fontinalis*) are not native to Oregon, but were introduced into several high mountain lakes in the late 1800s within the Sandy Subbasin to provide for angling opportunities in pristine wilderness settings. Recently, brook trout have been observed in Mud Creek both above and below Trillium Lake and are assumed to be descendants from earlier hatchery releases made in Trillium Lake (personal communication, Jeff Uebel, USFS, 1996). Brook trout are no longer released in Trillium Lake, but populations in Mud Creek are now believed to be self-sustaining. Brook trout are also documented to exist in the upper Salmon River near Salmon River Meadows and in the lower reaches of Ghost Creek. These populations are believed to have originated from hatchery releases made historically in the upper Salmon River near Highway 26.

Distribution

Much is unknown about general population dynamics of non-native brook trout in the Sandy Subbasin. In the early 1980s, brook trout were found in the upper Salmon River, Mud Creek, upper Camp Creek, and the Little Sandy River (Cain and Smith 1982). Presently, populations are confirmed only in the upper Salmon River and Ghost Creek near Salmon River Meadows, and in Mud Creek both above and below Trillium Lake. Populations in these streams are believed to be self sustaining but it does not appear that brook trout have invaded downstream areas and taken up residence.

Abundance

Population estimates are currently unknown in areas where they exist.

Hatchery Production

Hatchery brook trout are released only in designated high mountain lakes of the subbasin in cooperation with the USFS to enhance recreational opportunities in the watershed.

Angling and Harvest

Some angling occurs for brook trout in the upper Salmon River and Mud Creek, but information describing angler interest and harvest is limited. Most angling for brook trout in the subbasin occurs in high mountain lakes that are stocked periodically with juvenile brook trout. The angling season is the general trout season, late May to October 31, annually. Since 1997, no limits on minimum size have been allowed for brook trout taken from streams in Oregon, including the Sandy Subbasin.

Whitefish

Mountain whitefish (*Prosopium williamsoni*) are a member of the trout and salmon family and are indigenous to the Sandy Subbasin. Mountain whitefish are common in lakes and streams of western North America, and though information is limited, population status in the Sandy River is considered healthy and stable.

Distribution and Abundance

In the Sandy Subbasin, whitefish are most common in the mainstem and larger tributaries. They prefer deep pools or glides, good water quality, and cool temperatures. Subbasin distribution information is limited, but anglers report catching them in most large tributaries of the watershed. Mountain whitefish are primarily adapted as bottom feeders (Pontius and Parker 1973) and usually are found in schools near the substrate. Information on abundance is limited. Snorkel surveys for salmon during early fall (1993) in the lower Sandy revealed fair numbers of whitefish in pools and tailouts.

Angling and Harvest

Information that describes angler interest in whitefish is lacking. However, it is believed that few anglers fish specifically for whitefish in the watershed and harvest is thought to be minimal. There are no bag limits or minimum size restrictions, but anglers are restricted to trout and steelhead seasons, which vary depending on location in the subbasin.

Shad

American shad (*Alosa sapidissima*) are native to the Atlantic Coast, and were first introduced to the west coast with releases in the Sacramento River in 1871. Shad are documented to migrate up the Sandy River during the Columbia River spawning runs in late spring and early summer. Pirtle (1953) reported that shad were caught 9 miles upstream of the mouth. Though shad provide some sport angling opportunities in the lower Sandy River, little is known about angler interest or use.

Bull Trout

The ODFW has no historic documentation or evidence of bull trout (*Salvelinus confluentus*), a federal threatened species, in the Sandy Subbasin. However, two bull trout have been documented recently in the subbasin. In November 1999, an angler caught and released a 17 inch suspected bull trout near the mouth of Gordon Creek. The photograph of the fish did not show the dorsal fin for positive identification, but in all other respects the fish looked like a bull trout. In April 2000, the ODFW crews identified a 18 inch bull trout caught in the trap at Marmot Dam. This fish was released over the dam. Subsequent to these sightings bull trout identification posters were placed at strategic locations in the subbasin to assist anglers with identifying bull trout. Biologists believe these two fish migrated into the Sandy River from the Columbia River.

Smelt

Millions of smelt (*Thaleichthys pacificus*), less commonly known as eulachon, annually ascend the Columbia River to spawn in the lower mainstem and tributaries, including the Sandy River. Typically, smelt enter the Columbia River in late December or early January, and migrate into lower Columbia tributaries starting in mid to late January. Historically, smelt supported large commercial fisheries in the Columbia River and its tributaries, at least as far back as 1895 (Pirtle 1953). Pirtle (1953) reports that smelt runs into the Sandy River were inconsistent, but in years of good abundance, smelt were caught in commercial and sport fisheries primarily with large dip nets. Sport and commercial regulations for smelt entering the Sandy River were first instituted in 1921 (Pirtle 1953).

Wildlife

From its high elevation alpine zones to its lower elevations, the Sandy Subbasin provides diverse habitats for a wide variety of wildlife species. A diverse variety of bird species can be found from the alpine habitats in the upper subbasin to the mature conifer stands in the lower elevations. The subbasin is located in the Pacific Flyway and is used by migratory birds as resting or nesting grounds during migration. A rich diversity of amphibian and reptile species also is found in the rivers, streams, marshes and ponds in the subbasin. Also, a wide variety of mammal species are known to occur including Roosevelt elk, black-tailed deer, black bear, coyote, cougar, bobcat, otter, raccoon, beaver, mink and wolverine. The habitats adjacent to the rivers and tributaries provide important travel corridors for wildlife movement and dispersal to and from adjacent areas. The subbasin also contains suitable habitat for several bat species. Many federal and state sensitive, rare, threatened and endangered species are known to occur within the subbasin (Table 17) as listed by the Oregon Natural Heritage Program (ONHP 2001).

Table 17. Federal and state sensitive, rare, threatened and endangered wildlife species in the Sandy Subbasin

Common Name	Scientific Name	Federal Status	State Status
Bird Species			
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened
Northern spotted owl	*Strix occidentalis caurina*	Threatened	Threatened
Northern goshawk	*Accipiter gentilis*	Species of concern	Sensitive-Critical
Harlequin duck	*Histrionicus hisrionicus*	Species of concern	Sensitive-Undetermined
Yellow-billed cuckoo	*Coccyzus americanus*	Species of concern	Sensitive-Critical
Lewis' woodpecker	*Melanerpes lewis*	Species of concern	Sensitive-Critical
American peregrine falcon	*Falco peregrinus anatum*	----	Endangered
Greater sandhill crane	*Grus Canadensis tabida*	----	Sensitive-Vulnerable
Pileated woodpecker	*Dryocopus pileatus*	----	Sensitive-Vulnerable
Bufflehead	*Bucephala albeola*	----	Sensitive-Undetermined
Mammal Species			
Canada lynx	*Lynx canadensis*	Threatened	----
California wolverine	*Gulo gulo luteus*	Species of concern	Threatened
Red tree vole	*Phenacomys longicaudus*	Species of Concern	----
Pacific western (Townsend's) big-eared bat	*Plecotus townsendii townsendii*	Species of Concern	Sensitive-Critical
Fringed bat	*Myotis thysanodes*	Species of concern	Sensitive-Vulnerable
Amphibian and Reptile Species			
Oregon slender salamander	*Batrachoseps wrighti*	Species of concern	Sensitive-Undetermined
Larch mountain salamander	*Plethodon larselli*	Species of concern	Sensitive-Vulnerable
Northern red-legged frog	*Rana aurora aurora*	Species of concern	Sensitive-Undetermined
Cascades frog	*Rana cascadae*	Species of concern	Sensitive-Vulnerable
Oregon spotted frog	*Rana pretiosa*	Candidate species	Sensitive-Critical
Cope's giant salamander	*Dicamptodon copei*	----	Sensitive-Undetermined
Painted turtle	*Chrysemys picta*	----	Sensitive-Critical

Bird Species

The bald eagle is a federal and state threatened species. Bald eagles breed throughout the Pacific Northwest and winter from the Alaska panhandle southward. In 1999, there were 343 known occupied breeding territories in Oregon and the Washington portion of the Columbia River Recovery Zone (Isaacs and Anthony 1999). Although they are most abundant during the winter when there is an influx of birds from the north, there are substantial spring and summer nesting populations. During the spring and summer breeding seasons, eagles migrate through the Upper Sandy watershed (67,816 acres extending east-west from Sandy to the western summit of Mount Hood); however, the Bull Run watershed supports higher quality nesting habitat and eagles are more likely to nest there (USFS 1996). A pair of breeding bald eagles nest in the Sandy River Delta area, and eagles forage along the Columbia River and probably use the shoreline of the Delta for foraging and perching (USFS 1995c).

The northern spotted owl is a federal and state threatened species, and suitable old growth/late seral forest stands that support breeding populations are found in the Sandy Subbasin. Habitats selected by spotted owls exhibit moderate to high canopy closure (60% to 80%); multi-layered, multi-species canopy dominated by large overstory trees; high incidence of large trees with various deformities (large cavities, broken tops, debris accumulations); large accumulations of fallen trees and other debris; and sufficient open space below the canopy for flying (Thomas et al. 1990). Dispersal habitat includes stands that have at least an 11-inch average tree diameter and at least 40% canopy closure (Thomas et al. 1990). According to the USFS (1996), there are five active owl pairs in the Upper Sandy watershed and one additional pair on the border with the Bull Run watershed. For the Upper Sandy watershed, 20,000 acres were identified as suitable nesting habitat for spotted owls; most of this habitat occurs within the Mt. Hood Wilderness, the upper end of the Old Maid Flats area, and the Wildcat Mountain area (USFS 1996). In addition, about 58% of the Upper Sandy watershed (39,200 acres) has been identified as dispersal habitat, which is used for both foraging and as a crucial link for owls to travel between blocks of suitable habitat (USFS 1996).

The northern goshawk is a federal species of concern and a state sensitive species with critical status. They are forest-dwelling raptors and are distributed across most of Canada, the northern and western United States, and into Mexico (USFS 1993). Goshawks use mature or late seral stage forests for nesting. Although no known nest sites have been found, the Old Maid Flats area in the Upper Sandy watershed may provide suitable nesting habitat (USFS 1993).

The harlequin duck is a federal species of concern and a state sensitive species. Historical records of harlequin ducks place them throughout the Cascade Range in Oregon to northern California. Habitat exists in the entire upper Sandy River system; harlequins have been observed using the Sandy River and its tributaries, and are sighted regularly throughout the summer along the Sandy River, Still Creek, Camp Creek, and the ZigZag River (USFS 1996). The Sandy River functions as a migration flyway for the harlequin duck between its nesting habitat on generally higher elevation rivers and streams to its coastal wintering habitat (USFS 1996). A nest site was recorded on Clear Creek in 1991 and both young and adult birds have been observed in Lost and Clear Creeks (USFS 1996). The species has been declining because of impacts on breeding habitat from timber harvest, recreation increases, and degraded riparian habitat.

The American peregrine falcon is a state endangered species. Potential nesting habitat exists in the Sandy Subbasin for the peregrine falcon (USFS 1996). This species is dependent on cliff habitat especially for nesting and roosting, and they feed almost exclusively on birds, many of which are associated with riparian zones and wetlands (USFS 1996). Surveys in the Upper Sandy watershed located no nest sites, and there have been no known historical eyries either (USFS 1996). The Upper Sandy watershed is used for foraging; the Columbia River Gorge Scenic Area currently supports high quality habitat with three wild pairs documented nesting in the cliffs on the Gorge's Oregon side (USFS 1996). A peregrine hack site was introduced on the Zigzag Ranger District from 1990-1994, and several hacking programs also have been introduced in the Columbia River

Gorge (USFS 1996). The tagged, released birds have been seen in the Upper Sandy watershed on numerous occasions.

The pileated woodpecker is a state sensitive species with vulnerable status. It is identified as a management indicator species for mature and old-growth forest-dependent species on the Mt. Hood National Forest (USFS 1993). They require large contiguous forest stands to forage for their preferred food, the carpenter ant, and for other insects. In the Mt. Hood National Forest Land And Resource Management Plan, one pileated woodpecker management area was established in the Sandy River drainage; at least 300 acres of mature and/or old-growth forest habitat is maintained within each 600-acre management area (USFS 1993). The pileated woodpecker also is a permanent resident in the Sandy River Delta area.

Mammal Species

The Canada lynx is a federally threatened species. It formerly ranged throughout the upper-elevation forests of Oregon's North Cascades. Habitat consists of coniferous forests of mixed age and structural classes. Early successional forest stages provide habitat for the lynx's primary winter prey, the snowshoe hare. Mature forests with downed logs and windfalls provide cover for denning sites, escape, and protection from severe weather. A key component of lynx habitat is dense understory vegetation. There have been no confirmed lynx reports from the Sandy Subbasin or any counties nearby (personal communication, Holly Michael, ODFW, 2001). There was a report in 1997 that genetic analyses of hair samples confirmed its presence in the Mt. Hood, Willamette and Deschutes National Forests. However, the samples were retested and these results were found to be from coyote and bobcat, not lynx (personal communication, Holly Michael, ODFW, 2001).

The California wolverine is a federal species of concern and a state threatened species. There have been unconfirmed sightings of the wolverine from Clackamas County and near the Barlow Ranger District, and one confirmed road kill along the Columbia Gorge Highway near The Dalles (personal communication, Holly Michael, ODFW, 2001). In the Upper Sandy watershed, potential denning habitat exists in the higher elevation portions of the Mt. Hood Wilderness (USFS 1996).

The red tree vole is a federal species of concern. It spends most of its life in the canopy of coniferous trees and feeds on the needles; voles are considered to be closely associated with old-growth Douglas-fir forests (USFS 1996). Red tree voles in Oregon are distributed along the entire length of the coast and in the northern Cascades on the western slope (USFS 1996). The spotted owl is believed to be its main predator. Several nest sites have been found in the Bull Run watershed (USFS 1996).

The Townsend's big-eared bat is a federal species of concern and a state sensitive species with critical status. In Oregon, this bat is a statewide resident, but are scattered due to the fragmented nature of their habitat (USFS 1996). These bats occur in numerous plant community types using caves, buildings, mines, and bridge undersides for nursery and hibernation purposes (USFS 1996). Populations have declined 58% west of the Cascade Range during the 1975-1985 period. Disturbance appears to be the main reason for their decline. A 1995 survey of bridges and other potential habitat on the Zigzag Ranger District did not identify the presence of this bat (USFS 1996).

The fringed bat is a federal species of concern and a state sensitive species with vulnerable status, and is known to occur in the subbasin. It is a species of the woodlands at moderate elevation in mountains. The status granted to this species may indicate that the population and critical habitat may be declining or that very little information is available regarding its population status or habitat needs.

Although not "species of concern," black-tailed deer and elk are important resources and have been selected as Management Indicator Species on the Mt. Hood National Forest (USFS 1993, 1996). There are two main elk herds in the Upper Sandy watershed, in the Marmot and Wildcat Mountain areas, with isolated, smaller elk herds throughout the drainage (USFS 1996). The Clear Fork of the Sandy drainage and the high elevation meadows provide quality summer range for deer and elk as well as a good seasonal migration corridor linking the high elevation summer elk ranges with the lower elevation winter ranges (USFS 1993). Areas with high quality forage and cover with reasonable freedom from human disturbance provide the most productive habitat for deer and elk. Elk populations appear to be declining within the Zigzag Ranger District, and is likely due to high human presence, low amounts of available forage, and high road densities (USFS 1996).

Amphibian and Reptile Species

The Oregon slender salamander is a federal species of concern and a state sensitive species. They are endemic to the west-slope of the Oregon Cascade Range and are most common in mature and old-growth forested habitat types, but may be found in very limited numbers in younger forests and recently harvested areas (Vesely 1999). The species is classified as sensitive largely due to the lack of information about population trends. It is thought, however, that forestry practices may contribute to degradation of suitable habitat through outright removal of forests and reduction in forest canopy. Canopy closure, aspect of the site, and woody debris have been shown to be important factors in determining slender salamander abundance. It is unknown whether the current spatial distribution of Late-Successional Reserves on federal land designed for northern spotted owls will be sufficient to maintain this species.

The Larch Mountain salamander is a federal species of concern and a state sensitive species with vulnerable status. It occurs in the Cascade Mountains of southern Washington and northern Oregon. This terrestrial salamander has a restricted range in the Columbia River Gorge of Oregon and Washington, and north in the Cascade Mountains to the vicinity of Mount St. Helens, Washington. This salamander inhabits mesic talus slopes, and other rocky areas. Most populations are found in humid mixed forests of Douglas-fir and hardwoods. The talus slope habitat of many populations is extremely fragile and populations are also threatened by logging, and road building (which uses talus). Sightings have been reported in the Columbia River Gorge Scenic Area; no sightings have occurred in the Upper Sandy watershed (USFS 1996).

The northern red-legged frog is a federal species of concern and is a state sensitive species. The red-legged frog occurs widely west of the Cascade Mountains from British Columbia to California. They live in forests, damp meadows, marshes, ponds, lakes, and along streams. They are sensitive to destruction or damage (such as from pollution) of wetlands habitats throughout their range. In the subbasin, the red-legged frog is common in the lower end of the Bull Run watershed and breeds there, and is found at the Sandy River Delta area (USFS 1995c, 1997).

The Cascades frog is a federal species of concern and a state sensitive species in a vulnerable status. It is found in the Cascade Mountains from northern Washington south through Oregon to California border. It lives at elevations of 800 to 2,740 meters, almost to timberline. This frog inhabits small streams, meadow puddles, ponds, and lakes, usually in open coniferous forest and is found in water or among grass, ferns and riparian vegetation. The Cascades frog requires similar habitat to that of the red-tailed frog, and is likely to occur in the Sandy drainage (USFS 1993).

The Oregon spotted frog is a federal candidate species and a state sensitive species with critical status. Records for the Oregon spotted frog exist from Multnomah and Clackamas Counties in a variety of elevations at ponds and lakes, some near rivers. It is thought that the species may be pushed towards extripation in Oregon due to hydrologic modifications, habitat loss, and the introduction non-native predatory fishes and bullfrogs (Hayes 1994). Oregon spotted frog populations occur in association with relatively large wetland complexes.

Cope’s giant salamander, a state sensitive species, occurs in the Olympic Mountains of Washington, the Cascade Mountains and Willapa Hills of southern Washington, and extreme northwestern Oregon. These salamanders live and breed in clear, cold, fast-flowing streams with rock or gravel bottoms. They are sensitive to stream siltation and warming caused by excessive logging and other human activities. In the subbasin, this salamander is found in tributaries to Bull Run Lake, Cougar Creek, and Bear Creek (USFS 1997).

The western painted turtle is a state sensitive species with critical status. It prefers slow-moving shallow water, as in ponds, marshes, lakes, and creeks. A soft bottom, basking sites, and aquatic vegetation are preferred. It is known to occur in the Sandy River Delta area (USFS 1995c).

Habitat Areas and Quality

Fish

Aquatic habitats in the Sandy Subbasin have undergone both chronic and acute destabilization throughout recent history. Historic unmanaged grazing, mining, logging, stream channelization, riparian clearing, wetlands filling, streamflow diversion for hydropower, and other developments have all contributed to reduced riparian and stream habitat productivity. Ongoing effects from mismanaged land use activities, instream heavy equipment use, road-related activities, and catastrophic floods are responsible for many negative effects to spawning and rearing habitat. Winter steelhead, spring and fall chinook, coho salmon and pacific lamprey production is limited primarily by existing spawning and rearing conditions. Land use activities have not only detrimentally affected habitats for fish, but also water quality and quantity, and trophic organization. These activities act to destabilize natural hydrologic processes and amplify the impacts of natural events such as storms. The principal management concerns for fish habitat in the Sandy Subbasin are (ODFW 1997):

- Lost spawning and rearing habitat in the subbasin including the Bull Run River, Little Sandy River and Cedar Creek.
- Diminished flows from the Bull Run watershed caused by both municipal water withdrawals and water diversions for power production, and subsequent effects on downstream spawning areas in the lower Sandy River, flows for both upstream and downstream fish migrants and reduced natural hydrological function during freshets like channel reconfiguration, scouring and sediment transport.
- Potential in-stream thermal differentials at the confluence of the Bull Run and Sandy Rivers during summer due to flow manipulations for hydropower and municipal use.
- Lack of screening at the Little Sandy Diversion Dam canal to prevent naturally produced trout from being transported to Roslyn Lake.
- Upstream and downstream fish passage at Marmot Dam, including the rotating screens and juvenile bypass facility in the Marmot Diversion Canal.
- In-stream channelization projects following the 1964 flood in the Salmon, ZigZag and upper Sandy rivers which significantly reduced fish habitat and impacted natural hydrological and riparian zone functions.
- Population growth in both the Portland Metropolitan area and outlying urban areas and urbanization effects on water quality and general watershed health and natural function of certain ecological characteristics of the basin.

The ODFW (1998) identified the following information for the Sandy Subbasin in their *Willamette River/Sandy River Guide to Restoration Site Selection* for steelhead.

- Priority Steelhead Areas: Salmon River
- Streams with anadromous fish passage blockages due to dams: Bull Run River, Little Sandy River
- Potential Restoration Areas: Beaver Creek, Alder Creek, Wildcat Creek, Gordon Creek, Hackett Creek, Buck Creek
- Many of the potential sites in the Sandy Subbasin are on smaller tributaries at the confluence with the main river, with the exception of Gordon Creek.
- The Sandy Subbasin has an overall low potential for in-stream habitat enhancement. This low potential is due primarily to the low number of steelhead bearing tributaries in the lower part of the watershed coupled with the high development of the smaller tributaries that do exist. Most of the streams in the lower watershed would benefit from riparian enhancements designed to protect the stream banks, encourage conifer reestablishment, and filter agricultural and

stormwater runoff. The dams on the Bull Run and Little Sandy Rivers prevent steelhead from accessing some of the more protected areas of the subbasin.

- Emphasis on riparian enhancements should be placed on the streams that harbor all species of salmonids, as well as the larger river channels that cannot be targeted for in-channel wood placements. Areas that could use increased protection in the Sandy subbasin include any side channel and off channel area in the main river, especially the area around the confluence with Alder Creek.
- Potential in-channel habitat restoration sites in the Sandy Subbasin include:
    - Alder Creek from the mouth to the end of steelhead range.
    - Wildcat Creek from the mouth to the end of steelhead range.
    - Boulder Creek from the mouth to the end of steelhead range.
    - Hackett Creek from the mouth to the end of steelhead range.
    - Buck Creek from the mouth to the barrier.
    - Gordon Creek from Cat Creek.
    - Kelly Creek from the mouth to the end of steelhead range.
    - Beaver Creek from the mouth to the end of steelhead range reaches 1 and 2.
    - Beaver Creek tributary 1 from the mouth to the end of steelhead range.
    - Beaver Creek tributary 2 from the mouth to the end of steelhead range.

The 1964 Flood

According to the ODFW (1997), one of the single most important natural events to manifest an impact upon the Sandy basin in recent history was the 1964 flood. In December of 1964, heavy snow was followed by warm rain and precipitated a 100-year flooding event. Estimated flows from the Sandy River at the confluence with the Columbia River was about 82,000 cfs. The impact of the flood on the stream channels in the upper basin was catastrophic in terms of the natural hydrologic effects and from the channelization efforts that followed. In response to the severity of this event, the USACE and local communities worked cooperatively to channelize several miles of the lower reaches of the Salmon, ZigZag, and Sandy Rivers, and Still Creek with the intent to allow large volumes of water to move more freely from the upper subbasin. Heavy equipment was used to reconfigure and straighten the channels, and most large obstructions such as large logs and boulders were removed. Many side channels were blocked by the berms built with the rock removed from the channel.

Though well intended, this project manifested significant long-term effects on the overall biological productivity of the basin as a whole. The upper watershed is known to be a key spawning and rearing area to several species of native fish that include winter steelhead, coho, spring chinook, and cutthroat and rainbow trout, and to a lesser degree fall chinook. In-stream channelization can reduce aquatic physical habitat complexity, which is especially important for over-wintering survival of juvenile anadromous fish and also increases flow velocity. The increased velocity can scour out spawning gravels, and increase the energy expenditures of rearing fish. Sealing off side channels has also reduced areas of refuge during high flow events, and decreased the biological productivity of the aquatic environment.

The USFS and the BLM have worked cooperatively in recent years to identify and reopen historic side channel areas that have been blocked to fish passage since 1965, primarily in the lower Salmon River, and the Sandy River near the confluence with the Salmon River. Significant numbers of juvenile coho and trout have been observed using these side channel areas in summer and winter.

Riparian Habitat Loss

Plentiful riparian cover along streambanks is a vital part of a healthy watershed, providing multiple benefits in the form of nutrient cycling, shading and cover, bank stability, water storage, and filtration and retention. Riparian vegetation also hosts various insect species for the aquatic food chain. Loss of riparian cover leads to accelerated surface runoff and erosion, which in turn leads to siltation of spawning beds. Loss of riparian areas increases water temperature in winter. Cumulative losses of habitat complexity can make fish populations more vulnerable to flash floods. Loss of riparian cover potentially exposes spawning adults and rearing juveniles to predation and disturbance (Federal Caucus 2000). When riparian vegetation is lost, channel structure becomes more simple as inputs of large woody debris and their influence on channel structure are diminished, affecting instream habitat.

Erosion and Sedimentation

The headwaters of the Sandy and ZigZag Rivers are greatly influenced by glaciers and steep unstable slopes on the western flank of Mount Hood. Glacial sediment and sand deposits are evident throughout the mainstem Sandy River and may suppress natural production of fish (ODFW 1997). Fine sediment in spawning substrate has a major effect on salmon survival from egg to smolt. As silt settles into coarse gravels, spawning habitat is eliminated and eggs are suffocated by reduced water and oxygen flow. Sedimentation increases temperature and reduces dissolved oxygen concentrations (Federal Caucus 2000) and is abrasive to gill tissue.

Unusually high levels of erosion can result from urban and rural activities, such as construction, road building, agricultural activities, and timber harvesting. The Natural Resources Conservation Service (NRCS) and others compile subbasin information relating to watershed health, in part through its National Resources Inventory (NRI). The NRI is an inventory of land cover and use, soil erosion, prime farmland, wetlands, and other natural resource characteristics on non-federal rural land in the United States. The estimated amount of cropland erosion in the Sandy Subbasin is shown in Table 18. Based on the NRI from 1982-1997, approximately 5,700 acres of cropland, pasture, range and forestlands are converted annually to urban use in the Lower Columbia (170800) hydrologic unit.

Table 18. Estimated cropland erosion in the Sandy Subbasin

Hydrologic Unit Code	Watershed	Cropland Erosion (tons)	Cropland Area (acres)
17080001	Lower Columbia-Sandy	31,100	28,900

Source: 1992 National Resource Inventory

Roads frequently generate overland flow from relatively impervious running surfaces and cutslopes. Additionally, interception of interflow at cutslopes can substantially increase the amount of runoff, converting subsurface flow to surface flow. Where flow is continuous between roads and streams such as via ditch and drainage systems the road can be considered "hydrologically-connected" to the stream network. Examples of such interconnections include, but are not limited to, aggregate (unpaved) road surfaces, ditches, cross culverts, bridge approaches and roadway that parallel stream systems. Wherever a connection exists, accelerated runoff, sediments, and road-associated chemicals such as spills or oils generated on the road surface and cutslope have a direct route to the natural channel network and surface waters.

The impact and number of hydrologically-connected roads is difficult to quantify for the Sandy Subbasin, although models do exist for site specific calculations (USFS, Water Erosion Prediction Project, April 1998). "…Road treatments to "disconnect" roads from streams – to reduce the amount of hydrologically-connected roads – are usually simple, inexpensive, and effective in reducing road effects and risks to water quality and aquatic habitats..."

Efforts by some local road agencies to develop best management practices for road maintenance activities as part of their ongoing NMFS ESA response programs are being finalized and ultimately will have a cumulative benefit on fish and wildlife habitat.

Flows

Peak flows from increased, unretained runoff scour redds and dislodge eggs or alevins. Peak flows in the lower basin are inflated by urbanization. Low summer streamflows also occur in many of the streams in the Sandy Subbasin, primarily as a result of water withdraws, and degraded channels associated with urbanization. Low flows from water withdraws are most common in the lower subbasin. Low flows in the lower subbasin are a result of water storage at the Bull Run facility, water diversion at the Marmot dam facility, and water withdraws from lower basin tributaries. Lack of flow interferes with movement, spawning, and rearing of salmon, steelhead, and trout and significantly impairs habitat productivity and causes stream intermittency. Studies suggest that minimum water depth for passage by chinook is 24 cm. Lack of adequate water depth reduces the connectivity between aquatic systems, impeding passage to traditional spawning grounds, affecting rearing of juvenile steelhead, and impacting all life stages of cutthroat trout. Low flows also reduce the depth of pools used for holding adults and rearing juveniles. Low summer stream flows also have the effect of concentrating pollutants (phosphates, nitrogen), which can be hazardous to aquatic health.

Water Temperature

Water temperatures in the Sandy Subbasin are generally cool and favorable for natural production and survival of native fishes (NWPPC 1990). Temperatures in the subbasin, like all northwest streams, vary daily, monthly and between years, and fish spawning and migratory behavior is greatly influenced by thermal changes in the aquatic environment.

The DEQ has listed the following river segments on the 1998 303(d) list as water quality limited for exceeding the summer water temperature standard applied to waters designated for salmonid rearing: the Sandy River, mouth to Marmot Dam; lower Bull Run River, mouth to the Bull Run Reservoir No. 2; and the Salmon River, mouth to Boulder Creek. Based on data, summer water temperatures can also exceed standards in Alder Creek, Clear Creek, and the Clear Fork of the Sandy (USFS 1996). Table 19 shows the water bodies of concern in the Sandy Subbasin as described in DEQ's final 1998 Section 303(d) Decision Matrix (http://waterquality.deq.state.or.us).

Water temperatures in the Sandy River are primarily controlled by the local climate and by snow that accumulates at higher elevations during winter and thaws in summer. Leonards (1960) reported that water temperatures during the period 1951-1956 varied from a low of 33° F in winter to a high of 61° F in summer at a gauge site located about a 1/2 mile from Marmot Dam. Limited temperature information shows that the upper watershed typically ranges from 55° to 65° F in the summer and is believed to decrease with significant increases in elevation. In the lower subbasin below Marmot Dam, water temperatures in summer usually range from 60° to 70° F. However, some records show that water temperature in the extreme lower basin near Troutdale can exceed 70° F when long hot spells prevail. During winter, temperatures in the lower basin often range between 40° and 50° F.

It appears that a thermal differential may occur during summer months at the confluence of the Bull Run and Sandy Rivers. In August of 1993, water temperature of the Sandy River just upstream with the confluence with the Bull Run River (RM 18.5) was 70° F. However, the temperature of the water in the Bull Run River just upstream from its confluence with the Sandy River was 64° F. It is important to note that most of the water leaving the Bull Run watershed in August is Sandy River water diverted at Marmot Dam to Roslyn Lake. This temperature differential is substantial, and is believed to occur because water diverted at Marmot Dam is cool, and is transferred to Roslyn Lake via a network of flumes and underground canals that may prevent water from increasing in temperature. Sandy River water diverted to Roslyn Lake may be exposed to sunlight in the reservoir for a period prior to being diverted into the penstocks at the PGE powerhouse, but thermal gains are not great. The Sandy River at Marmot Dam near the same time of day was about 62° F. It appears that water flowing down the natural channel in the Sandy River corridor below Marmot Dam is exposed to the thermal effects of sunlight for a longer period of time and over a greater distance than Sandy River water diverted to Roslyn Lake. It should be noted that most of the water entering the Sandy River from the Bull Run watershed in August is water that has been diverted from the Sandy River at Marmot Dam for power production purposes. The channel above the PGE powerhouse on the Bull Run River is mostly dry during summer because river water is stored upstream.

Table 19. Water quality concerns in the Sandy Subbasin

Water Body	303(d) List	Parameters of Concern	Parameters OK
Alder Creek		Flow Mod	Temp
Bear Creek			Bacteria, pH
Beaver Creek		Toxics (metals, total dioxins, & furans), Bacteria, Flow Mod., Nutrients, Sediment, Temp.	
Bull Run River	Temp. (mouth to Dam)	Flow Mod.	Bacteria, pH, Temp in upper basin
NF Bull Run River			Bacteria, pH, Temp.
SF Bull Run River			Bacteria, pH, Temp.
Camp Creek		Habitat Mod., Sedimentation	Bacteria, pH
Cedar Creek		Algae	Temperature
Chance Creek			Temperature
Clear Creek		Habitat Mod., Sedimentation	
Cougar Creek			Bacteria, pH
Deer Creek			Bacteria, pH
Fir Creek			Bacteria, pH, Temp.
Fivemile Creek			Bacteria, pH
Ghost Creek		Sedimentation	
Henry Creek			Temperature
Kelly Creek		Bacteria, Nutrients, Sedimentation, Temp.	
Linney Creek		Habitat Mod., Temp.	
Little Sandy Creek		Flow Modification	Temp. (dam to headwaters)
Lost Creek		Habitat Mod., Sedimentation	
Mud Creek			Temperature
Salmon River	Temp. (mouth to Boulder Cr.)	Habitat Mod., Sedimentation	Bacteria, pH, Temp. (Boulder Cr. Up)
SF Salmon River		Habitat Modification	
Sandy River	Temp. (mouth to Marmot Dam)	Flow and Habitat Mod., Sedimentation	Bacteria, Chl *a*, DO, pH
Clear Fk. Sandy R		Habitat Mod.	Temperature
Muddy Fk. Sandy R		Habitat Mod., Sedimentation	
Still Creek		Habitat Mod., Sedimentation	Temperature
ZigZag River		Habitat Mod., Sedimentation	

Instream Habitat Loss

Loss of instream habit and habitat diversity limits salmonid production. Human caused channelization has eliminated floodplains and wetlands and reduced channel complexity, eliminating rearing habitat for juveniles and disconnecting floodplains with the stream. Reductions in beaver populations have also limited their contribution to forming wetland and riparian habitat. Reduced riparian areas also limit woody debris in streams, diminishing pool quality and frequency, which are important for holding adults and rearing juveniles. Loss of floodplains and wetlands has eliminated rearing areas for juveniles. Loss of instream habitat also increases vulnerability to predation (Federal Caucus 2000).

Wildlife

Wildlife abundance has been limited by loss of habitat quantity, quality, and diversity. Direct habitat conversion for transportation, urban uses and agriculture, recreational use, logging and other land use activities over the past 150 years have altered the extent, structure and composition of wildlife habitat in the subbasin, thus decreasing the populations of wildlife species. The cultivation of lands for agricultural uses impacted habitat conditions especially along the lower Sandy and tributaries. A growing urban population has now replaced agriculture in many areas in the lower subbasin.

In addition, habitat conditions and diversity changed as wetlands and floodplains were drained and filled for development. Habitat diversity also was affected by removal of riparian vegetation in many places in the subbasin. Riparian habitat along many of the streams in the subbasin has been significantly altered or lost because of transportation, recreation, residential, agricultural, and logging activities. Restoration of riparian areas, including removal of non-native species and planting of native species, would provide more and better-connected habitat throughout the subbasin.

Also, channelization, closing off of oxbows and side channels, and in-stream clearing was done by the USACE, USFS, other public agencies, and private individuals in the upper Sandy subbasin following the 1964 flood. Substantial amounts of habitat were lost from these activities, and the diversity and quality of remaining habitat was significantly reduced.

The effects of wildfire have also led to ecosystem changes in the Sandy Subbasin. Historically, fire played a central role in most Pacific Northwest ecosystems. The earliest fire history for the subbasin has only been documented for the Bull Run Watershed. According to the USFS (1997), two remnant stands of mixed Douglas fir, Pacific silver fir, Alaska yellow cedar, and western hemlock in the watershed date back to 750 years to a large fire event circa 1243 A.D. The next major fire event in the watershed occurred in 1493. This event burned virtually the entire watershed, with the exception of the two remnant stands. Large fires also occurred in 1663 (Bull Run Lake area) and in 1693 (southwestern end of watershed). One hypothesis for the large burn during 1493 and other years is that the burning resulted from a combination of multiple fire starts sparked from passing lightning storms (USFS 1997). The USFS (1996) indicates that between 1873 to 1920, nearly 75% of the Upper Sandy watershed had been burned by stand replacing fire. According to the USFS (1996), wildfire has been and will continue to be an influential factor affecting ecosystem development, and virtually all ecosystem resources are affected either directly or indirectly by fire. In a variety of ways, wild fire alters the landscape and affects wildlife primarily through its effects on habitat (USFS 1996).

In the Cascades region, intensive timber harvest has left much of the Douglas-fir zone in early successional stages (younger than 40 years). These stands lack key habitat attributes that would have existed historically after major fires, such as remnant large trees and snags, shrubs, and a spectrum of stand densities. In mid- to lower elevations of the Cascades, plantations established after timber harvest have higher tree densities and more simplified forest structure than what would result from natural disturbance (Oregon Progress Board 2000).

As mentioned previously, riparian areas have been greatly changed in the subbasin by fire suppression and other management activities. According to the USFS, the major factors that have influenced riparian condition in the western Cascades are fire, floods, timber harvest and log transport, road construction and residential development, and flow regulation by dams. Because of their resistance to fire, prior to logging, riparian areas had relatively high densities of large conifer trees. Timber harvest in streamside areas resulted in a 50% or more loss of large conifers in many drainages of the Cascades ecoregion (Oregon Progress Board 2000).

According to the USFS (1996), invasive non-native plant species pose one of the greatest threats to natural biodiversity in the upper Sandy watershed (this would apply to the other watersheds of the subbasin as well). They list road density, timber sales, and the BPA powerline corridor as factors that contribute to the abundance of non-native plant species in the watershed. The most widespread include gorse, knapweeds, Canada thistle, scotch broom, St. Johnswort, tansy ragwort, Himalayan and evergreen blackberries, Japanese knotweed, and English ivy (USFS 1996). The spread of such invasive species has a profound economic impact on agricultural production, natural resource management, and fire suppression. Noxious weeds can poison livestock and pets, increase fire hazard, compete with desirable plants, require investment of effort and resources to control, reduce the suitability of wildlife habitats, and change the nature and composition of plant communities.

Watershed Assessment

Watershed assessments are being conducted at a number of scales and by a variety of entities in the Sandy Subbasin. These activities are consistent with and support the "RPA" habitat action for Restoring Tributary Habitat as found in the Columbia Basinwide Salmon Recovery Strategy: "With the Northwest Power Planning Council, develop subbasin and watershed assessments and plans; ensure that assessments and plans are coordinated across nonfederal and federal ownerships and programs."

The USFS has conducted a number of watershed analyses in the Sandy Subbasin including the Salmon River Watershed Analysis (USFS 1995a), Zigzag Watershed Analysis (USFS 1995b), Sandy River Delta Watershed Analysis (USFS 1995c), Upper Sandy Watershed Analysis (USFS 1996), and the Bull Run Watershed Analysis (USFS 1997). Under the Oregon Plan, many Watershed Councils also have developed or are developing watershed assessments and restoration plans. In 1999, the Sandy River Basin Watershed Council (SRBWC) conducted a Phase 1 Watershed Assessment and Action Plan to guide their activities in the subbasin (SRBWC 1999a, b). Also, in 2000 the City of Portland conducted a Comprehensive GIS Analysis of the Sandy Subbasin.

A Columbia Basin-wide loss assessment was conducted in the late 1980s to quantify a construction/inundation impacts from federal hydropower development. Wildlife mitigation objectives for the Lower Columbia subregion are based partially on the results of this loss assessment effort. Estimated wildlife losses caused by the construction/inundation of the federal hydropower system were amended into the NWPPC's Fish and Wildlife Program. Losses were measured in Habitat Units (HUs) for selected target/indicator species and are linked to priority habitats. The NWPPC also documented changed conditions within the Columbia Basin hydropower system in its *Return to the River* report (1996).

The ODFW and OWRD have established priorities for restoration of streamflow from consumptive uses as part of the Oregon Plan for Salmon and Watersheds (Measure IV.A.8). The ODFW has identified the "need" for streamflow restoration through ranking of biological and physical factors, water use patterns and the extent to which flow is a primary limiting factor. The OWRD ranked the opportunities and likelihood for achieving meaningful stramflow restoration. Rankings were performed for subwatersheds ant approximately the fifth field hydrologic units (HUCs). The OWRD Watermasters will incorporate the priorities into their field activities as a means to implement flow restoration measures. The "needs" priorities will be sued by the Oregon Watershed Enhancement Board as one criterion in determining funding priorities for enhancement and restoration projects. Watershed councils and other entities may also use the needs priorities as one piece of information determining high priority restoration projects.

The DEQ and the Natural Resource Conservation Service initiated a process to develop a Unified Watershed Assessment (UWA) as part of the federal Clean Water Action Plan (CWAP) put forth by the USDA and EPA. Using existing assessment information, public input, and tribal, federal, and state participation, the 1998 UWA and Restoration Priorities for Oregon assessed the condition of water resources and prioritizes watersheds for restoration (www.deq.state.or.us). The assessment is intended to identify potential opportunities to link the Oregon Plan, tribal restoration plans, federal plans, and other collaborative watershed assessment and restoration efforts. Subbasins that contain core and fringe populations of salmon with high genetic integrity, including the Sandy, were identified as presenting key opportunities for restoring fisheries and water quality. The DEQ has also inventoried state waters, including those in the Sandy Subbasin, for listing through the DEQ's Clean Water Act Section 303(d).

Soil and Water Conservation Districts (SWCD) in Oregon also have roles defined by state law to conduct resource assessments. They develop annual work plans and are in the process of developing business plans that based on their assessments will prioritize resource concerns. Districts are also involved in TMDL analyses, Oregon Agriculture Water Quality Management Plan (SB1010) assessments, geographic priority area assessments for USDA Environmental Quality Incentive Program, watershed council watershed assessments and other watershed scale programs.

Limiting Factors

The Sandy Subbasin is an example of the sensitivity of watersheds along the western slope of the Cascades to human activity. Loss of quality habitat and a loss of connectedness are the over-riding limiting factors to fish and wildlife production in the Sandy Subbasin. Because salmon, steelhead, lamprey, and some trout are migratory fish to varying degrees, intact and healthy habitat is required throughout their life cycle range for healthy populations to exist. For wildlife, habitat loss has restricted the range of many species through fragmentation and isolation, and altered species communities. Furthermore, both migratory fish and wildlife have limiting factors outside the subbasin. For example, neotropical birds need good overwintering habitat; anadromous fish need good passage conditions and estuary rearing habitat.

Factors specific to fish declines in the Sandy Subbasin include blockage of valuable upstream spawning habitats by dams; fish passage impediments on rivers and tributaries by diversions and culverts; channelization, loss of side channel habitat, and stream system disruption from urbanization; change in stream temperature regimes; deteriorating water quality; loss of wetlands and riparian shade, structure, and diversity; change in flow regimes; loss of stock diversity; excessive harvest rates in the past; adverse ocean and estuary conditions; and predation by birds, other fish, and marine mammals.

Limiting factors also include lack of resources to monitor populations and obtain information, lack of necessary tools to monitor environmental variables, or lack of a coordinated framework to tie efforts and results together. Factors that have caused the decline of natural resources are limiting in themselves.

Factors Specific to Fish Passage

Ensuring that migratory fish are not impeded at manmade barriers is an ongoing concern in the Sandy Subbasin. Passage barriers for both upstream and downstream fish migrants may occur at culverts, debris jams, weirs, and diversion dams located in the subbasin. In addition, channelization projects in the subbasin following the 1964 flood blocked passage into many side-channels that historically provided substantial rearing and spawning habitat.

Current laws give ODFW the authority to require maintenance of fish passage at all man-made in-channel obstructions in streams where fish are present (ORS 498.268 and ORS 509.605 - 509.645). In addition, the USFS recognizes fish passage as a high priority under direction from the President's Forest Plan. The USFS has prepared watershed assessments for several large tributary streams of the subbasin and they address passage concerns in these watersheds, particularly at road crossings. The USFS is required by the Forest Plan to maintain adequate fish passage at such crossings (personal communication, Jeff Uebel, USFS, 6/28/96, Zigzag Ranger District).

Factors Specific to Water Temperature

The DEQ has listed the following river segments on the 1998 303(d) list as water quality limited for exceeding the summer water temperature standard applied to waters designated for salmonid rearing: the Sandy River, mouth to Marmot Dam; the lower Bull Run River, mouth to the Bull Run Reservoir No. 2; and the Salmon River, mouth to Boulder Creek. Based on data, summer water temperatures can also exceed standards in Alder Creek, Clear Creek, and the Clear Fork of the Sandy (USFS 1996).

Factors Specific to Land Use Practices

Three key physical concerns form the context for the analysis of habitat conditions, the limiting factors for fish and wildlife resources, and ultimately the restoration recommendations for the Sandy Subbasin. First, historic and current land use practices have directly reduced the amount of habitat in the subbasin by filling or altering wetlands, clearing riparian forests, and changing the species composition of meadows and other important habitat types. Cumulatively, these actions have caused significantly less habitat availability for terrestrial and avian species.

Second, the historic and current land use practices have altered the hydrologic cycle- the storage movement, and character of the water resource over entire areas of the Sandy Subbasin and its tributary system. Changed in the hydrologic cycle are demonstrated by excessive runoff, altered peak flow regimes, lack of ground water recharge reduction in soil moisture storage, and low late-season flow.

Third, historic and current land uses, in combination with hydrologic changes, have resulted in some portions of the Sandy Subbasin reflecting marked stream channel instability (i.e. channel widening, downcutting, vertical cut banks, and excessive gully development). Each of the limiting factors specifically within the Sandy Subbasin and highlighted in this report is related in part to the broad-scale problems of hydrology and basin-wide stream channel instability. The actual causes of these conditions in the subbasin are multiple; therefore, the restoration of stream flows and stream channel stability will require combined action across many land uses and geographic areas in the subbasin.

Factors Specific to Hydropower Projects and Dams

The hydropower projects and dams located in the Sandy Subbasin include the Marmot Dam on the mainstem Sandy River (RM 30); the Little Sandy Diversion Dam on the Little Sandy River (RM 1.7); the Headworks Dam (RM 6), Bull Run Dam No. 1 (RM 11) and Bull Run Dam No. 2 (RM 6.2), all on the Bull Run River; and a hatchery diversion dam on Cedar Creek. The non-federal hydropower facilities are licensed through FERC, and numerous powerlines and infrastructure are operated in conjunction with the FCRPS to provide power to the Northwest power grid system. There are BPA power transmission lines and accompanying rights-of-way in the Sandy Subbasin. The USFS (1996) described the powerline impacts on the Upper Sandy watershed as follows:

- The linear nature of the powerline severs natural terrestrial connectivity corridors and limits opportunities to restore connectivity.
- The powerline corridor is a major barrier to movement of species with poor or very poor dispersal capabilities.
- Natural flow patterns are disrupted between key natural ecosystems within the Bull Run watershed to the north and both the Mt. Hood and Salmon-Huckleberry Wilderness areas to the south.
- The powerline corridor is a landscape pattern that does not occur naturally on this landscape and adversely affects scenic qualities.
- The initial clearing and periodic maintenance of the right-of-way has created a vegetation composition that is outside the range of natural condition.
- The right-of-way has been a vector for noxious weeds.
- The high road density of primitive access roads used to access powerline towers and the lack of adequate maintenance has led to a concern that water quality has been compromised. Also, this primitive road system is attractive to recreationists pursuing off-road vehicle use, which has compounded the soil erosion problem.

While dams and hydropower projects offer society certain beneficial uses, they have significantly altered natural river systems in the Northwest. The effects of these facilities on anadromous and resident fish have been well documented and cumulative losses are substantial. Dam construction and operation, in many cases, have stressed aquatic systems, and the fish that reside and migrate in them, beyond their ability to adapt. Hydropower projects and storage dams affect fish and rivers in many ways. Below is a general overview of potential adverse ecological impacts associated with dams.

1. Dams can reduce river levels by diverting water for power or other purposes. This streamflow would otherwise contribute to healthy in-stream ecosystems. In the worst cases, bypass reaches below dams are completely de-watered. Most original (state and federal) licenses issued to existing hydropower projects in the mid-twentieth century required very little, if any, flow to remain in a project's bypass reach as a license condition. This fact has resulted in poor water quality, fish passage barriers, stranding, and loss of fish rearing, holding and spawning habitat.
2. Dams can block rivers. They can prevent the flow of plants and nutrients, on which fish and their prey depend, and impede the migration of fish. Upstream habitat is either completely cut off or underutilized, unless passage is provided at the dam and through the bypass reach. While fish passage structures, when present, enable some fish to pass around a dam, these species/ESUs are still jeopardized by the cumulative impact of passing multiple dams. The fish population decreases with each dam passing. Some dams have no fish passage structures at all. Barging and trucking of fish around dams increases the risk of disease, predation, and a diminution of homing abilities.
3. Dams with reservoirs decrease water velocities and/or cause a confusing flow pattern that results in fish being lost or delayed. Steelhead and other salmon depend on steady flows to flush them downriver as smolts and guide their return upstream to spawning grounds as adults.
4. Reservoirs behind dams displace riverine habitat. The creation of reservoirs behind dams results in a permanent loss of spawning habitat in the affected reaches and potentially diminishes the quality of habitat for juvenile rearing and cover.
5. Dams can alter water temperatures. Factors such as reservoir size, retention rate, and type of outlet structure affect whether water releases are warmer or cooler. Salmon and other fish are sensitive to non-natural temperature regimes, which can affect negatively native populations.
6. Dams can alter the timing of flows. By withholding and then releasing water to generate power for peak demand periods, or for other extractive uses, dams cause extreme variations in in-stream and riparian habitat conditions downstream. Conditions can alternate from no water to great surges of water, a situation which can strand fish and erode soil and vegetation. These irregular releases interfere with natural seasonal flow variations that help trigger growth and reproduction cycles. Unnatural seasonal fluctuations also often conflict with seasonal habitat needs of aquatic organisms both upstream and downstream.

7. Dams can fluctuate reservoir levels. Peaking power operations can cause dramatic changes in water levels, which degrade upstream shorelines and disturb fish and bottom dwelling organisms.
8. Dams can decrease oxygen levels in reservoir waters and disturb the balance of other natural gases downstream. When oxygen-deprived water is released from behind a dam, it degrades the quality of downstream riparian habitat, affecting production and diversity of aquatic species. In addition, the spilling of large amounts of water from big dams contributes to super-saturation of nitrogen in the water immediately downstream of the dam, which can also kill fish.
9. Dams can hold back silt, debris, and nutrients. By slowing flows, dams allow silt to collect on river bottoms and bury habitat for fish spawning and benthic organisms, on which fish feed. Silt trapped above dams may accumulate heavy metals and other pollutants. Gravel, logs and other debris are also typically trapped by dams, making them unavailable for downstream food and habitat.
10. Hydropower dams can kill and injure fish as they pass through turbines, unless adequate screening is installed and maintained. Fish are drawn into power turbines, where they are subject to striking turbine blades and hydraulic shear. Fish are also drawn into diversion channels if not properly screened.
11. Dams can increase risk of predation. Reservoirs, with slower velocity and often warmer water, provide ideal habitat for many naturally occurring predator species. In addition, passage through fish bypass systems and turbines can injure or stun fish, and concentrate them, making them easy prey for avian hunters, such as gulls, herons and eagles.

Methods to Reduce Impacts of Dams on Fish and Aquatic Habitat

While the existence of dams typically alters dramatically the functions of a natural river system, in most circumstances, changes to the operation of the dam can yield significant benefits to fish. Such changes include:

- improved base flows for diversion reaches and below large reservoirs;
- reduced ramping or fluctuation of flows for power peaking;
- installation or improvement of fish passage facilities, including fish screens and ladders to implementing minimum in-stream flow releases;
- regulation of reservoir flow releases to reflect natural water temperature, dissolved oxygen and other water quality parameters; and
- implementation of off-site habitat improvement measures to mitigate for unavoidable losses.

In some cases, dam removal and site restoration may be the most feasible option for reducing fish losses associated with a project. Portland General Electric has announced plans to decommission the Marmot Dam hydroelectric project (includes the Little Sandy Dam). The company has notified the FERC that they will not seek a new license for the project when the current license expires in 2004 (DEQ 2001). Planning for this effort is currently underway.

Artificial Production

Hatchery operations have likely had a number of direct and indirect effects on listed fish species in the Sandy Subbasin. Potentially beneficial influences include supplementation on natural populations that are at critically low levels, and depending on stream size and character, increasing nutrient inputs. One of the principal adverse effects has been genetic changes to populations through extensive inter-basin stock transfers and subsequent inter-breeding between wild and hatchery fish. Fish derived from natural spawning likely have genes originating from non-native stocks. Consequently, the fitness of resulting offspring for successful spawning and survival in the wild may be in question.

Other adverse effects include increased competition between artificially- and naturally-produced juveniles for food and rearing habitat. Usually hatchery fish are larger on release than comparably-aged, naturally-produced fish and thus may have been able to outcompete. Furthermore, larger hatchery juveniles have been able to prey on smaller natural fish. Hatcheries also have been subject to diseases because of the increased density of fish in rearing facilities, and upon release, these fish carry disease to natural stocks. Increased hatchery production also has encouraged increased fishing, potentially resulting in over-fishing.

Adults that enter trapping facilities may incur injury or disease prior to being taken to hatcheries for egg-taking and fertilization, or transport. It is unknown whether this effect is sufficiently adverse to result in reduced spawning fitness, or if any trapped fish that might die has a significant influence on overall reproductive potential of the ESU. Improvements to trapping and handling facilities are currently under study.

Hatchery and Genetic Management Plans (HGMPs) are described in the final salmon and steelhead 4(d) rule (July 10, 2000; 65 FR 42422) as a mechanism for addressing the take of certain listed species that may occur as a result of artificial propagation activities. The NMFS will use the information provided by HGMPs in evaluating impacts on anadromous salmon and steelhead listed under the ESA. Completed HGMPs may also be used for regional fish production and management planning by federal, state, and tribal resource managers. No HGMPs within the Sandy Subbasin have been developed to date.

Existing and Past Efforts

Summary of Past Efforts

Long before any species were listed under the ESA, there have been efforts in the Sandy Subbasin to restore certain aspects of watershed function. Soil erosion, stream channel instability, and riparian function-oriented projects have been underway in the subbasin in different land use sectors using a combination of federal, state, local and privately-led efforts. Improved timber management practices and instream water rights agreements also achieve value for salmon in the long run. Improvements in the scientific understanding of species distribution and needs, watershed management, and techniques for watershed restoration are expected to enhance these on-going efforts for additional benefit to fish and wildlife resources.

The following section describes existing and past efforts undertaken by federal, state, local and private entities in addressing the needs of fish and wildlife resources in the Sandy Subbasin. The challenge for resource managers is to find an appropriate analytical and institutional framework and means to harness this exceptional energy toward comprehensive salmon recovery.

Accomplishments by Year

BPA-funded Projects

Bonneville Ongoing Fish and Wildlife Projects - Sandy River Delta

Two projects are at the Sandy River Delta, and both are in the Sandy and Lower Columbia subbasins. These projects have been funded in 1999, 2000 and 2001.

Project 99-025, Lower Columbia River Wetlands Restoration and Evaluation Program, has the following goals: restore 200 acres of wetland and associated upland habitat, and monitor and evaluate restoration success; convert vegetation on 200 acres from invasive species (reed canary grass) to a more native plant community; convert 10 existing acres of seasonal open water to 25 acres of seasonal open water; convert 55 acres of upland meadow to palustrine emergent wetlands; improve vegetative condition on remaining 120 acres palustrine emergent wetlands; develop a restoration and management model that can be implemented in other Pacific Northwest watersheds; and document the contribution of restored wetlands to biodiversity.

Project 99-026, Sandy River Delta Riparian Restoration, has the following goals: restore a 600-acre block of "gallery" Columbia River bottomland riparian forest (dense, unbroken stands of black cottonwood, willow, and ash).

Programmatic Goals: The Sandy River Delta was historically a wooded, riparian wetland with components of ponds, sloughs, bottomland woodland, oak woodland, prairie, and low and high elevation floodplain. It has been greatly altered by past agricultural practices and the Columbia River hydropower system. Restoration of historic landscape components is a primary goal for this land. The USFS is currently focusing on restoration of riparian forest and wetlands. Restoration of open upland areas (meadow/prairie) would follow substantial completion of the riparian and wetland restoration.

Regional History: The majority of the extensive pre-European settlement wetlands, prairies and riparian forests of the lower Columbia River have been inundated, cleared, diked, drained, farmed and urbanized. The Columbia River hydropower system has significantly decreased the frequency and magnitude of high flow rates (floods). This, in turn, has encouraged the human use of riparian habitats and their destruction. The pre-dam Columbia River floods and pattern of floods were a causal factor associated with creating and maintaining a unique set of wetland, meadow, and riparian habitat conditions in this floodplain. As a result of the hydropower system, wetland, meadow, and riparian forest habitats are becoming increasingly scarce in the region.

Site Significance: The 1,400 acre Sandy River Delta is the last large undeveloped remnant of Columbia River floodplain in the Portland metropolitan area. The potential for wetland, meadow and riparian forest restoration at the Sandy River Delta is very good.

Site History: The Sandy River Delta is an undeveloped, but disturbed site. Before European settlement, the area was largely forested, with some level "prairies", small lakes and wetlands. Beginning in the late 1800s, forests were cleared, grazing was initiated and ditches installed to drain wetlands. Prior to completion if the Columbia River Hydropower System, annual spring floods in the 800,000 cfs range were common. Flows over 1,000,000 cfs were occasionally observed. Now, spring flows rarely exceed 300,000 cfs. As a result, the land is massively altered. The natural disturbance regime was altered by the dam system, and the land has been cleared, drained, diked, grazed, seeded and invaded by undesirable species.

Current Condition: The project area is a former pasture infested with reed canary grass, blackberry and thistle. The limited overstory is native riparian species such as cottonwood and ash. The shrub and herbaceous layers are almost entirely non-native, invasive species. Native species have a difficult time naturally regenerating in the thick, competing reed canary grass, Himalayan blackberry and thistle. A system of drainage ditches installed by past owners drains water from historic wetlands. The original channel of the Sandy River was diked in the 1930s, and the river diverted into the "Little Sandy River." The original river channel has subsequently filled and has largely become a slough.

Management Direction: The completed comprehensive management plan (USFS Sandy River Delta Plan and EIS 1996) envisions wetland, riparian forest, shrub-scrub, upland forest, and upland meadow restoration, with moderate recreation and natural resource interpretation. Riparian forest and wetland restoration were identified as first priorities. The long-term objectives are re-establishment of 600 acres of Columbia River bottomland riparian forest (dense stands of black cottonwood, will and ash), and re-establishment of about 200 wetland acres and associated upland habitat. Breaching of levees and dikes can be considered to restore sloughs and backwater channels (USFS 1995c). Monitoring will evaluate restoration success.

Federal, State, and County Restoration Projects

Some habitat restoration projects have been completed by federal, state and county agencies in the Sandy Subbasin to enhance and restore habitat complexity to degraded streams identified as important spawning and rearing areas. Typically, land management agencies like the USFS and BLM are the principal agencies responsible for designing and completing habitat restoration projects in the subbasin. However, the USFS (Zigzag Ranger District) administers most of the land in the upper Sandy Subbasin, and has proposed and implemented most of the habitat restoration activities in these areas. Table 20 shows some of the major habitat projects completed in the tributaries and mainstem reaches of the subbasin (personal communication, Mark Mouser, Clackamas County, 2001; ODFW 1997).

Table 20. Major habitat projects completed in the Sandy Subbasin

Stream	Habitat Restoration Type	Agency
Upper Sandy River		
Clear Fork	1 step placed in falls; 75 structures placed in 2 miles of stream (primarily large wood)	USFS
Lost Creek	110 structures over 3 miles of stream (primarily large wood and logs)	USFS
Unnamed tributary	Replaced 1 culvert restoring access to 1,056 feet of spawning and rearing habitat	Clackamas County
Salmon River Subbasin		
Lower Mainstem	160 structures placed in 3 miles of stream (primarily large wood)	USFS
South Fork	20 structures placed in 0.5 miles of stream	USFS/BLM
Unnamed tributary	500 feet stream bank stabilization; 2 side channel fish ponds; 8 structures placed	Clackamas County
ZigZag River Basin		
Still and Cool Creeks	990 structures of 9 miles of stream in both streams (primarily large wood and logs)	USFS
Camp Creek	300 structures over 3 miles of stream	USFS
Lady Creek	2 ladders with 10 steps to improve passage	USFS
Lower Sandy River		
Buck Creek	Log steps placed on both sides of culvert at Gordon Creek Road crossing to improve passage.	ODOT
Beaver Creek	Riparian plantings (primarily willows); cooperative effort between ODFW/STEP and the Beaver Creek Corridor Group	

Passage/Connectivity – Road/Stream Crossings

Existing data and reports underrepresented the degree to which connectivity limits fish migration and production within the Sandy Subbasin. Partial fish passage assessments at road/stream crossings have been performed by the USFS, ODFW, USFS, Clackamas and Multnomah Counties. However, assessment methodologies vary considerably, dependent upon agency focus and need. The lack of a consistent, subbasin-wide fish passage barrier inventory inhibits the subbasin's ability to accurately reflect the loss of access to high quality spawning and rearing habitat. To optimize habitat recovery, a coordinated effort is necessary. Many local road authorities have initiated the remediation process of replacing or retrofitting road/stream crossings that are barriers to either juvenile or adult fish passage. Long-term funding remains the limiting factor for most whose primary mission is public safety and the maintenance and operation of the transportation system.

The Oregon Department of Transportation (ODOT 1997) contracted with ODFW to assess and prioritize for repair the culverts associated with state and county roads in the subbasin. Also, Clackamas County's program addresses the restoration of anadromous and resident fish passage through county-owned and maintained culverts (see Present Subbasin Management section). The identified culverts and their priority for repair from these programs are shown in Table 21.

Table 21. Clackamas County and ODOT culverts/priority for repair in the Sandy Subbasin

Road	Road Mile	Stream	Culvert Type	Culvert Length (ft)	Culvert Diam. (in)	Habitat Quality	Priority for Repair
Sandy River Watershed							
Hwy 26	28.3	Beaver Cr	MLPP	216	114	good	high
Bull Run Rd	2.95	Deer Cr	CMP	120	60	fair	high
Hwy 26	31.38	Badger Cr	MLPP	415	90	fair	medium
Hwy 26	27.18	Firwood Cr	CMP	415	90	fair	medium
Dodge Park Rd	0.60	Unamed	PP	63	36 x 2	fair	medium
Bull Run Rd	0.31	Walker Cr	CMP	70	36	fair	medium
Bull Run Rd	1.06	Walker Cr	CCL	102	30	fair	medium
Lusted Rd	5.12	Unnamed	PP	40	48	fair	medium
Baty Rd	0.15	Badger Cr	CMP	29	24	fair	medium
Marmot Rd	7.82	Unnamed	CMP	35	48	fair	medium
McCabe Rd	0.13	Beaver Cr	CMP	65	72	good	medium
Salmon River Watershed							
Hwy 35	57.42	West Fork	CMP	120	72	good	medium
Hwy 35	57.44	West Fork	CMP	120	36	good	medium
Hwy 35	57.78	Salmon R	CMP	120	72	good	high
Zig Zag River Watershed							
Arlie-Mitchelle	0.85	Henry Cr	CMP	75	120	good	high
Hwy 26	53.2	Unnamed Cr to Camp Cr	CCL	120	38	fair	low
Hwy 26	54.57	Still Creek	CCL	150	36	good	medium

Culvert types: MLPP = multiplate pipe; CMP= corrugated metal pipe, CCL = concrete, PP = plastic pipe.
Source: ODOT, 1997; personal communication, Mark Mouser, Clackamas County, 2001.

Multnomah County's program addresses the restoration of anadromous and resident fish passage through county-owned and maintained culverts (see Present Subbasin Management section). The identified culverts and their priority for repair from this program are shown in Table 22.

Table 22. Multnomah County culverts/priority for repair in the Sandy Subbasin

Culvert	Stream/Creek - Mile	Road Name - Milepost	Estimated Cost
Anadromous ESA Listings: Highest Priority			
404-01	Beaver - 2.4	Stark St, SE - MP 1.129	$1,300,000
450-12	Beaver Trib. - 0.6	Division Dr, SE - MP 0.881	$391,085
450-17	Beaver - 3.2	Division Dr, SE - MP 2.109	$120,000
466-02	Beaver Trib. - 1.4	Lusted Rd, SE - MP 0.285	$335,786
493-01	Beaver Trib. - 0.5	282nd Av, SE - MP 0.031	$768,912
450-15	Beaver - 3.2	Division Dr, SE - MP 1.763	$182,000
506-10	Buck - 4.0	Gordon Creek Rd, SE - MP 1.271	$2,300,000
443-08	Kelly - 1.0	257th Av/Kane Dr, SE - MP 2.79	$240,000
458-01	Beaver - 3.3	Cochrane Rd, SE - MP 0.096	$1,000,000
411-09	Beaver - 6.1	302ND Av, SE - MP 2.066	$75,000
402-01	Kelly - 2.0	Division St, SE - MP 0.482	$720,000
489-12	Beaver - 2.0	Troutdale Rd, SE - MP 2.476	$1,300,000
452-18	Beaver - 0.0	Oxbow Dr, SE - MP 1.228	$75,000
452-22	Beaver - 7.6	Oxbow Dr, SE - MP 1.513	$75,000
466-13	Beaver - 8.3	Lusted Rd, SE - MP 3.015	$75,000
489-06	Beaver - 4.6	Troutdale Rd, SE - MP 0.615	$1,733,000
450-13	Beaver - 4.6	Division Dr, SE - MP 0.94	$900,000
		Subtotal	$11,590,783
High Priority			
411-07	Beaver Trib. - 1.0	302ND Av, SE - MP 1.492	$120,000
503-08	Unknown - 0.9	Littlepage Rd, SE - MP 0.421	$276,000
505-11	Pounder - 1.3	Pounder Rd, SE - MP 0.018	$276,000
506-24	Trout - 10.4	Gordon Creek Rd, SE - MP 2.73	$180,000
		Subtotal	$852,000
Middle Priority			
468-01	Beaver Trib. - 1.5	Pipeline Rd, SE - MP 0.1	$360,000
537-01	Smith - 0.2	Christensen Rd, SE - MP 0.745	$276,000
493-04	Kelly - 1.2	282nd Av, SE - MP 0.84	$180,000
		Subtotal	$816,000
Low Priority			
534-02	Buck - 3.0	Deverell Rd, SE - MP 1.879	$276,000
534-11	Buck - 1.0	Deverell Rd, SE - MP 0.248	$276,000
535-01	Smith - 0.3	Northway Rd, SE - MP 0.262	$276,000
520-03	Smith - 1.9	Hurlburt Rd, SE - MP 0.38	$180,000
		Subtotal	$1,008,000

Oregon Watershed Enhancement Board

The OWEB administers funds for the Oregon Plan and the Healthy Streams Partnership. The Oregon Plan emphasizes treating the entire watershed and accountability of state agencies for implementing watershed improvement projects, which will result in a more ecosystem-based management strategy to benefit the watershed. The OWEB estimates that during 1999-2001, over $8 million was allocated to the Willamette Basin, which includes the Sandy Subbasin, split evenly between "capacity" expenditures, such as watershed council support, monitoring, planning and assessments and education and "restoration" expenditures such as land acquisitions, riparian treatment, and passage improvements (Oregon Plan, Annual Progress Report 2001). The OWEB funded the SRBWC's Phase 1 Watershed Assessment and Action Plan efforts, and provides funding for Council support.

Conservation Partnership (NRCS, SWCDs and RC&Ds)

The NRCS and the rest of the conservation partnership use the National Performance and Results Measurement System (PRMS) to report conservation progress on private lands. The PRMS is not complete for SWCDs and other conservation partners to enter all their accomplishments so the following report underestimates total accomplishments of the partnership. Nationally state and local options are being added to PRMS which will improve its capability to capture total accomplishments. During federal FY 2000, over 2,100 acres of resource management systems were planned and almost 1,600 acres applied in the Lower Columbia and Columbia Estuary Subbasins. They benefit fish, wildlife, water quality and overall watershed health by reducing erosion, controlling non point source pollution and restoring riparian and upland wildlife habitat. The PRMS summary for performance items in FY 2000 for the East Multnomah SWCD is shown in Table 23.

Table 23. FY 2000 Performance Items for the East Multnomah County SWCD

Performance Items	Total
Resource Management Systems Planned, acres	70
Resource Management Systems Applied, acres	70
Riparian Forested Buffers, acres	150
Tree and Shrub Establishment, acres	104
Prescribed Grazing, acres	60

Sandy River Basin Watershed Council

The SRBWC developed a Phase 1 Action Plan (1999b) for the Sandy Subbasin that consists of goal statements, issues and opportunities, and specific action items for the five watersheds in the subbasin: the Lower Sandy River, Bull Run/Little Sandy, Sandy River, Salmon River and the ZigZag River (see Existing Goals, Objectives and Strategies section). The Council currently is engaged in the following activities: outreach and information to local residents; recruiting volunteers for projects such as tree planting and removal of invasive plant species; planning habitat restoration projects; and beginning the development of "Friends of the Creek" groups in key parts of the subbasin. This effort will recruit and engage landowners that are interested in implementing habitat restoration projects on their land.

Other Restoration Efforts

The Nature Conservancy owns and manages the 391-acre Sandy River Gorge Preserve. The preserve protects one of the last remaining low elevation old-growth Douglas fir forests in the Pacific Northwest, including trees more than seven feet in diameter and over 500 years old. Also, Metro (the nation's only elected regional government serving Washington, Multnomah, and Clackamas Counties) has acquired 1,045 acres of land in the Sandy River Gorge, including about 370 acres of land in the Gordon Creek watershed. Acquisition of this land ensures a big game corridor ("connectivity") between Larch Mountain and the lower Sandy River, and protection of critical habitat for steelhead, resident trout and salmon. Many other organizations are working on restoration issues in the subbasin including the Mt. Hood Independent Steelheaders, Cascade Geographic Society, NW Steelheaders, and Oregon Trout.

Present Subbasin Management

Existing Management

Federal Government

The Federal Columbia River Power System

For purposes of this Summary, the first management "overlay" of critical interest is the body of federal law, regulation and planning that drives recovery in the Columbia River and its tributaries, including the Sandy Subbasin.

Primary federal management drivers for Columbia River Basin recovery include: the Northwest Power Act, the Fish and Wildlife Coordination Act; the Fish and Wildlife Act; the Flood Control Act; the Water Resources Development Act; the Endangered Species Act; the Clean Water Act; the Federal Power Act; the Migratory Bird Treaty Act; and treaties between the U.S. Government and the federally recognized Indian tribes of the Columbia River Basin. Other drivers in the Sandy Subbasin include the revised statutes of Oregon, Oregon Administrative rules, and the plans and policies of state agencies, including the Oregon Plan for Salmon and Watersheds. The Fish and Wildlife Managers recognized under the Northwest Power Act have established goals and objectives for fish and wildlife management in the Columbia Basin.

Salmon Recovery

The NMFS and the USFWS issued Biological Opinions on the Federal Columbia River Power System in December 2000 delineating "reasonable and prudent actions" (RPAs) that three specific federal agencies must undertake to meet obligations under the federal Endangered Species Act. In response, the three "action" agencies (BPA, USACE, and the Bureau of Reclamation) developed a Draft Endangered Species Act Implementation Plan in July 2001 built around a 5-year timeframe. In addition, the Federal Caucus (a group of nine cooperating federal agencies) have developed a broader Columbia Basinwide Salmon Recovery Strategy to be used by all federal agencies to target actions needed to recover threatened and endangered salmon and steelhead in the Columbia River Basin (Federal Caucus 2000). These efforts are explained in more detail below.

Draft Endangered Species Act Implementation Plan

The Plan is a 5-year blueprint that organizes collective fish recovery actions by the three action agencies. The Plan looks at the full life cycle of the fish - also known as "gravel to gravel" management or an "All-H" approach (Hydro, Habitat, Hatcheries, and Harvest). It does not, however, describe the obligations of other Federal agencies, states, or private parties. It focuses on meeting the biological requirements of listed fish and calls for the development, implementation and testing of strategies for each H and for each species/ESU.

The Action Agencies' priorities for 2002-2006 emphasize short-term benefits and longer term needs consistent with the provisions of both the NMFS and USFWS BOs. Anadromous fish priorities include:

- Adult and juvenile fish passage improvements at dams, including spill and surface bypass.
- Investigation of future flow improvements.
- In tributary rivers, enhancement of flows, riparian areas, passage, and screening.
- In the estuary, acquisition, restoration, and evaluation of habitats.
- Completion of sub-basin assessments and plans
- Implementation of Hatchery Genetic Management Plans and hatchery reforms.

Basinwide Salmon Recovery Strategy

The Strategy sets out actions that can immediately stabilize populations and show results across all salmon life stages. It identifies actions in terms of Habitat, Harvest, Hatcheries, and Hydropower, and commits the federal hydropower system to fund these actions to mitigate for unavoidable mortality in the system. The Strategy (or "All H Paper") places a premium on habitat conservation in tributary areas. For tributary habitats on non-federal lands, the federal agencies propose a "fast start" approach that will first fund action with immediate benefits, including:

- Removing passage barriers.
- Screening diversions.
- Purchasing in-stream flow rights.
- Restoring water quality.
- Protecting high-quality habitat through conservation easements or land purchase (Federal Caucus 2000).

U.S. Forest Service

The USFS, Mt. Hood National Forest, has developed watershed analyses for the Salmon River, ZigZag River, upper Sandy River, Little Sandy River, Bull Run River, and the Sandy River Delta. Watershed analyses is a process under the Northwest Forest Plan, by which the USFS evaluates respective watersheds, located in lands administered by the USFS, to develop sound resource management decisions. Watershed analyses is an important element of the Aquatic Conservation Strategy, as described in the Northwest Forest Plan, which provides direction to maintain and restore the productivity and resiliency of riparian and aquatic ecosystems. Each watershed analysis is a comprehensive description of the history and land use within each watershed. Habitat management objectives are developed to move landscape units from existing to future desired conditions. The USFS has also completed the Upper Sandy and Salmon River Wild and Scenic Rivers plans.

The USFS purchased 1,380 acres at the mouth of the Sandy River in 1991. This Sandy River Delta area was acquired to protect and enhance the natural resource values of the site, particularly the floodplain character and associated wetlands; and to provide for recreation uses compatible with the natural resources of the site. The Columbia River Gorge National Scenic Area Management Plan applies to the Sandy River from its mouth to about RM 6. The high water mark (more or less) is the National Scenic Area boundary on the west side of the river. Between river mile 4 and river mile 6, only the Sandy River is in the National Scenic Area, not the adjacent lands above the high water mark. The first purpose of the National Scenic Area is to protect scenic, natural, cultural and recreation resources. New land uses and developments must be buffered from all streams, wetlands, ponds, lakes and sensitive plant or wildlife sites. The size of the buffers depends on the resource. These protection measures apply to all lands, federal, state, county and private.

Tribal Interests

The Columbia River Intertribal Fish Commission (CRITFC) is the coordinating body of the four Columbia River treaty tribes - the Nez Perce, Umatilla, Warm Springs and Yakima - for management of Columbia Basin anadromous fish resources. The Commission provides technical and professional assistance to its member tribes while working with state and federal agencies, local watershed communities, conservation groups, Native American organizations and other local, regional, national and international entities concerned with restoration and protection of Northwest fisheries. Within the framework of preserving Indian treaty rights, the Commission's primary goal is to rebuild Columbia River salmon and steelhead runs for the benefit of all people in the Pacific Northwest (Oregon Legislative Commission on Indian Services 2001).

The CRITFC has developed a significant body of goals, objectives, actions and recommendations for species and habitat above Bonneville Dam. However, many could be equally applicable to fish and wildlife below Bonneville, including the Sandy Subbasin. These are expressed primarily through Wy-Kan-Ush-Mi Wa-Kish-Wit , the Spirit of the Salmon, the Columbia River Anadromous Fish Restoration Plan. Although specific actions are not identified in Wy-Kan-Ush-Mi Wa-Kish-Wit for the lower Columbia, the CRITFC member tribes maintain an active presence in several forums as related to fisheries management, water quality and public outreach.

Wy-Kan-Ush-Mi Wa-Kish-Wit covers the following fish that spawn in areas above Bonneville Dam: chinook, sockeye, steelhead, coho, and chum salmon; Pacific lamprey; and white sturgeon. The geographic scope of the plan extends to the Columbia River Basin and Pacific Ocean regions where these fish migrate and wherever activities occur that directly affect them. Simply stated, the plan’s purpose is to put fish back in the rivers and protect the watersheds where fish live. The objectives and principles of The Spirit of the Salmon, the Anadromous Fish Restoration Plan of the CRITFC are shown below.

Objectives:

- Halt the decline of salmon, lamprey and sturgeon populations above Bonneville Dam within seven years.
- Rebuild salmon populations to annual run sizes of four million above Bonneville Dam within 25 years in a manner that supports tribal ceremonial, subsistence and commercial harvests.
- Increase lamprey and sturgeon to naturally sustaining levels within 25 years in a manner that supports tribal harvests.
- To achieve these objectives, the plan emphasizes strategies and principles that rely on natural production and healthy river systems.

Principles:

- Adaptive management
- Gravel-to-gravel management
- Put fish back in the rivers
- Protect watersheds where fish live
- [Recognize tribes'] co-management [authority]
- Holistic decision-making

The Plan has 13 technical recommendations, including:

- Begin improving in-channel stream conditions for anadromous fish by improving or eliminating land-use practices that degrade watershed quality.
- Protect and increase in-stream flows by limiting additional consumptive water withdrawals, using the most efficient irrigation methods, preventing soil compaction and riparian vegetation removal and wetland destruction; where necessary, restore soil, restore riparian vegetation and re-create wetlands.
- Actively restore watersheds where salmon populations are in imminent danger of extirpation. Use "Coarse Screening Process" to develop demonstration projects.
- Use supplementation to help rebuild salmon populations at high demographic risk of extirpation.
- Use supplementation to reintroduce salmon to watersheds from which they have been extirpated.
- Use flow, spill, drawdowns, peak efficiency turbine operation, new turbine technology, and predator control projects to improve in-river juvenile salmon survival.
- Improve water quality by eliminating sources of toxic pollution that accumulates in fish tissue and by reducing discharges of other contaminants to meet water quality criteria for anadromous fish.

State

Oregon Department of Fish and Wildlife Management and Operational Plans

The management responsibilities of the ODFW were well-summarized in the John Day Subbasin Summary (ODFW 2001), which is shown below.

The ODFW "is responsible for protecting and enhancing Oregon fish and wildlife and their habitats for present and future generations. Management … is guided by ODFW policies, collaborative efforts with affected tribes, and federal and state legislation. Direction for ODFW fish and wildlife management and habitat protection is based on the amendments and statutes passed by the Oregon Legislature through the 2001 session" as further described in state administrative rules (Table 24). In addition, ODFW has adopted Vision 2006 as a 6-year strategic operational plan and has issued Oregon Guidelines for Timing of In-water Work to Protect Fish and Wildlife Resources (ODFW 1997b).

Fish Management Plans

The ODFW Fish Management Policy requires that management plans be prepared for each basin or management unit. The Sandy Basin Fish Management Plan (ODFW 1997) was developed to direct management of the fish resources of the subbasin, which includes the mainstem Sandy River, its tributaries including the Bull Run Watershed and all lakes and reservoirs in the subbasin. Most of the fisheries information and data for this subbasin summary was taken from the plan. The plan presents a logical, systematic approach to conserving the aquatic resources and establishes management priorities and directs attention to the most critical problems affecting the fisheries resources in the subbasin.

Table 24. Management regulations for the ODFW

OAR 635 Division 07 - Fish Management & Hatchery Operation	Sets policies on general fish management goals, the Natural Production Policy, the Wild Fish Management Policy, and other fish management policies.
OAR 635 Division 008 - Department of Wildlife Lands	Sets management goals for each State Wildlife Area
OAR Divisions 068-071	Sets deer and elk seasons
OAR Division 100 - Wildlife Diversity Plan	Sets wildlife diversity program goals and objectives, identifies species listings, establishes survival guidelines, and creates other wildlife diversity policy.
OAR Division 400 - Instream Water Rights Rules	Provides guidelines for inflow measurement methodologies, establishes processes for applying for instream water rights, and sets forth other instream water rights policies.
OAR Division 415 - Fish and Wildlife Habitat Mitigation Policy	Establishes mitigation requirements and recommendations, outlines mitigation goals and standards, and provides other mitigation guidelines.

The Sandy Plan was developed by the ODFW with the assistance of a public advisory committee and a technical advisory committee. The public advisory committee represents user groups and interested members of the community at large, and served during the planning process as a liaison to other public entities interested in the development and administration of this plan. The technical advisory committee is composed of representatives from federal and state fishery and land management agencies, PGE and the City of Portland.

The steelhead and salmon sections of the plan were originally prepared as part of the Integrated System Plan for Salmon and Steelhead Production in the Columbia River Basin (NWPPC 1990). Those sections have since been modified to fit ODFW's format for basin plans, and to comply with the ODFW's Natural Production and Wild Fish Management Policies (OAR 635-07-521 through 635-07-529).

The plan is responsive to changes in resource conditions and public concerns, and adaptive to new information. Federal concerns and listing of certain fish species under the federal Endangered Species Act may also drive future management of fish stocks native to the Sandy Subbasin. The plan is reviewed every other year to evaluate progress in achieving its objectives, to modify the plan where necessary, and to set priorities for carrying out the plan in the succeeding two years. More information on the Sandy Fish Management Plan can be found in the Existing Goals, Objectives, and Strategies section of this Summary.

Wildlife Plans and Management Programs

The wildlife management objectives for Oregon and the Sandy Subbasin are established by the ODFW, primarily through statute, individual species plans, and programs on sensitive species and wildlife diversity. Overarching statutes and major species program goals and objectives include those for Oregon's Wildlife Diversity Plan, Black Bear Management Plan, Cougar Management Plan, Elk Management Plan, and Migratory Game Bird Program Strategic Management Plan. One of the most significant wildlife management programs in the subbasin is the Wildlife Diversity Program, which has two major purposes: to maintain sustainable native wildlife populations and to provide opportunities for the public's enjoyment of wildlife. More information on the program goals and strategies relating most directly to sustaining native wildlife populations can be found in the Existing Goals, Objectives, and Strategies section of this Summary.

Oregon Department of Environmental Quality

The federal Clean Water Act (CWA) requires each state to undertake specific activities to protect the quality of their rivers, estuaries and lakes. The DEQ is required to develop and implement water quality standards that protect sensitive beneficial uses of waters throughout Oregon. Section 303(d) of the CWA requires each state to develop a list of waters that do not meet the water quality standards. These are called Water Quality Limited waters. The Sandy Subbasin has three streams listed for temperature: the Bull Run River from its mouth to Bull Run Reservoir 2, the Salmon River from its mouth to Boulder Creek, and the Sandy River from its mouth to Marmot Dam (DEQ 2001).

The CWA further requires DEQ to develop Total Maximum Daily Loads (TMDLs) for all water quality limited waters. In general, TMDLs define the maximum amount of controllable impacts a water body can accept and still assure that designated beneficial uses are being adequately protected and water quality standards met. The DEQ completed the fieldwork, including FLIR data and imagery, for the subbasin temperature TMDL during the 2001 field season. A TMDL is expected to be developed in 2002 (DEQ 2001).

Oregon Department of Agriculture

Senate Bill 1010 (passed in 1993 as the Agricultural Water Quality Management Act, ORS 568.900-568.933) gives the ODA authority to develop, implement, and enforce an agricultural water quality management program where required by state or federal law. SB 1010 provides a structure to develop and implement local water quality management plans to prevent and control water pollution resulting from agricultural activities and soil erosion. It directs the Department to work with farmers and ranchers by developing water quality management plans and rules for listed watersheds. The local SWCD serve as the lead management agency for developing and implementing these plans. The Agricultural Water Quality Management Plan for the Sandy Subbasin was completed in May 2001 by the Sandy Subbasin Local Advisory Committee with assistance from ODA and the Clackamas County SWCD.

Local Government

Endangered Species Act and Clean Water Act Activities

Cities and counties in the subbasin are responding to requirements of the federal Endangered Species and Clean Water Acts. Activities include capital improvement projects for water quality improvements, conducting sampling to determine locations of populations of listed species, and undertaking on-the-ground projects to fix culverts, screen diversions, or physically protect or improve habitat areas (often in partnership with watershed councils). Some of the on-going fish and wildlife habitat related activities by local governments are described below.

Metro has adopted “Title 3,” a regional water quality approach to meet land use Goals 6 and 7 through erosion control, floodplain regulations, and identification of water resource management areas. Metro is also working on a new regional planning process for fish and wildlife habitat protection. Through its Regional Parks and Greenspaces Program, Metro has identified and is acquiring some important habitat areas in the lower Sandy River area.

Clackamas County’s Goal 5 program focuses on protection of riparian corridors. The buffer width for structure setback varies by the flow of a stream, ranging from 100 feet for large streams to 50 feet for small streams. Regulations in these areas address building location and footprint, sewage disposal, and vegetation preservation. The county also has adopted a surface water management ordinance.

Clackamas County Fish Passage Program

Clackamas County is currently responsible for over 1,300 culverts in seven subbasins within the county road/stream crossing system. Of these, an estimated 975 are barriers to the passage of anadromous and or resident fish. An estimated 107 of these are in the Sandy Subbasin with an estimated remediation cost of $7.6 million. Barriers are identified using the ODFW Road and Stream Crossing Guide as culverts with more than a 6 inch drop from the downstream end of the culvert, a slope of great than 0.5%, or velocity in the culvert that is greater than 2 cfs. Clackamas County has an active program that addresses the restoration of anadromous and resident fish passage through county-owned and maintained culverts. Using a prioritization tool jointly developed by Clackamas County, NMFS and ODFW (Clackamas County 1999), the county has replaced or retrofitted 46 culverts since 1998 at a cost of $3.3 million.

Multnomah County Fish Passage Program

Multnomah County, with help from the ODFW, has identified a $14 million unfunded need to replace or reconstruct 28 culverts for fish passage in the Sandy Subbasin (see Existing and Past Efforts section). County staff developed a rating system that utilizes a stream habitat assessment at each of the crossings. An in-house database uses multiple habitat measurements, stream temperature data, potential for habitat recovery, length of newly accessed habitat, and project cost to generate rating scores. Final design solutions include a "Stream-passage Design", devised to reclaim natural stream meandering and channel gradient characteristics, and provide a wildlife corridor (to reduce "road kill"). The County has also worked with regional governments and watershed councils in determining subbasin fixes with consolidated inventories and environmental mapping analysis. Multnomah County is promoting the recovery of Beaver Creek in the Sandy Subbasin. The county has prepared GIS maps and an inventory fact sheet with the complete list of culverts and their environmental and financial impacts.

Soil and Water Conservation Districts and Resource Conservation and Development Area Councils

Soil and Water Conservation Districts (SWCD's) are units of state or tribal government that are charged with identifying natural resource problems within their boundaries and offering assistance to resolving them. Guiding this assistance is a board of local leaders who know the people in their communities and who are familiar with conservation needs in the district. Resource Conservation and Development (RC&D) Area Councils are local people, representing local units of government, working together to help improve and sustain local economies, the environment, and standards of living. These groups have development management plans, as listed below.

- Clackamas County Soil & Water Conservation District, July 2000-June 2001 Annual Work Plan
- East Multnomah County Soil & Water Conservation District, July 2000-June 2001 Annual Work Plan
- Cascade Pacific RC&D Area Plan, 1994
- Northwest Oregon RC&D Area, 2000-2001 Plan of Work

- NRCS Lower Willamette Basin Team, Strategic Plan, October 1, 2000-September 30, 2001
- NRCS Oregon, Strategic Plan, October 1999

Organizations

Sandy River Basin Agreement

The Sandy River Basin Agreement is a collaborative project of more than 10 organizations. The partners include the Portland Water Bureau, Mt. Hood National Forest, BLM, NMFS, USFWS, DEQ, ODFW, Clackamas County, Multnomah County, Metro, Oregon Trout, NW Steelheaders, PGE, and the SRBWC. The Agreement partnership involves a Policy Committee and a Technical Team. The two primary products desired as a result of the process are: (1) a basin-wide strategy to enhance federally-listed salmonids in the Sandy River and its tributaries; and (2) context and direction for the City of Portland's Endangered Species Act and CWA compliance plan for the Bull Run water supply system. Work is underway to develop a watershed-based plan that will provide an opportunity for both public and private entities to develop scientifically-based, legally-defensible conservation and enhancement strategies for listed species (DEQ 2001). A plan is expected to be developed in 2002.

The Conservation Partnership

The Conservation Partnership in Oregon is a unique coalition of local, tribal, state, federal groups that mobilizes staff and program funding to help people and communities address natural resource conservation issues. Relying on mixed expertise, authorities, and common sense each member organization brings to the table, the Partnership strives to realize a shared vision - local people making informed decisions for healthy and economically viable lands. The core partnership is made up of NRCS, USDA Farm Services Agency (FSA), USDA Rural Development (RD), the Oregon Soil and Water Conservation Commission, Oregon Association of Conservation Districts, Oregon Associations of Resource Conservation and Development Area Councils, and Oregon Department of Agriculture (ODA). The Partnership is expanded at the local level to include individual soil and water conservation districts, watershed councils, tribes, environmental and user groups, in addition to other federal, state and local agencies needed to fully address resource needs.

Conservation Districts are subdivisions of state or tribal government that are charged with identifying natural resource problems within their boundaries and offering assistance to resolving them. Guiding this assistance is a board of local elected leaders who know the people in their communities and who are familiar with conservation needs in the district. The NRCS works with private land users, units of state and local government, and other federal agencies in planning and implementing conservation systems. This assistance is provided in a partnership effort to help conserve, improve, sustain our natural resources and environment through a locally led, watershed-based, voluntary approach.

Resource Conservation and Development (RC&D) Area Councils are local people, representing local units of government including conservation districts working together to help improve and sustain local economies, the environment, and standards of livings.

Land users, stakeholders, and technical advisors working together formulate watershed health at the local level. This local planning team must realize the best technical information available to evaluate the quality of soils, water, air, plants, and animals, in addition to human factors. This evaluation must include an in-depth look at each resource independently, but should also extend to the relationship and interdependence of the individual resources as a system. The Partnership is committed to the vision of a voluntary, locally led, watershed-based approach to resource management on private land.

Sandy River Basin Watershed Council

The SRBWC was formed in April 1997 and is a group of citizens, government and industry representatives working together to take a pro-active approach in addressing watershed management issues in the Sandy Subbasin. The mission statement of the Council is *"to protect the natural, cultural, and historical resources of the Sandy River Basin Watershed."*

In 1999, the Council prepared a Phase 1 Watershed Assessment for the Sandy River Basin using funding from OWEB and the Portland Water Bureau, as well as using in-kind contributions and cooperation from many state and federal agencies and organizations with interests in the Sandy Subbasin. The report provides an initial scoping-level assessment of the natural and historical conditions in the basin, based upon existing information and data, as well as identifies problem areas and data gaps (SRBWC 1999a).

An Annotated Bibliography also was prepared which compiled existing publications, reports, other documents and data identified to date for the subbasin. These reports provided the technical background used by the Council for developing its basin-wide Phase 1 Action Plan (SRBWC 1999b). The plan identified goals, priority actions, and additional study needs aimed to contribute to and support the long-term integrity of watershed functions, and historic and cultural resource preservation in the subbasin.

Existing Goals, Objectives, and Strategies

Columbia Basin Fish and Wildlife Authority Regional Goals

The basis for the fish and wildlife Managers actions in fulfilling the requirements of the Northwest Power Act derives from a number of statutory and other legal sources, e.g. Fish and Wildlife Coordination Act 16 U.S.C. 661-666c; Fish and Wildlife Act, 16 U.S.C. 742; Endangered Species Act 16 U.S.C. 1531-1543; Federal Power Act §18, 16 U.S.C. 811; Migratory Bird Treaty Act, 16 U.S.C. 703-711; Revised Code of Washington, Titles 75 & 77; and treaties between the U.S. Government and the federally recognized Indian tribes of the Columbia River Basin. The Northwest Power Act did not amend these authorities, nor did the Act delegate the exercise of these authorities to the Council or other bodies. Instead, the Act supplemented these authorities including a focus on "fish and wildlife management coordination and research and development (including funding) …". 16 U.S.C. 839b (h)(2)(C).

Regional Goal, Principles and Objectives

The managers' proposed framework for fish and wildlife recovery starts with a basin-wide goal and principles, which guide fish and wildlife management. Sub-goals and regional objectives for anadromous and resident fish and wildlife provide more specific guidance. This framework includes information gleaned from the Council's Fish and Wildlife Program, Proposed Recovery Plan and Biological Opinions for Endangered Species, Wy-Kan-Ush-Mi Wa-Kish-Wit, and other tribal, state and federal plans and policies. It also responds to the points raised by the Independent Scientific Group in its report, "Return to the River." This section outlines goals and principles, and general strategies to accomplish the goals. More detailed objectives and strategies for each subregion and/or subbasin are outlined in the following sections.

Goal for Columbia Basin Fish and Wildlife Restoration

Restore sustainable, naturally producing fish and wildlife populations to support tribal and nontribal harvest and cultural and economic practices. This goal will be achieved by restoring the biological integrity and the genetic diversity of the Columbia River ecosystem and through other measures that are compatible with naturally producing fish and wildlife populations. This goal is intended to fulfill the nation's and the region's obligations under treaties and executive orders with Northwest Indian tribes, treaties with Canada, and applicable resource protection, restoration and enhancement statutes and regulations.

Regional Principles

General Principle: The scientific foundation of the fish and wildlife managers' Multi-Year Plan views ecosystems as dynamic networks of natural and human factors. While the Columbia River ecosystem can be described and studied, it is a constantly moving target, and opportunities for prediction and manipulation are limited. It is prudent to understand and utilize the natural physical and biological processes that create and maintain productive ecosystems. Species reflect their associated landscapes and ecosystems. Hence, the condition and abundance of desired species reflect the condition of the ecosystem. Technology should be used to foster needed ecosystem attributes rather than replace them.

Specific Principles: This general principle is consistent with three principles identified by the Independent Scientific Group. Fish and wildlife managers have added specific references to anadromous fish, resident fish, and wildlife to the ISG principles.

- Restoration of Columbia River fish and wildlife resources must address the entire natural and cultural ecosystem including upland, riparian, freshwater, estuarine and ocean habitats where appropriate. This consideration includes human developments, as well as natural habitats.
- Sustained natural productivity requires a network of complex and interconnected habitats, which are created, altered and maintained by natural physical processes in uplands, riparian, freshwater, the estuary and the ocean. These diverse and high-quality habitats are crucial for reproduction, rearing, migration, maintenance of food webs and predator avoidance.

- Life history diversity, genetic diversity and meta-population organization are ways fish and wildlife populations adapt to their complex and connected habitats. This bio-diversity and its 2 organization contribute to the ability of fish and wildlife populations to cope with the environmental variation that is typical of terrestrial, freshwater, and saltwater environments. The members of the Columbia Basin Fish and Wildlife Authority agree with these basic tenets of the ISG and have incorporated them into their plan. The fish and wildlife managers have identified three additional principles which they believe are important for restoration activities.
- Salmonid species can function as keystone populations throughout their historic range. For example, the decay of large numbers of salmon carcasses effectively cycle nutrients from the ocean to freshwater ecosystems. Salmon probably had a key role in physically structuring the environment and providing an appreciable food base for terrestrial species. It is important to re-establish the nutrient cycle in those areas still accessible to salmon. The loss of that nutrient cycling in those areas now blocked to anadromous fish must be adjusted for when developing restoration plans.
- Restoration of fish and wildlife resources depends upon managing human impacts to achieve ecosystem conditions that allow natural development of suitable ecosystem functions. Suitable ecosystem conditions can be achieved by managing human impacts to allow natural development of needed characteristics. Technology should be used to foster the development of suitable conditions rather than replace natural functions.
- Salmonids, and other species, can function as indicator species to define desired environmental conditions. In those subbasins still accessible to anadromous fish, salmon are a suitable yardstick for defining normative conditions. In this sense the needs of salmon also describe the majority of needs of a particular assemblage of other native species which, historically, occupied the same freshwater habitat. In areas blocked to anadromous fish, other sensitive native fish and wildlife species such as Kootenai River white sturgeon, bull trout, and bald eagles can serve as indicators of ecosystem condition. We should strive to reestablish and maintain the bio-diversity represented by these historically co-evolved native fish and wildlife species assemblages.

Regional Anadromous Fish Objectives

The Anadromous Fish Managers have chosen some regional objectives, including:

- By 2005, implement actions sufficient to halt the declining trend in salmon and steelhead populations above Bonneville Dam.
- Restore healthy, naturally reproducing populations of salmon in each subregion accessible to salmon. Healthy populations are defined as having an 80 percent probability of maintaining themselves for 200 years at a level that can support harvest rates of at least 30 percent.
- By 2001, obtain the information necessary to manage and restore Pacific lamprey.

- By 2025, increase the total adult salmon and steelhead returns above Bonneville Dam to 5 million annually in a manner that supports tribal and non-tribal harvest.
- Fully mitigate for losses of anadromous fish, resident fish, and wildlife within 200 years.

Regional Resident Fish Sub-Goals and Objectives

The Resident Fish Managers have chosen several sub-goals and objectives to guide resident fish management, including:

- Mitigation efforts to address resident fish losses due to human caused impacts, including the construction and operation of the hydrosystem.
- Substitute lost anadromous populations with resident populations to address the loss of salmon and steelhead in those areas permanently blocked to anadromous fish as a result of the construction and operation of hydroelectric dams.
- Mitigate and compensate for resident and anadromous fish losses caused by the construction and operation of federally-operated and federally-regulated hydro-power projects.
- Ensure the continued persistence, health, and diversity of existing resident fish species by reducing or removing impacts caused by habitat degradation (including water quality, water quantity, and hydropower development), competition and/or hybridization with non-native species, and over-harvest (direct and incidental).
- Restore native resident fish species (subspecies, stocks and populations) to near historic abundance throughout their historic ranges where habitats exist and where habitats can be feasibly restored.
- Maintain and restore healthy ecosystems and watersheds which preserve functional links among biota to ensure the continued persistence, health and diversity of all species including game fish species, non-game fish species, and other organisms.
- Administer and increase opportunities for consumptive and non-consumptive resident fisheries for native, introduced, wild, and hatchery-reared stocks that are compatible with the continued persistence of native resident fish species and their restoration to near historic abundance (includes intensive fisheries within closed or isolated systems).

Regional Wildlife Sub-goal and Objectives

The wildlife sub-goal is to achieve and sustain levels of habitat and species productivity in order to fully mitigate for the wildlife losses that have resulted from the construction and operation of the federal and nonfederal hydroelectric system in the Columbia River Basin.

- Develop mitigation plans that will fully mitigate for wildlife losses.
- Coordinate efforts within the Columbia Basin.
- Ensure that trust/settlement agreements and other mitigation programs demonstrate consistency with mitigation goals, objectives, and methods.
- Track mitigation goals and the gains in habitat units (HU) as a result of implemented mitigation plans.

- Ensure consistent application of Habitat Evaluation Process (HEP) methodology. Ensure baseline HEP estimates are completed as projects come on line.
- Conduct operational loss assessments.
- Develop a monitoring and evaluation plan that measures habitat and species response to management actions.
- Develop policy regarding substitution of habitat types.

Northwest Forest Plan and Aquatic Conservation Strategy

The Northwest Forest Plan was adopted in 1994 and prescribes a comprehensive long-term management approach for nineteen National Forests and six Bureau of Land Management districts in Oregon, Washington, and California. It amended Land and Resource Management Plans for the 19 National Forests and 7 BLM Districts or portions of Districts within the range of the northern spotted owl. The Plan directs management of habitat for late-successional and old-growth forest-related species in a manner that provides for the species long- term health, while also providing for a predictable and sustainable level of timber harvest. The Plan represents a shift to an ecosystem approach that crosses jurisdictional boundaries and puts in place analysis at the watershed scale to support decision-making.

The Plan is implemented at an ecosystem province level through a Regional Interagency Executive Committee, supported by Provincial Interagency Executive Committee, and provincial Public Advisory Committees. An interagency Regional Ecosystem Office provides coordination, monitoring, research and staffing functions to support Plan implementation.

The core components of the Plan conservation strategy are:

- a network of late-successional and other reserves distributed across the landscape;
- an aquatic conservation strategy providing for delineation of riparian reserves and other measures to protect or improve aquatic and riparian habitats; and
- a series of broadly stated standards and guidelines that guide management actions across the planning area.

One of the major components of the Plan is the Aquatic Conservation Strategy. The Aquatic Conservation Strategy was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems on public lands, including salmon and steelhead habitat. The Aquatic Conservation Strategy is designed to meet the following objectives.

Maintain and restore:

- the distribution, diversity, and complexity of watershed and landscape-scale features;
- spatial and temporal connectivity within and between watersheds;
- the physical integrity of the aquatic system;
- water quality necessary to support healthy riparian, aquatic, and wetland ecosystems;

- the sediment regime under which an aquatic ecosystem evolved;
- in stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing;
- the timing, variability, and duration of flood plain inundation and water table elevation in meadows and wetlands;
- the species composition and structural diversity of plant communities in riparian zones and wetlands; and
- habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.

The components of the Aquatic Conservation Strategy are Riparian Reserves, Key Watersheds, Watershed Analysis, and Watershed Restoration. Riparian reserves provide habitat for Special Status Species and other terrestrial species. Riparian management widths are intended to provide a high level of fish, wildlife and plant habitat, and riparian protection until watershed and site analysis can be completed. A system of Key Watersheds offers critical refugia is for conserving habitat for at-risk stocks of anadromous and resident fish. These refugia include areas of high quality habitat (to serve as recovery anchors) and areas of degraded habitat (to become future habitat). Watershed analyses support ecosystem management at approximately the 20 to 200 square mile watershed level. Watershed analysis focuses on collecting information within the watershed to inform project-specific proposals, and determining monitoring and restoration needs.

Watershed restoration aids recovery of fish habitat, riparian habitat, and water quality. The most important components of a watershed restoration program are control and prevention of road-related runoff and sediment production, restoration of the condition of riparian vegetation, and restoration of in-stream habitat complexity.

ODFW Fish Habitat Management

A long-term goal for fish habitat management in the Sandy Subbasin (ODFW 1997) is to restore and maintain natural aquatic function to the riverine environment so wild fish populations can naturally rebuild to healthy sustainable levels. This long-term goal recognizes that complete habitat recovery is impossible in some areas due to established allocation of land and water to other uses that conflict with restoring optimal fish habitat.

The short-term goal for managing fish habitat in the Sandy Subbasin (ODFW 1997) is to restore aquatic habitat diversity, complexity, and function to meet the natural production capability of fish populations where possible. Goals and actions include:

1. Restoring in-stream fish habitat complexity and diversity in tributaries and mainstem reaches where losses have occurred.
2. Ensuring that riparian zones in the basin are managed in a way that allows natural function of riparian systems to be restored to provide the aquatic environment with shade and natural large wood components.
3. Re-opening reaches of the basin, where possible, that historically provided migratory fish with spawning and rearing areas including side-channel habitat and areas above diversion dams.

4. Decreasing human related sediment input into the waterway caused by road building, logging, nursery stock production and urbanization.
5. Maintaining water quality including natural water temperatures and flows.
6. Restoring natural flow conditions where possible.
7. Ensuring municipal and hydropower water management activities comply with all pertinent federal and state laws, policies and rules.

Management Direction

Goal: Protect, restore, and improve fish habitat throughout the basin to improve healthy native fish populations that provide ecological function and diversity to the Sandy watershed, and greatly benefit people in the region.

Objective 1 Maintain and improve upstream and downstream passage for fish in the Sandy River basin at dams, water diversions, existing fishways, culverts and, where needed, at in-channel debris jams.

Action 1.1 Under agreement with FERC license #477, ensure that PGE maintains upstream adult passage and downstream juvenile passage at Marmot Dam.

Action 1.2. Prior to renewal of FERC license #477, begin immediate discussion with PGE and NMFS to make a final evaluation and recommendation on necessary improvements of the rotating screens and downstream fish bypass system at Marmot Dam to ensure compliance with ODFW operational criteria. FERC re-licensing for the facility is in 2004. All migratory fish stocks need to be considered in the decision making process.

Action 1.3 Under agreement with FERC license #477, ensure that PGE maintains the newly upgraded counting facility at Marmot Dam to provide ODFW and the public reliable daily fish counts.

Action 1.4 Develop a list of culvert sites in fish bearing streams in the basin, including the Bull Run basin, and determine if they provide adequate passage to upstream and downstream salmonid migrants and other nongame fish like lampreys, sculpins, and cyprinids. The list should provide the name of the managing agency or responsible party. In addition, evaluate culverts to assess their potential for failure during peak flow events, and improve the culverts before they affect fish passage due to such a failure.

Action 1.5 Develop a list of culvert sites in fish bearing streams in the basin; if a culvert is determined to not provide adequate passage, coordinate with the responsible agency or owner to improve the passage problem.

Action 1.6 Work with Multnomah County to resolve the culvert passage problem on Buck Creek near its confluence with the Sandy River near RM 13.

Action 1.7 Determine if migratory fish are capable of ascending the newly structured channel at the mouth of Buck Creek. Assess passage in consideration of all life history stages.

Action 1.8	If Multnomah County determines that the culvert at Buck Creek needs replacement, recommend that it be replaced with either a bridge or a culvert of open bottom arch design.
Action 1.9	Coordinate with Multnomah and Clackamas Counties to determine replacement schedules for county owned and maintained culverts in streams of the Sandy basin. When culverts are replaced, ensure that fish passage for migratory fish at all life histories are considered.
Action 1.10	Work with all entities involved in road construction and ensure adequate passage for migratory fish is provided at all new stream and river crossings. Upstream and downstream passage needs for both juvenile and adult life history types needs consideration.
Action 1.11	Ensure that adequate passage is provided at the debris jam in Gordon Creek at RM 0.5. Make an annual site inspection each summer before anadromous fish begin upstream migrations in fall and winter.
Action 1.12	Evaluate passage concerns for migratory salmonids at the Sandy Hatchery diversion dam on Cedar Creek. Issues include funding maintenance of the existing ladder, disease introductions above the diversion dam and potential consequences of fish loss in the hatchery, and habitat quality in the basin above the dam.
Action 1.13	Prior to any FERC re-licensing effort, conduct a stream habitat inventory of the affected streams consistent with current ODFW inventory standards, and determine factors that may limit natural production capacity of wild fish including the species that historically used these streams. Note that the Marmot Dam and Little Sandy project are up for re-licensing in 2004, and hydropower projects in the Bull Run River are up for re-licensing in 2029.
Action 1.14	Prior to FERC re-licensing of any project in the Sandy basin, reassess all lost native resident and anadromous fish production lost as a result of the construction and function of these migrational barriers and develop mitigation agreements in consideration of all affected species.
Action 1.15	Estimate lost fish production for all native salmonid species in the basin caused by an artificial migrational barrier including the Little Sandy Diversion Dam, the Bull Run dams, the hatchery diversion dam on Cedar Creek, the city of Corbett's municipal water supply diversion dam on Gordon Creek, any other in-stream diversion structure, and identified problem culverts in fish bearing streams in the entire basin.
Action 1.16	Coordinate with pertinent agencies to ensure design of in-stream habitat enhancement structures do not impede upstream or downstream passage of adult or juvenile migratory fish.
Action 1.17	Coordinate with the USFS and the BLM to identify additional side channel habitat artificially blocked by human activities that could potentially be reopened and reconnected to the watershed.
Action 1.18	Review and comment on new fish passage structures constructed in the Sandy basin, and require appropriate standard designs to accommodate passage of fish at all life history phases.

Action 1.19	Work with landowners to ensure that appropriately sized culverts and bridges are properly installed on streams on private property.

Objective 2 Protect, enhance, and restore fish habitat in the Sandy River basin.

Action 2.1	Continue to restore in-stream habitat and riparian zones in degraded reaches of the Sandy River basin, and in the Bull Run basin where possible, through application of approved stream enhancement techniques. Restoration objectives should include increasing the large wood component in appropriate reaches, increasing habitat complexity, increasing pool habitat types in channelized areas, recruitment of spawning gravels, maintenance or replacement of riparian native vegetation, allowing beaver to utilize historic ranges in the watershed, restoring and/or maintaining passage at culverts and other manmade obstacles, and reduction of human caused siltation.
Action 2.2	When planning habitat improvement projects, especially full spanning structures, consider size differences and jumping capability of different fish species for all life-history types to ensure fish movement into, around or through project areas.
Action 2.3	Design habitat projects based on surveys of physical and biological surveys, limiting factors analysis, seasonal habitat requirements of the species intended to benefit from the project, and production capacity assessment of habitat in the basin. Comply with ODFW's Aquatic Habitat Inventory standards and current understanding of seasonal habitat requirements for each species.
Action 2.4	Coordinate with the pertinent land management agencies (i.e. USFS and BLM etc.) to develop an effective monitoring plan to evaluate habitat restoration projects in the basin.
Action 2.5	Support the USFS effort to study the potential for restoration and improvement of spawning and rearing habitat in the lower 6 mile mainstem reach of the Bull Run River from the confluence with the Sandy River upstream to the Headworks Dam (RM 6). Coordinate with the City of Portland, USFS, PGE and other stakeholders to assess the practicality and potential for such a project.
Action 2.6	Support, promote and encourage the establishment of Watershed Councils and Friends of Stream Groups throughout the Sandy basin. Host coordination meetings when needed or requested. Consult with known stream protection organizations in the region for information on successes and failures.
Action 2.7	ODFW will participate in cooperative partnerships with private landowners to identify and complete fish habitat enhancement projects in areas that are a priority to watershed function and fish productivity.
Action 2.8	Encourage, support, and provide assistance for local school projects aimed at assessing stream habitat conditions in basin tributaries. Begin developing a data exchange system where local schools could provide

ODFW with biological information needed in making management decisions, and ODFW could supplement trend information maintained at these schools for continued educational purposes.

Action 2.9 Coordinate with the appropriate hatchery managers to provide surplus salmon carcasses for distribution into specific streams of the basin to enhance nutrient availability. Coordinate with the USFS and the BLM to identify key tributaries in the upper basin where salmon carcass distribution would provide the greatest benefit to the fish resource, and the least conflict to property owners.

Action 2.10 Coordinate with DEQ and any other pertinent regulatory agency to secure any necessary permit required to conduct such an activity.

Action 2.11 Coordinate with the USFS to monitor the salmon carcass distribution program.

Objective 3 Inventory stream and watershed conditions using current methods to assess factors limiting fish production in the Sandy River basin.

Action 3.1 Complete fish distribution (presence and absence) surveys within the entire basin to guide habitat protection and restoration activities. A priority will be placed on securing funding for these actions on private lands.

Action 3.2 Conduct physical and biological surveys of riparian habitat, in-stream structure, spawning gravels and geomorphological characteristics. Conduct stream habitat surveys in stream reaches that have not been surveyed in recent years.

Action 3.3 Conduct stream habitat inventories in areas that have recently been altered or enhanced to assess current productivity potential in these reaches.

Action 3.4 Coordinate with the USFS and City of Portland to conduct stream habitat inventories in pristine stream reaches of the Bull Run watershed to measure levels of stream habitat complexity historically common to the entire basin.

Action 3.5 Implement future stream habitat restoration projects in the basin to reflect natural habitat composition as measured in streams of the Bull Run subbasin or other streams in neighboring wilderness areas that have not been impacted by human activities.

Objective 4 Reduce artificial introductions of sediment into the Sandy River and basin tributaries.

Action 4.1 Identify standardized methods to measure and monitor sedimentation rates in the basin.

Action 4.2 Coordinate with other resource agencies, local schools or Watershed Councils to monitor artificially caused sediment loading in the basin, particularly Beaver Creek.

Action 4.3	Ensure timber harvest practices on both private and public lands comply with current laws, rules and policies by timely review and comment on proposed management activities.
Action 4.4	Continue to coordinate with the USFS and BLM to identify potential road closures on public land in the upper basin, and recommend ripping and reseeding old road surfaces where options allow.
Action 4.5	Continue to make recommendations to correct road system problems that contribute to increased erosion and sedimentation of waterways.
Action 4.6	Coordinate with the appropriate land management agencies to develop a table that identifies significant mass land failures in the basin and their causes (i.e. roads, logging, urbanization, etc.) to prevent or reduce these occurrences in the basin.
Action 4.7	Coordinate volunteers individually or through "Friends of Streams" groups to plant native riparian vegetation in degraded streams in the basin to reduce stream bank erosion. This is currently underway in Beaver Creek through cooperation between STEP and the Beaver Creek Corridor Committee.
Action 4.8	Continue to ensure that all in-stream work projects in the basin comply with current Fill and Removal and Essential Salmonid Habitat laws and policies.

Objective 5 **Restore natural streamflows where possible, and protect existing streamflows and water quality from degradation associated with operation of dams, water diversions, effluents, mining, timber harvest, recreation, and other in-stream activities.**

Action 5.1	Continue to assess operational impacts of existing dams, diversions, fish ladders, and juvenile bypass facilities on fish passage and natural production, and advise pertinent agencies on ways to minimize impacts on fish.
Action 5.2	Continue to participate with FERC in reviewing permit applications for new and existing hydroelectric development in the basin.
Action 5.3	Coordinate with other agencies (i.e., WRD and DEQ) to improve water quality. Support and participate in interagency efforts to increase monitoring of water quality and pollutants in the Sandy Basin.
Action 5.4	Require PGE to continue complying with the following current minimum flow agreement for flows below Marmot Dam: June 16 through October 15 - 200 cfs; October 16 through October 31 - 400 cfs; and November 1 through June 15 - 460 cfs.
Action 5.5	ODFW will be involved in any plans for a new reservoir in the Bull Run Reserve and will provide recommendations for minimum stream flows in the lower Bull Run River if a new reservoir is built.
Action 5.6	ODFW will continue to observe stream flows in the lower Sandy River as they relate to the Diack Decision.

Action 5.7	Ensure lake levels in the Bull Run Lake are adequate to maintain passage for cutthroat trout to migrate into important spawning streams that feed into the lake. Coordinate with the USFS and the City of Portland to monitor lake level effects on the resident cutthroat trout population in the lake.
Action 5.8	Place thermographs at appropriate sites in the basin to monitor water temperature differences that may affect natural fish population dynamics in the basin. Sites to consider include 1) the mainstem immediately above Marmot Dam, 2) the confluence with the Bull Run and Sandy Rivers both in the Sandy River above and below the confluence, and in the Bull Run River, and 3) in the Bull Run River above the PGE Powerhouse (RM 1.5).

ODFW Wildlife Management

Oregon Wildlife Policy

The Oregon Legislature establishes broad authority and policy direction for the ODFW, including the Wildlife Diversity Program. All subsequent policies and administrative rules (e.g., mission, goals, objectives) stem from this state law; ORS 496.012 states:

"It is the policy of the State of Oregon that wildlife shall be managed to prevent the serious depletion of any indigenous species and to provide the optimum recreational and aesthetic benefits for present and future generations of the citizens of this state." In furtherance of this policy, the Commission shall implement the following co-equal goals of wildlife management:

- To maintain all species of wildlife at optimum levels.
- To develop and manage the lands and waters of this state in a manner that will enhance the production and public enjoyment of wildlife.
- To permit an orderly and equitable utilization of available wildlife.
- To develop and maintain public access to the lands and waters of the state and the wildlife resources thereon.
- To regulate wildlife populations and the public enjoyment of wildlife in a manner that is compatible with primary uses of the lands and waters of the state."

Wildlife Diversity Program Goal and Objectives

The goal and objectives that follow provide the framework and overall direction for the Wildlife Diversity Program as well as other agency programs in order to carry out the State Wildlife Policy and the Department Mission. These are adopted by the Commission by administrative rule (OAR 635-100-0010, 635-100-0015). Strategies and sub-strategies identify *how* the objectives, and ultimately the goal, are to be achieved. Specific actions and tasks for each sub-strategy are identified in the Operational Schedule (Part IV of the Plan), which is reviewed and updated annually by ODFW staff.

Goal: To maintain Oregon's wildlife diversity by protecting and enhancing populations and habitats of native wildlife at self-sustaining levels throughout natural geographic ranges.

Objective 1 Assess, conserve and enhance wildlife habitats.

Strategy 1.1 Habitat Inventory and Monitoring: identify and monitor habitats needed to maintain Oregon's wildlife diversity.

Sub-strategy 1.1.a Determine quantity, distribution and condition of dominant plant communities and major habitat elements on a basin, physiographic province (ecoregional) and statewide basis.

Sub-strategy 1.1.b Identify priority habitats of concern and their ecological relationships to native species.

Sub-strategy 1.1.c Monitor changes and trends in habitats on a basin, physiographic province (ecoregional) and statewide basis, with emphasis on priority habitats.

Strategy 1.2 Habitat Conservation and Management: identify and implement habitat conservation and management actions needed to maintain Oregon's wildlife diversity.

Sub-strategy 1.2.a Identify conservation, restoration and management needs and opportunities for priority habitats.

Sub-strategy 1.2.b Take actions to conserve, restore, enhance or acquire important habitat areas.

Sub-strategy 1.2.c Promote land use patterns and management practices that conserve, restore and enhance habitats needed to maintain wildlife diversity.

Sub-strategy 1.2.d Provide technical information and support to landowners, land managers and local governmental agencies regarding habitat protection, restoration and enhancement.

Sub-strategy 1.2.e Develop incentives and recognition programs to assist in the conservation, restoration and enhancement of habitats on private lands.

Objective 2 Assess, conserve and enhance populations of native species at self-sustaining levels throughout their natural geographic ranges.

Strategy 2.1 Species and Population Status Surveys and Monitoring: determine the status of species, populations, and groups of species, and monitor them on a regular basis for appraising the need for management actions, the results of such actions, and for evaluating other environmental changes.

Sub-strategy 2.1.a	Maintain listings of species, populations, and distinct smaller groups that are, or could be, facing extinction or extirpation in Oregon using such categories as: endangered, threatened, and sensitive.
Sub-strategy 2.1.b	Determine the status of poorly known species or populations.
Sub-strategy 2.1.c	Conduct research to address incomplete information on the taxonomic status of species.
Sub-strategy 2.1.d	Maintain listings of species, populations, groups of species, or distinct smaller groups requiring special attention.
Sub-strategy 2.1.e	Monitor populations of endangered, threatened and sensitive species and populations of other species requiring special management attention.
Sub-strategy 2.1.f	Develop and establish cooperative survey and monitoring protocols for priority species lacking such procedures.
Sub-strategy 2.1.g	Monitor populations of common species.
Sub-strategy 2.1.h	Record verified unusual sightings of rare or unusual wildlife occurrences.

Strategy 2.2 Species Conservation and Management: identify, establish and implement management measures necessary for restoring threatened and endangered species; preventing sensitive species from qualifying as threatened or endangered; and maintaining or enhancing other species requiring special attention.

Sub-strategy 2.2.a	Conduct research to address incomplete information on species' habitat requirements, limiting factors, population demographics, and effectiveness of species conservation and management programs.
Sub-strategy 2.2.b	Identify measures needed to protect, restore, maintain or enhance populations of threatened, endangered and sensitive species, and other requiring special attention. Populations, additional measures will need to be identified.
Sub-strategy 2.2.c	Plan and implement measures needed to protect, restore, maintain or enhance populations of threatened, endangered and sensitive species, and others requiring special attention.
Sub-strategy 2.2.d	Reintroduce native species or populations where they have been severely depleted or extirpated as may be biologically feasible and ecologically valid.
Sub-strategy 2.2.e	Provide technical information and support to landowners, land managers and local governmental agencies on species protection, restoration and enhancement.
Sub-strategy 2.2.f	Promote conservation of species populations and related ecosystems through state and local governmental agencies, landowners, land managers and the public.

Objective 3 Provide recreational, educational, aesthetic, scientific, economic and cultural benefits derived from Oregon's diversity of wildlife.

Strategy 3.1 Public Awareness and Outreach: foster broad public awareness and understanding of wildlife benefits and conservation issues and needs in Oregon.

Sub-strategy 3.1.a Identify opportunities and implement activities that promote the values of wildlife, habitat conservation, conservation ethics, and ODFW's mission.

Sub-strategy 3.1.b Identify opportunities and implement activities that showcase Wildlife Diversity Program activities.

Sub-strategy 3.1.c Identify important wildlife conservation issues and ways of providing information about them to the public.

Sub-strategy 3.1.d Provide science-based wildlife information to the public and the media both upon request and proactively.

Sub-strategy 3.1.e Keep Program supporters and other members of the public informed about the direction, progress, accomplishments, and funding of the Wildlife Diversity Program, and solicit their opinions and input.

Sub-strategy 3.1.f Broaden support for the Wildlife Diversity Program by reaching out to new potential constituents.

Strategy 3.2 Wildlife Education: provide wildlife information to educators and the public.

Sub-strategy 3.2.a Identify wildlife information, curricular and training needs of formal and non-formal educators, and develop and implement programs that meet those needs.

Sub-strategy 3.2.b Identify the public's need for wildlife information and develop and Implement programs that meet those needs.

Sub-strategy 3.2.c Develop and implement programs and materials that encourage lifestyles that foster stewardship for wildlife and their habitats.

Sub-strategy 3.2.d Develop opportunities for the public to volunteer for wildlife-related projects and provide experiences that encourage people to become lifetime stewards of wildlife resources.

Sub-strategy 3.2.e Seek out and develop partnerships with agencies, organizations, businesses, schools, communities and landowners where collaboration will result in wildlife-oriented educational experiences and opportunities.

Sub-strategy 3.2.f Provide hunters, anglers, canoeists, hikers, equestrian, and other outdoor enthusiasts with wildlife information that will enhance their outdoor experiences.

Strategy 3.3 Public Wildlife Experiences: increase or enhance opportunities for the public to enjoy and learn about wildlife in the out-of-doors through "Watchable Wildlife" activities, without compromising biological objectives.

Sub-strategy 3.3.a Identify opportunities for wildlife viewing and other outdoor wildlife-oriented activities, and measures that can be taken to provide such activities.

Sub-strategy 3.3.b Implement measures that provide wildlife viewing and other wildlife-oriented recreational opportunities.

Sub-strategy 3.3.c Provide resources and expertise to other agencies, organizations, businesses, communities and landowners who wish to provide wildlife-oriented recreational experiences and opportunities.

Sub-strategy 3.3.d Provide wildlife-viewing and other wildlife-oriented recreational skills development opportunities for the public, in order to enhance their enjoyment of, and responsible participation in, those activities.

Sub-strategy 3.3.e Conduct research on the potential impacts of recreational activities on wildlife and their habitats. Apply those results, and those of other researchers, and share them with cooperators and other providers of outdoor wildlife experiences.

Sub-strategy 3.3.f Monitor the impacts of recreational activities on wildlife and their habitats and modify those activities as necessary.

Objective 4 Minimize adverse biological, social and economic impacts resulting from interactions between people and wildlife.

Strategy 4.1 Law Enforcement: support enforcement of federal, state and local wildlife and wildlife habitat conservation laws.

Sub-strategy 4.1.a Support law enforcement by the Oregon State Police, Fish and Wildlife Unit, through funding, program cooperation and training.

Sub-strategy 4.1.b Cooperate with federal wildlife enforcement officials, and with local law enforcement officers to ensure compliance with laws affecting region's native wildlife species and habitats.

Strategy 4.2 Permits: regulate and monitor a variety of permit activities affecting wildlife.

Sub-strategy 4.2.a Administer the Wildlife Scientific Taking Permits Program so that educators and researchers can collect native wildlife without compromising Program Objectives.

Sub-strategy 4.2.b Maintain a program of licensed Wildlife Rehabilitators to assist the public and the Department, and to ensure quality care.

Sub-strategy 4.2.c Administer the Wildlife Integrity Program in order to protect Oregon's native species and their habitats from potential threats of non-native species.

Sub-strategy 4.2.d Administer Wildlife Holding and other miscellaneous permits.

Sub-strategy 4.2.e Provide biological information to the Falconry Program for the establishment of raptor-capture and other regulations.

Strategy 4.3 Damage and Nuisance: help address nongame property damage and nuisance problems without compromising wildlife objectives, using education and self-help in place of landowner assistance wherever possible.

Sub-strategy 4.3.a Develop brochures and other materials that provide information for homeowners and landowners who are experiencing damage or nuisance problems.

Sub-strategy 4.3.b Work with local companies and organizations that offer wildlife nuisance and damage assistance or advice to the public to insure that the most appropriate response and information is provided.

Objective 5 Provide financial and human resources for program planning, administration, implementation and evaluation.

Strategy 5.1 Program Planning: maintain an active planning and evaluation program to keep the *Oregon Wildlife Diversity Plan* current and effective.

Sub-strategy 5.1.a Review and update the *Oregon Wildlife Diversity Plan*, with agency and public input.

Sub-strategy 5.1.b Develop a five-year Operational Schedule for implementation of the Plan.

Sub-strategy 5.1.c Assess public needs, values and expectations on a regular basis.

Sub-strategy 5.1.d Monitor implementation of the Operational Schedule and assess progress on an annual basis.

Sub-strategy 5.1.e Evaluate agency laws, authorities, rules, and cooperative agreements and their ability and effectiveness in addressing conservation needs; seek new authorities and partnerships as needed.

Sub-strategy 5.1.f Begin assessing implications of human population growth on wildlife and their habitats, and establish short-term (10-25 year) and long-term (25-50-year) Program benchmarks for conservation, education and recreation.

Strategy 5.2 Internal Program Integration and Implementation: integrate the Wildlife Diversity Program's Goal, Objectives, and other plan elements throughout the Department's other administrative units.

- Sub-strategy 5.2.a Work closely with Department divisions, programs and field offices to develop and implement the *Oregon Wildlife Diversity Plan* and Operational Schedule to ensure Wildlife Diversity Program Objectives are collectively achieved.
- Sub-strategy 5.2.b Keep the Commission and other Department staff informed of Program progress, planning activities, problems, needs and accomplishments.

Strategy 5.3 Evaluation: Regularly evaluate Program efforts to determine outcomes, effectiveness and how well Objectives are being met.

- Sub-strategy 5.3.a Evaluate effectiveness of conservation, restoration and enhancement programs, and modify those programs as needed using adaptive management principles.
- Sub-strategy 5.3.b Evaluate the effectiveness of public awareness, outreach, education and recreation efforts.
- Sub-strategy 5.3.c Assess the economic benefits and costs associated with wildlife diversity recreation program activities.

Strategy 5.4 Information Systems and Data Management: establish and maintain information management systems for the continuous recording, storage, and retrieval of information.

- Sub-strategy 5.4.a Maintain a species/habitat information management system to assure continuous recording, storage, and retrieval of inventory, monitoring, and research data required for species conservation.
- Sub-strategy 5.4.b Make habitat/species information available to cooperators and the public.

Strategy 5.5 Funding: ensure adequate funding to conserve the wildlife diversity of Oregon and to meet wildlife education/recreation needs of the public.

- Sub-strategy 5.5.a Maintain and increase state funding sources.
- Sub-strategy 5.5.b Promote the Oregon Nongame Tax Checkoff.
- Sub-strategy 5.5.c Seek cooperative funding with federal and state agency partners.
- Sub-strategy 5.5.d Seek *Teaming with Wildlife* or other Congressionally-approved funding for Wildlife Diversity Program activities.
- Sub-strategy 5.5.e Seek other funding sources including private individual and corporate donations, and other ways in which people who do not hunt or fish can support the Wildlife Diversity Program.

Sub-strategy 5.5.f Seek funding from the Oregon Wildlife Heritage Foundation and other private foundations and institutions which can provide financial assistance to the Wildlife Diversity Program.

Sub-strategy 5.5.g Maintain a grants/contracts program to support projects and activities at state/local levels to help achieve Objectives.

Strategy 5.6 Human Resources and Training: Establish and maintain qualified, well-trained, and well-equipped staff and volunteers.

Sub-strategy 5.6.a Conduct an assessment of personnel, facilities, support services and equipment necessary to implement the Wildlife Diversity Program at state and local levels.

Sub-strategy 5.6.b Staff and equip the Program at state/local levels to carry out laws, administrative rules and meet Objectives.

Sub-strategy 5.6.c Maintain an active volunteer program to assist in achieving Program Objectives.

Sub-strategy 5.6.d Support an active agency personnel and volunteer training to maximize the efficiency/effectiveness of the Program.

Sub-strategy 5.6.e Maintain and expand annual recognition and awards programs for cooperators, citizens and volunteers.

Wildlife Diversity Program Priorities for 1999-2004

The Wildlife Diversity Program has two major purposes: to maintain sustainable native wildlife populations and to provide opportunities for the public's enjoyment of wildlife. The latter cannot exist without the former. While the intent is to carry out all strategies and sub-strategies presented in this plan, priorities must be established for purposes of program planning and direction, budget allocation, and staffing. Program priorities are presented below in three categories: biological, public assistance, and administrative.

BIOLOGICAL	PUBLIC ASSISTANCE	ADMINISTRATIVE
	HIGH	
Priority Habitats Conservation	Public Awareness, Outreach and Information	Funding
Endemic Endangered, Threatened and Sensitive Species Conservation		Information Management
Nonendemic Endangered, Threatened and Sensitive Species Conservation	Wildlife Recreation Experiences (Watchable Wildlife)	
Secure Endemic Species Conservation	Wildlife Education	Human Resources Development and Training
	MEDIUM	
Widespread and Common Habitats Conservation		Program Planning and Evaluation
Widespread Species (Secure Nonendemics) Conservation		Law Enforcement
	LOW	
Extirpated Species Reintroduction	Nongame Nuisance and Damage Complaints	Permits
	Wildlife Rehabilitation and Spill Response	

Oregon's Comprehensive Land Use Planning Program

Oregon's Land Use Planning Program was established in 1973 and requires 277 city and county governments in Oregon to plan and zone land use consistent with 19 Statewide Planning Goals. The Department of Land Conservation and Development administers the program and reviews the consistency of local plans with the statewide goals. Two of the 19 goals directly address activities affecting fish and wildlife - Goals 5 and 6:

- Goal 5: Open Spaces, Scenic and Historic Areas and Natural Resources. Goal 5 covers more than a dozen natural and cultural resources such as wildlife habitats and wetlands. It establishes a process for each resource to be inventoried and evaluated. If a resource or site is found to be significant, a local government has three policy choices: preserve the resource, allow proposed uses that conflict with it, or strike some sort of balance between the resource and the uses that conflict.

Goal 5 generally does not require local governments to develop new inventories, allowing them to rely instead on existing information.

- Goal 6: Air, Water, and Land Resources Quality. This goal requires local comprehensive plans and implementing measures to be consistent with state and federal regulations on matters such as groundwater pollution.

According to state regulations, local governments must adopt programs to protect natural resources and conserve scenic, historic, and open space resources for present and future generations. Resources that must be inventoried include:

- Riparian corridors, including water and riparian areas and fish habitat.
- Wetlands
- Wildlife habitat
- Federal Wild and Scenic rivers
- State scenic waterways
- Groundwater resources
- Natural areas

Local governments must identify which of these are significant and then develop programs according to state-issued planning guidelines, which include the following:

- "Natural resources….should be conserved and protected…."
- "Fish and wildlife areas and habitats should be protected and managed in accordance with the Oregon Fish and Wildlife Commission's fish and wildlife management plans."
- "Stream flow and water levels should be protected and managed at a level adequate for fish, wildlife, pollution abatement, recreation, aesthetics, and agriculture."
- "Plans should provide for the preservation of natural areas consistent with an inventory of scientific, educational, ecological, and recreational needs for significant natural areas."

Therefore, there is a mosaic of local and legally-binding plans that are required to address fish and wildlife habitat in some fashion. Most counties have ordinances addressing riparian setbacks and several counties have limits on vegetation removal which typically prohibit the removal of more than 25% of the vegetation within the riparian area on a given property.

Oregon Conservation Partnerships

These fish and wildlife habitat and water quality goals, objectives, and strategies were derived from NRCS state and basin strategic plans and from individual Soil and Water Conservation District work plans.

Goals

- Functional aquatic, wetland, riparian, and upland habitats, supporting diverse native fish and wildlife populations, will be viewed and managed as essential components of healthy watersheds.
- Quantity and quality of water is acceptable for its intended uses and is managed in an efficient and sustainable manner.

Objectives

- Focus fish and wildlife restoration efforts on the connectivity between uplands, riparian areas and wetlands within a watershed.
- Furnish the technical and financial assistance needed by landowners to meet local, state and federal goals for fish and wildlife and water quality.
- Utilize a cooperative approach between local groups (i.e. SWCDs and watershed councils), state and federal agencies having fish, wildlife and water quality responsibilities to provide technical assistance, implementation funding and environmental certainty to private landowners.
- Develop partnerships to ensure participation through outreach and education of all interested parties.
- Private land conservation is accomplished through voluntary, locally led approaches.
- The Conservation Partnership will work together to carry out the Oregon Plan through watershed management.
- Promote the public awareness, interest and participation in natural resource protection program.

Strategies

- Ensure farm conservation plans and watershed plans contain scientifically-sound alternatives to enhance fish and wildlife objectives consistent with the requirements under the Endangered Species Act and with those of the landowner.
- Ensure farm conservation plans contain scientifically-sound alternatives to protect and improve water quality consistent with state water quality requirements (Agricultural Water Quality Management Plans, Total Daily Maximum Loads, and state water quality standards) and with those of the landowner.
- Market the concept that properly managed productive agricultural lands provide habitat for numerous species of concern.
- Work with state and federal agencies and private groups to coordinate the provision of technical and financial assistance to develop and implement conservation plans with private landowners.
- Provide a trained, qualified staff with the expertise needed to work with private landowners.
- Maintain partnerships to efficiently use and leverage available implementation funds (EQIP, WHIP, WRP, CRP, CREP, OWEB, 319, etc.).
- Implement adopted Agricultural Water Quality Management Area Plans (SB1010).

- Provide assistance to Confined Animal Feeding Operations (CAFOs) to eliminate or control pollution.
- Conduct educational and outreach efforts related to soil, water, and other natural resources.
- Maintain NRCS Field Office Technical Guides to provide the latest guidance, tools and technical standards for planning and implementation.
- Seek streamlined permitting processes and ESA consultations.
- Participate on local, state and regional initiatives to guide efforts to protect and restore fish and wildlife and water quality.

Sandy River Basin Watershed Council

The SRBWC developed a Phase 1 Action Plan (1999b) for the Sandy Subbasin that consists of goal statements, issues and opportunities, and action items for the five watersheds in the subbasin: Lower Sandy River, Bull Run/Little Sandy, Sandy River, Salmon River and Zig Zag River. The goal statements are:

- Goal 1: Education and Outreach. Conduct education and outreach activities regarding human activities and relationships with the environment with private land owners, recreationists, public and public agencies about fish and wildlife habitat needs and conditions in the basin. Continue to spread general awareness of the rich cultural and historic history and resources in the basin.
- Goal 2: Water Quality. Improve water quality conditions in the basin including but not limited to state water quality standards by: reducing the use of chemicals by urban and recreational users in the basin that impact basin waterways; striving to correct temperatures in tributaries and mainstem reaches to within ranges of natural variability; and reducing human-induced sediment in basin watersheds.
- Goal 3: Water Quantity. Ensure natural seasonal flow regions in rivers and streams in basin watersheds to maintain and increase fish and wildlife habitat and populations, while meeting municipal and domestic water supply needs.
- Goal 4: Riparian Areas and Floodplains. Improve and maintain existing riparian areas, floodplains, and floodways in basin watersheds with a goal of restoring historic ecological functions by: mitigating the historic loss of riparian areas and floodplains; stopping construction in floodplains and floodways; restoring natural drainage patterns; and advocating for increasing riparian buffers for intermittent and perennial streams in the basin.
- Goal 5: Fish Passage. Maintain free flowing nature of streams and rivers by improving/removing manmade barriers to fish migration while considering flood protection needs, through repairing culverts and other barriers to fish passage.
- Goal 6: In-Stream Fish Habitat. Restore and improve in-stream fish habitat in basin rivers and streams where appropriate with short- and long-term enhancement measures.
- Goal 7: Wild Fish. Protect and enhance wild fish populations in basin watersheds.
- Goal 8: Vegetation. Encourage the removal and control of non-native and invasive species in basin watersheds and restore native vegetation.

- Goal 9: Enforcement. Encourage and support the enforcement of fish, wildlife and other regulations in basin watersheds, including the poaching of fish and wildlife species and other resources in the basin.
- Goal 10: Cultural and Historical Resources. Protect and restore cultural and historical resources in basin watersheds.
- Goal 11: Private Lands. Enforce existing city, county, state and federal laws and regulations on private lands by: increasing penalties and fines for violations, and advocating for passage of regulations and ordinances that strengthen protection and restoration of basin watersheds.
- Goal 12: Public Lands. Enforce laws and regulations on public lands by: increasing penalties and fines for violations, and advocating for passage of regulations and ordinances that strengthen protection and restoration of basin watersheds.
- Goal 13: Wildlife. Mitigate the historical loss of wildlife habitat, including seasonal rages and nesting areas, and protect and restore historical migration corridors, wildlife habitat and seasonal ranges by: identifying and preserving land for wildlife migration corridors; supporting setting aside land for big game; and supporting efforts to reduce and eliminate wildlife road kills within the basin.
- Goal 14: Scenic Resources. Preserve and protect the high quality natural visual environment in the basin.
- Goal 15: Air Quality. Preserve and protect the air quality and visibility conditions in the basin.

The preliminary issues and opportunities developed by the Council were presented for public review and comment at a basin-wide workshop. The list of issues and opportunities was further refined into the four priority action groups by watershed for short-term (less than two years), longer-term (greater than two years) and ongoing actions in the following areas: (1) further research/data gaps; (2) restoration; (3) cultural and historical resources; and (4) education and outreach. The restoration category further identifies actions according to fish passage, in-and-out-of-stream-habitat restoration, water quality and water quantity subcategories. The action items were then developed by watershed to meet these issues and opportunities and were presented at three regional forums were held in Sandy, Welches and Troutdale.

The Council currently is engaged in the following activities: outreach and information to local residents; recruiting volunteers for projects such as tree planting and removal of invasive plant species; planning habitat restoration projects; and beginning the development of "Friends of the Creek" groups in key parts of the subbasin. This effort will recruit and engage landowners that are interested in implementing habitat restoration projects on their land.

Research, Monitoring, and Evaluation Activities

Federal Activities

Northwest Forest Plan

The research, monitoring, and evaluation activities under the Northwest Forest Plan are guided by an interagency Strategic Research Plan. The plan identifies high-priority research themes to support ecosystem management activities; provides linkage to other federal research plans; guides interagency research coordination and the feedbacks; and promotes scientific information transfer to managers and other stakeholders.

Major research organizations involved are the Pacific Northwest and Pacific Southwest Research Stations of the Forest Service; the Forest and Rangeland Ecosystem Science Center of the U.S. Geological Survey; the Pacific Northwest Ecosystem Management Research Program of the Environmental Protection Agency; and the Northwest Fisheries Science Center of the National Marine Fisheries Service.

The federal research agencies have identified seven major research themes: (1) Understanding Ecological Systems; (2) Individual Species Research; (3) Developing and Evaluating Alternative Management Systems; (4) Resource Restoration and Enhancement; (5) Economic and Social Dimensions of Cultural and Natural Resources; (6) Research to support Monitoring and Inventory Systems; and (7) Decision Support Systems.

The Northwest Forest Plan identifies three different types of monitoring requirements: Implementation monitoring, effectiveness monitoring, and validation monitoring. Implementation monitoring occurs on an annual basis and assesses the degree to which the Northwest Forest Plan standards and guidelines are being followed in project implementation. Results of the implementation monitoring are analyzed by a Provincial Monitoring Team made up of scientists form the USFS, BLM, USFWS, and the Regional Ecosystem Office.

Bureau of Land Management Science Strategy and Bioregional Activity Catalogs

In September 2000, the BLM released a Science Strategy setting forth an overall approach to science. While the BLM does not have a specific research mandate, it seeks research support from science providers within and outside the Federal government. The BLM Science Strategy clearly acknowledges that social and economic values, political factors, and statutory and regulatory requirements must be considered, along with scientific information, in resource management decisions. It establishes a clear process for identifying science needs and assure their reflection in the BLM Strategic Plan and budget.

In implementing the Strategy, the BLM is currently in the process of compiling a catalogue addressing national, regional, and local science needs. The catalog will be a communication tool in working with science providers and partners, including other agencies, universities and interested providers. Draft regional management issues in the Pacific Northwest place emphasis on:

- Watershed Scale Needs. Information on physical and biological processes of headwater streams, evaluation of forest management activities and their effects on headwater drainages, and testing of various management practices to determine the

efficacy of management prescriptions in mitigating actions and protecting headwater drainage systems.
- Aquatic/Riparian System Needs. Science surrounding riparian reserves, Aquatic Conservation Strategy and salmon components of the Northwest Forest Plan. Comprehensive inventory and assessment information of perennial water sources and streams, including baseline water quality information, and updated information on appropriate water rights.
- Management and Protection of Salmonid Fish Needs. Information to understand an integrated approach to analyze habitat influences on salmonid populations; determine levels of protection, needed restoration, and management techniques/options for rebuilding and maintaining salmonid populations; understand the role of genetics and hatchery programs in protecting and restoring salmonid populations.

Pacific Northwest Forest and Range Experimental Station

The Pacific Northwest Forest and Range Experimental Station is one of eight research units in the Forest Service. The research units collectively conduct the most extensive and productive program of integrated forestry research in the world. The PNW Research Station was established in 1925. The Station has its headquarters in Portland, Oregon, and 10 research locations in Alaska, Oregon, and Washington. Research, monitoring and evaluation in the region includes:

- Aquatic and Land Interactions
- Ecosystem Processes
- Resource Management and Productivity
- Social and Economic Values

National Marine Fisheries Service Science Center/Willamette-Lower Columbia Technical Recovery Team

The Northwest Fisheries Science Center is one of five research centers of NOAA Fisheries (NMFS) and is responsible for providing scientific and technical support for the management, conservation, and development of the Pacific Northwest region's anadromous and marine fishery resources. The Northwest Fisheries Science Center is organized into five research divisions: Conservation Biology, Environmental Conservation, Fishery Resource Analysis and Monitoring, Fish Ecology, Resource Enhancement, and Utilization and Technologies. Research objectives include:

- Understanding and mitigating the impacts of hydroelectric dams on salmon, and ecological and genetic research on salmon in support of the ESA.
- Evaluating effects of marine pollutants on coastal ecosystems.
- Enhancing the quality, safety, and value of fishery products.
- Developing methodologies for marine aquaculture and salmon enhancement.
- Emerging fields of marine biotechnology.
- Assessing trends in fish abundance and potential fishery yield.

Salmon-related research is categorized around major themes: conservation, cumulative risk, ecology, education, fish health, genetics, habitat, harmful algal blooms, harvest, hatcheries, hydropower, and resource utilization.

State Activities

Independent Multidisciplinary Science Team/OPSW Monitoring Team

The Team was established by Legislation to provide scientific advice to the State on the Oregon Plan for Salmon and Watersheds. The IMST has two broad areas of work: independent projects and review projects. Independent projects deal with the scientific basis for management of resources and settings crucial to the Oregon Plan. Review projects represent ongoing or proposed activities that could influence accomplishing the mission of the Oregon Plan. These are projects that are brought to the Team for scientific review and evaluation. Selected projects Oregon's Independent Multidisciplinary Science Team are shown below.

Independent Projects

- Predation. This project evaluated the impact of predation by pinnipeds (seals and sea lions) and sea birds on salmonids. Technical Report 1998-1.
- Hatchery Management, Phase I. This project evaluated Oregon Plan hatchery strategies against criteria common to four independent scientific reviews of hatchery programs. Technical Report 1998-2.
- Forest Practices. This project is the first of several projects relating to land use in Oregon. It evaluated the scientific basis for forest practices, including the regulatory and voluntary aspects of them, with respect to the mission of the Oregon Plan. The scope is Western Oregon. Technical Report 1999-1.
- Harvest Management (adult fish escapement to spawning). Part one is a report of a scientific workshop on harvest management (Technical Report 1999-2). Part two is on the scientific basis for harvest management as it relates to the mission of the Oregon Plan (Technical Report 2000-3).
- Western Oregon Lowland Resources (land uses in western Oregon that are not forest and are not urban). This project evaluates the scientific basis for the management of low land resources in Western Oregon as it relates to the mission of the Oregon Plan. It includes a wide variety of agricultural land uses, estuaries and other low land systems. In progress.
- Hatchery Management, Phase II. This project is an evaluation of the results of the audit of hatchery operations conducted by ODFW. It is limited in scope and is relatively brief. It is the subject of a letter report dated October 25, 2000.
- Hatchery Management, Phase III. This project evaluates hatchery management. Technical Report 2001-1.

Review Projects

- Water Temperature Standards. This review is of the proposed water temperature standards of the state. It is underway and is expected to be completed in calendar year 2000.
- Monitoring Report, 1999. This is an annual report required of the IMST on the monitoring activities under the Oregon Plan.
- Native Fish Conservation Policy. This will be a review of ODFW Native Fish Conservation Policy, which is being developed to replace the existing Wild Fish Policy. In progress.

Joint, Cooperative Activities

Cooperative Forest Ecosystem Research Program (CFER)

The Cooperative Forest Ecosystem Research (CFER) program is a multidisciplinary, integrated research program to develop and convey research information to land managers in western Oregon. Acquisition of information that supports implementation of the Northwest Forest Plan is a top priority. The program includes the USGS Forest and Rangeland Ecosystem Science Center, Oregon State University, BLM, and the Oregon Department of Forestry. The program has initiated three integrated research projects throughout western Oregon to answer questions at different scales of time and space:

- Stand Structure And Biotic Responses To Changes In Structure Of Young Forests Of Western Oregon
- Large Woody Debris in the Terrestrial and Aquatic Riparian Zone: Production, Recruitment, Retention, and Function
- Influence of Landscape Pattern and Composition on Species in Forested Ecosystems of Western Oregon

Project Level Activities

There is a huge assortment of species-, habitat-, and issue-specific investigations being conducted by universities, non-governmental organizations, and state, federal, and local agencies which regularly occurs in the context of their respective academic and land management activity.“ It is beyond the scope of this Summary to fully list all such projects in the subbasin.

The two BPA-funded projects at the Sandy River Delta (Project 99-025, Lower Columbia River Wetlands Restoration and Evaluation Program and Project 99-026, Sandy River Delta Riparian Restoration) include the following research, monitoring and evaluation activities:

- Neotropical use of Sandy River Delta riparian forest.
- Wildlife use, particularly waterfowl, at Sandy River Delta wetland restoration.
- Vegetation response to reed canary grass control, using tools of disking, flooding and scalping.
- Planting success at Sandy River Delta riparian forest restoration.

Statement of Fish and Wildlife Needs

Summary of Sandy Subbasin Fish and Wildlife Needs

The ecosystems of the Sandy Subbasin are complex. On one hand, its ecosystems have been highly altered and consequently, its fish and wildlife populations severely affected. On the other hand, it retains areas of functioning ecosystems and other areas with high potential for restoration. The causes of ecosystem alteration are many and include direct habitat conversion for urban uses, agriculture, transportation and forestry, as well as the disruption of flow, temperature, and the blockage of anadromous fish habitat resulting from the construction of dams and water impoundments for hydropower and municipal water supply. The fish and wildlife needs commonly identified by a host of interests in the subbasin include:

- Improved in-stream habitat structure.
- More and better-connected habitat, especially riparian habitat.
- Improved riparian structure and function.
- More natural streamflow regimes, especially in low flow months.
- Higher quality water with temperatures closer to natural historic patterns.
- A reduction in human-caused water quality degradation resulting from sources such as stormwater and road runoff, agricultural runoff and sediment from a range of land management and development activities.
- Improved floodplain function and hydrologic integrity including reconnection of side channel areas and wetlands.
- Improved fish passage by continuing to identify and correct barriers such as culverts, bridges, weirs and diversion dams.
- A coordinated and consistent subbasin-wide fish passage barrier inventory to accurately reflect the loss of access to high quality spawning and rearing habitats and to optimize habitat recovery.
- Reduced harvest rates on chinook and steelhead.
- Reduced hatchery impacts by limiting effects of strays, and reducing competition and predation of wild juveniles by hatchery releases.
- Land use regulations and incentives should be used to increase protection of currently productive habitats and to encourage future restoration.
- Nutrient enrichment through increased escapement of adult salmon and the artificial placement of fish carcasses.
- Education and monitoring to inform people in the subbasin about the causes of habitat degradation and involve them in monitoring results.

Monitoring, Research and Evaluation Needs

Generally, the monitoring, research and evaluation needs in the Sandy Subbasin involve improving the understanding of ecological systems and individual species, including habitat/productivity relationships; developing and evaluating alternative management systems; and improving the inventory of sensitive species by determining distribution, abundance and population structure. The ODFW has identified the following critical research, monitoring, and evaluation needs for its draft Willamette River Basin Operational Plan, which can also be applied to the Sandy Subbasin (ODFW 2001).

Strategy	Collect and analyze scientific information for use in decision-making.
Activity 1	Assess the status of freshwater and marine fish and wildlife populations and their habitats to assist in establishing Department priorities and programs and to improve our understanding of how populations are performing under the status quo.
Activity 2	Define and characterize limiting factors and factors for decline, including stresses that potentially influence fish and wildlife populations and their habitats, and interpret how the factors influence observed trends to improve our understanding of the relationships between fish and wildlife populations and landscape conditions.
Activity 3	Assess likelihood of meeting goals and objectives for fish and wildlife populations under current management actions based on our best understanding of limiting factors and factors for decline.
Activity 4	Evaluate if and how current management programs can be improved to protect, mitigate and enhance fish and wildlife and their habitat.
Activity 5	Develop or refine coordinated information system to store and access information for use in research, monitoring, and evaluation.

The Oregon Plan has also identified key monitoring and evaluation needs (OWEB 1999). First, Oregon needs to develop a comprehensive restoration strategy. While restoration planning and prioritization generally occurs at the local level, larger-scale planning efforts are necessary to guide restoration investments towards actions that are most likely to produce the greatest gains in watershed health and species recovery. Second, Oregon needs to develop a comprehensive program for monitoring restoration effectiveness. Again, restoration effectiveness monitoring tends to occur at the local or site-specific level. Local monitoring efforts need to be coordinated with a larger-scale restoration effectiveness monitoring approach to determine if restoration investments are producing the intended benefits in watershed health and species recovery across the landscape.

Institutional Needs

Species declines will not be effectively addressed or habitat protection assured unless a number of institutional needs are met, including:

- Improving habitat on private lands, consistent with their inherent objectives to produce revenue. This, in turn, entails needs to expand and improve voluntary incentives programs, and to increase the capacity of local groups (especially watershed councils and districts) and agencies to market and help implement incentives programs.

- Improve coordination among al those working to manage Sandy Subbasin habitats at site, watershed, subbasin, and regional scales by promoting frequent communication among landowners, local governments, watershed groups, agencies, and non-governmental organizations.
- Promote more strategic targeting of restoration investments throughout all scales of management.
- Promote improved regulatory coordination especially with regard to the federal Endangered Species and Clean Water Acts.

Sandy Subbasin Recommendations

Projects and Budgets

The following subbasin proposal was reviewed by the Lower Columbia and Estuary Province Budget Work Group and is recommended for Bonneville Power Administration project funding for the next three years.

Continuation of Ongoing Projects

Project: 199902500 - Sandy River Delta Riparian Forest, Wetlands, and Anadromous Estuary Restoration

Sponsor: U.S. Forest Service

Columbia River Gorge National Scenic Area

Short Description:

- Restore 600 acre island of rare Columbia River floodplain "gallery" riparian forest.
- Restore 200 acres wetland/associated upland habitat.
- Remove 1930's dike from original Sandy River channel to restore hydrology and increase anadromous habitat.

Abbreviated Abstract

Sandy River Delta was historically a wooded, riparian wetland with components of ponds, sloughs, bottomland woodland, oak woodland, prairie, and low and high elevation floodplain. It has been greatly altered by past agricultural practices and the Columbia River hydropower system. Restoration of historic landscape components is a primary goal for this land. The Forest Service is currently focusing on restoration of riparian forest and wetlands, and the original Sandy River channel. Restoration of open upland areas (meadow/prairie) would follow substantial completion of the riparian and wetland restoration.

Riparian Forest Restoration: Restore a 600 acre block of rare "gallery" Columbia River bottomland riparian forest (dense, unbroken stands of black cottonwood, willow, and ash).

Original Sandy River Channel Restoration: Remove a 1930’s dike across the Sandy River to restore the hydrologic pattern and improve estuary habitat for anadromous fish. The original channel of the Sandy River was diked near its mouth, and the historic “Little Sandy River” was altered to become the new primary channel. The original channel has silted in and become a seasonal slough.

Wetlands Restoration: Restore up to 200 acres of wetland and associated upland habitat, and monitor and evaluate restoration success. Transform the existing Reed Canary Grass to a more productive wetland type, such as open water and emergent vegetation.

Convert vegetation from invasive species (reed canary grass) to a more native plant community.

Partnerships: Partnerships and volunteers are strongly sought to build local community ownership for Sandy River Delta, and to build advocacy and support for ecological restoration, public lands and natural resources.

Relationship to Other Projects

Project ID	Title	Nature of Relationship
199902600	Lower Columbia River Wetlands Restoration and Evaluation Program Sandy River Delta Riparian Forest Restoration	199902500 and 199902500 are being folded into this one proposal. The projects are in direct proximity and we have already folded them into one contract with BPA.

Review Comments

NMFS has identified that this project is a BiOp project.

Budget

FY2003	FY2004	FY2005
Rec: $162,000 Category: High Priority	Rec: $132,000 Category: High Priority	Rec: $912,000 Category: High Priority

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