SALMON AND STEELHEAD RUNS AND RELATED EVENTS OF THE SANDY RIVER BASIN – A HISTORICAL PERSPECTIVE

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[front cover photo: Aerial view of Sandy Basin near Marmot Dam. Mt. Hood in background
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[back cover photo: "Construction at Big Sandy end of tunnel for Bull Run Project"
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FOREWORD...

Over the past 30 years I have had a chance to hike, fish, snorkel, SCUBA, boat and, on many occasions, fly over most of the Sandy and Clackamas rivers. Once you begin to know an area well, some of the most intriguing conversations are with the people who came before you, the "old timers". Invariably these conversations end up on the subject of fish. The knowledge these people have often brings a new perspective to how we got to where we are today. We can only wonder what it was like before today's "old timers".

Salmon and trout populations are molded by the environments of the watersheds from which they come. To understand the fish populations of today, we must examine the historical record of activities in the watershed. Now, as the concern for the future of salmon and trout populations become more critical, thousands of new people are moving into the area. Their historical perspective of these rivers may be only the past few years. As PGE prepares to relicense its hydroelectric projects on the Sandy and Clackamas rivers, there is an opportunity to compile the historical record related to fish. This should help us all have a common understanding of how the fish populations in these two rivers have evolved to where they are today.

I did not know Barbara before this project, and she did not know the Sandy or Clackamas rivers, which is probably good as she started with no preconceived notions. It has been exciting to see the new information she has found. This was a difficult job as she had to be part detective; the information from the last 100+ years is scattered in various libraries, museums, file cabinets and memories. Sometimes she was frustrated, knowing there had to be more hard information out there, but was unable to find it. Thank you, Barbara, for a job well done.

One thing that we humans seem to do well is manipulate and modify our environment to suit our current needs. Hopefully, as we review our history we can identify pathways for the future that provide for the fish as well as for us.

—Doug Cramer
PGE Biologist

EXECUTIVE SUMMARY

The Sandy River, stretching from the flanks of Mt. Hood to the Columbia River, has attracted crowds of anglers and picnickers to its banks for more than 100 years. Fishing for spring chinook on the lower Sandy became popular during the late 1800s. More people came in the early 1900s as railroad and road development brought the banks of the scenic lower river within reach of area residents. On warm summer days in the mid-1920s, the railroad often carried hundreds of visitors from the nearby Portland area to picnic along the river's sandy shores, such as at Dodge Park. Visitors also came to fish for steelhead, trout and, at one time, the smelt that returned in large numbers to the river's mouth.

For centuries before these people arrived, the Sandy River Basin supported large runs of salmon and steelhead. Contained by pristine forests and gathering a seemingly endless supply of snowmelt and rainfall, most of its rivers ran cool and steady year-round (ODFW 1997). Fish thrived in its long shallow rapids and deep pools. Historically, the runs ranged as high as 15,000 coho, 20,000 winter steelhead, 10,000 fall chinook and 8,000 to 10,000 spring chinook (Mattson 1955). A small run of chum salmon also returned to the lower river.

Today, the Sandy continues to attract many visitors to fish along its banks or watch spawning fall chinook at Oxbow Park; however, the basin's anadromous fish runs are not what they once were. Salmon and steelhead, except for chum, still return to the river — but the runs have fallen far below historic levels. Comparisons of records from an old hatchery within the Salmon River watershed, along with recent spawning surveys in the Salmon and Zigzag watersheds, suggest that current adult returns are only 10 to 25 percent of 1890 levels, which were already reduced by decades of heavy fishing (USFS 1996). In addition, hatchery-reared fish now dominate the runs.

In many ways, the decline of these runs has been linked to a steady, rapid growth of activity over the last 150 years and a subsequent demand for more timber, water, power, salmon and other resources. The runs began declining in the mid-1800s, primarily due to overharvest by fisheries in the Columbia River. By the late 1870s the spring chinook run to the Columbia River — the preferred fish at the time — had already started dropping. This decline led fish propagators in the Northwest to experiment with fish culture as a means to improve the runs. In 1887, fish propagators built stations on the Sandy and Salmon rivers to collect eggs for hatchery production. These collections, which persisted in the drainage until the late 1950s, captured many would-be-spawners as brood stock for hatcheries in the Sandy Basin and elsewhere. Other Sandy River salmon and steelhead were harvested in the commercial fisheries that remained steady on the Columbia River and grew heavy over time on the ocean and Sandy River.

Modification of the watershed's pristine spawning and rearing conditions also reduced salmon and steelhead production. During the late 1800s, the booming population of the Willamette Valley and Portland metropolitan area turned toward the Cascades to provide for its growing needs. Logging companies cut large amounts of timber in lower, more accessible parts of the watershed and moved upstream as new roads and railroads permitted access to upper basin forests. Early settlers also removed instream logs and reshaped stream channels to ease the driving of timber downstream to mills or markets and mined lower stream reaches for sand and gravel. Other settlers cultivated the basin's fertile lowlands and plateaus for agricultural production.

Construction and operation of several dams in the basin during the early 1900s further tested the strength of the basin's fish runs. In 1912 and 1913, hydroelectric companies began operating two dams in the Sandy watershed to help meet the region's growing energy demands. They completed the Bull Run project in 1912, which included a powerhouse on the Bull Run River at river mile (RM) 1.5 and a diversion dam on the Little Sandy River (RM 1.7), a lower Bull Run tributary. While the powerhouse created little or no problems for fish passage, the diversion dam on the Little Sandy blocked fish passage to about 6.5 miles of habitat in the upper Little Sandy drainage and reduced production between the dam and the river's mouth. Hydro-related impacts on the basin's fish runs intensified the next year after completion of Marmot Dam on the Sandy River (RM 30). The dam included a fish ladder, but it was usually blocked to capture brood stock for hatchery production. The ladder also suffered repeated flood damage and required regular repair. Additional fish losses occurred when downstream migrating fish were swept into the dam's diversion canal. Streamflow diversions also affected fish migration and production below the dam for many years.

More habitat was lost in 1922 when the city of Portland built Headworks Dam on the Bull Run River (RM 6). While the Bull Run drainage had been earmarked in 1892 to provide high quality drinking water for Portland — and a small dam had existed on the river since 1895 — fish are believed to have continued migrating into the upper drainage until blocked by Headworks Dam. The dam, 22 feet high, stopped all fish migration to the upper Bull Run. In addition, the City began diverting large quantities of water from the river, significantly affecting fish production in the lower river.

By the late 1940s, the historically abundant runs of salmon and steelhead no longer returned to the Sandy River Basin. Spring chinook escapement to the main Sandy River and tributaries is believed to have dropped to no more than 1,500 adults. The coho salmon run had declined to about 2,000-3,000 adult fish and winter steelhead escapement to areas above Marmot Dam had dropped to about 2,200 fish (Mattson 1955). Fall chinook production had also fallen.

Several developments after 1950 influenced efforts to rebuild the runs. Some developments — such as improving fish passage at the Marmot Dam, maintaining minimum streamflows in the lower Sandy River, reducing egg takes, and tightening regulations for fishing and habitat disturbing activities — enhanced salmon and steelhead production and survival. Other developments — such as escalating road construction and timber harvest in the upper basin, stream mining, and channelization of the Sandy and several major tributaries following the flood of 1964 — caused new hardship. Fish managers also started releasing more hatchery fish in the basin at this time to supplement declining native stocks and support fisheries, including a new summer steelhead fishery.

Today, large numbers of winter steelhead, spring and fall chinook, coho and summer steelhead still return to the Sandy River. However, the proportion of native fish in these runs has dropped considerably over the years. Consequently, fish and habitat managers and other interested parties are working together to improve native salmon and steelhead production. Such actions, in concert with changes being made at the regional level, should help rebuild the basin's native fish populations in years to come.

INTRODUCTION

This report provides historical information on the Sandy River, focusing primarily on its salmon and steelhead runs. Portland General Electric has developed this information as part of the relicensing effort for its Bull Run hydroelectric project regulated by the Federal Energy Regulatory Commission.

The report looks at events and developments that have shaped conditions in the Sandy River watershed over the years and influenced the basin's salmon and steelhead runs. It gives an overview of physical conditions in the basin, including hydrology characteristics, geography, water quality and other features that have supported healthy fish runs for centuries, and describes human settlement and development within and outside the watershed since the early 1800s. The discussion focuses on activities such as timber harvest, dam development, and fishing, and discusses how these activities affected salmon and steelhead habitat and production.

Further, the report examines changes in salmon and steelhead production from the early 1800s to present times. This discussion is separated into three distinct periods. The first period, which covers salmon and steelhead production before 1900, includes the beginning of commercial fisheries and extensive egg takes for hatchery operations in the basin. The second period, extending from 1900 to 1950, shows changes in fish production over years when hydroelectric operations, municipal water supply development, timber harvest and other activities altered habitat conditions and blocked fish migration to historical habitat areas. The third period, from 1950 to the present, discusses efforts to rebuild salmon and steelhead production in the upper basin and hardships caused by escalating activities in the area.

Information available for this analysis, particularly describing salmon and steelhead runs and human developments in the Sandy River Basin before the middle 1900s, was often sketchy and limited in its scope. The report attempts to link various accounts of events in the basin over the years. As a result, it relies heavily on early records by fish propagators, harvesters and historians to depict the size and health of the runs before fish counts became available. It presents only limited information on coho and steelhead runs as the early reports (and activities) generally focused on chinook salmon, the preferred fish at the time.

THE PHYSICAL SETTING

THE RIVER SYSTEM

High on the west slope of Mt. Hood, the Sandy begins as a small intermittent stream. Gathering rainfall and snowmelt, it winds more than 55 miles toward the northwest where it joins the Columbia River. Its watershed covers an area of about 508 square miles. Major tributaries to the Sandy River include the Zigzag River, Still Creek and Salmon River in the upper basin, and the Bull Run River, Gordon Creek and Beaver Creek in the lower basin (Figure 1).

From its headwaters above the treeline at an elevation of about 6,200 feet, the Sandy drops sharply, reaching an elevation of 1,600 feet in the first 13 miles. The river's gradient exceeds 1,000 feet per mile in several places. The upper Sandy River and several tributaries, including the upper Zigzag and Salmon rivers, carve through miles of unstable volcanic ash and rock deposits before reaching less steep ground. Several of these reaches, including the upper Sandy above the Clear Fork, the upper Zigzag River and Clear Creek, have reaches that are too steep for fish production. Waterfalls also obstruct fish migration on the Salmon River above RM 14.

Leaving this steep upper reach, much of which lies within the Mt. Hood Wilderness Area, the Sandy River slows as it crosses a broad flat plain above its confluence with the Zigzag River (RM 43). This part of the glacially-carved upper river valley, known as Old Maid Flats, has been partially filled by past volcanic flows. The area displays soil conditions and vegetation, such as lodgepole pine and edible mushrooms, that are rare elsewhere within the Mt. Hood National Forest. The Sandy River widens below Old Maid Flats and the mouth of the Zigzag River and slows again as it nears Marmot Dam (RM 30) (Figure 2). Soils here are generally unstable, composed of loose alluvial rock and very susceptible to erosion during high flows.

Below Marmot Dam the Sandy enters a five-mile-long scenic narrow gorge with steep canyon walls and constrained chutes. Deep pools in this reach provide good, cool rearing habitat for migrating spring chinook. The river becomes wider below Revenue Bridge (RM 24) and bends between high bluffs that rise more than 200 feet in some areas.

At Dodge Park (RM 18.5) the Sandy merges with the Bull Run River and descends into the rugged and remote Sandy River Gorge. The upper stretch of the gorge displays long steep rapids and large pools contained by high bluffs. Below Indian John Island (RM 15) the river channel begins to meander. This reach of the river, which includes Oxbow Regional Park (RM 13), contains significant fall chinook

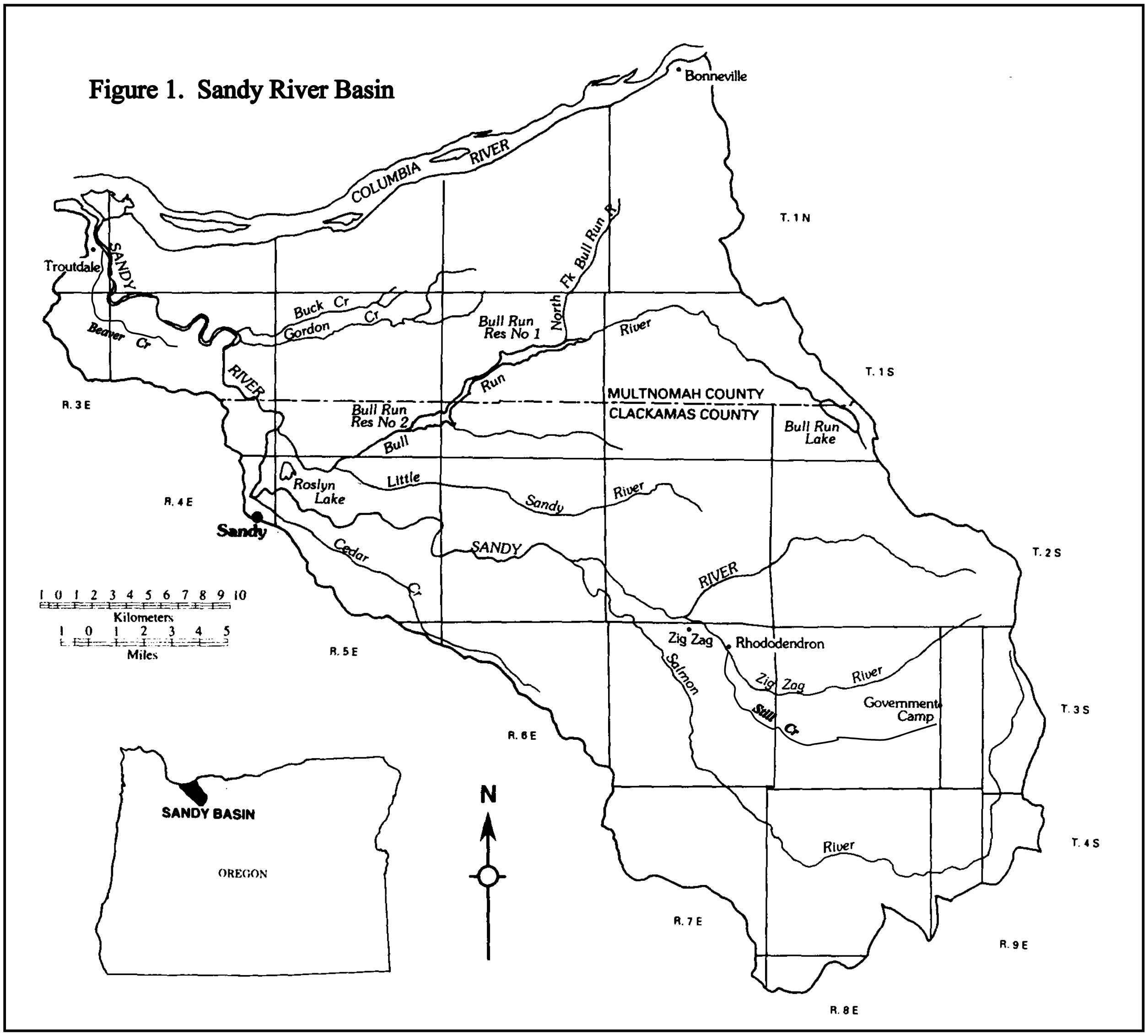

Figure 1. Sandy River Basin

spawning and rearing habitat. The Sandy River continues to slowly twist and bend toward Dabney State Park (RM 6). The scenic 12.5-mile reach between Dodge Park and Dabney State Park is designated a federal Wild and Scenic River and a state Scenic Waterway.

Below Dabney Park, the Sandy River again widens as it slowly meanders to its confluence with the Columbia River. This river reach has shifted often over the years during periods of high flow. Much of the reach is now armored with riprap to protect private property and roads. The reach contains many large sand deposits that historically provided spawning habitat for the great schools of smelt that once returned annually to the Sandy River. Nearing its confluence with the Columbia River, the Sandy River becomes shallow as it flows through a large delta of sand and other fine sediments that have accumulated over thousands of years. Flows at the river's mouth are affected by tidal influence from the Columbia River and are believed to provide adequate fish passage even during summer months (ODFW 1997). The Sandy River Delta is part of the Columbia River Gorge Scenic Area.

LAND USE

Forests cover about 78 percent of the Sandy River Basin, including most of the upper and middle watershed. About three-quarters of this forested land is in public ownership and managed as part of the Mt. Hood National Forest. The watershed contains several wilderness areas. These include the Salmon-Huckleberry Wilderness Area (44,600 acres, with one small corner draining a Clackamas River tributary) and the Mt. Hood Wilderness Area (47,160 acres). In addition, the Bull Run River drainage is protected to provide high-quality drinking water for the city of Portland.

Fertile plateaus and rolling hills cover much of the lower watershed. These lands are generally privately owned and support timber, agriculture or residential uses. Above the town of Sandy, most private lands support timber production, Christmas trees and some livestock use. Private forest lands in the basin cover 71,000 acres and stretch from the Sandy River to public forest lands in the middle watershed and east of the Sandy River in the lower watershed. Below the town of Sandy, agricultural uses are common, with widespread nursery stock production on the plateaus east and north of Gresham and south of Troutdale. The hills north of the lower Sandy River also support some agricultural use.

CLIMATE

Climatic patterns in the Sandy drainage vary from alpine conditions to those typically found along the shores of the lower Columbia River. This variation is reflected in precipitation and temperature records for the basin. Annual precipitation ranges from 70 inches near the river's mouth to 110 inches near its headwaters (ODFW 1997). The lower and middle portions of the Sandy River Basin generally experience seasonally mild temperatures and wet winters. At higher elevations, temperatures drop significantly and much of the precipitation falls as snow. For example, in the Bull Run subbasin, it rarely snows at elevations below 2,000 feet, but often accumulates to a depth of 6-10 feet in areas above 4,000 feet. Several glaciers, including the Reid, Zigzag and Sandy glaciers, have developed on the west and northwest slopes of Mt. Hood, which receives up to 300 inches of snow each year. The watershed's middle and lower areas receive more rainfall than snow. Most of the rainfall occurs between November and January.

These variations in temperature and precipitation play a significant role in determining patterns of streamflow. In watersheds with large snow accumulation, flows usually peak in late spring when streams swell with snowmelt. Streamflows in lower elevation watersheds receive mostly rainfall and may peak several times during the winter in response to storm events (USFS 1996).

Samplings of trees covering a large geographic area in the Columbia River Basin suggest that climatic changes may have affected conditions within the Sandy River watershed — and elsewhere in the region — during the late 1800s and early 1900s. Studies show that the region received a higher level of precipitation around 1900. This wet period was followed by a drier climate through the 1920s, 1930s and 1940s. Reconstruction of historic temperatures in the Andrew Forest in Oregon's Central Cascades shows periods of cool temperatures in 1892-1920 and warmer temperatures in 1921-1946 (Lichatowich and Mobrand 1995). Such large-scale climatic changes likely affected the quality of fish habitat in both freshwater and marine environments during 1900-1940 (Lichatowich and Mobrand 1995).

HYDROLOGY

The snows falling on Mount Hood, combined with glacier ice melts, usually maintain good streamflows in the Sandy River all year. The glaciers and heavy snowpack store water over the winter months and supplement flows in the spring and summer. Large groundwater contributions associated with basin size and gains in elevation may also contribute to runoff.

Glacial influence is particularly noticeable in the upper Sandy and several tributaries, including the Salmon, Muddy Fork and Zigzag rivers, which are fed by glacial melt. In these river systems, moderate and low flows are tempered by the glaciers. They are not as "flashy" or quick to respond to runoff.

Streamflows fluctuate more in the lower Sandy, which also collects flows from many lower elevation tributaries, such as the Little Sandy River, that receive more rainfall than snow. As a result, streamflows in the lower Sandy River can range widely between days, particularly during the rainy, mid-winter months. The river typically runs higher from March through May, the spring snowmelt season. Average monthly flows in the Sandy at its confluence with the Bull Run River (RM 18.5), the lowest gauge site on the river, range from a low flow of 377 cfs in September to a high flow of 3,437 cfs in February. Peak flows generally happen during major storm events, such as during the flood of February 1964 when the highest flow ever, 84,400 cfs at a height of 22.3 ft, was recorded at the gauge. A high flow of 68,600 cfs was measured at the gauge during the Flood of 1996, at a height of 22.59 ft (USGS 1996). No gauge station exists below RM 18.5, but the Sandy was carrying an estimated flow of 85,000 cfs when it entered the Columbia River during this flood. This topped the estimated high flow of 82,000 cfs during the 1964 flood (ODFW 1997).

Water allocations for agriculture and other out-of-stream uses are limited along much of the river by geography. As discussed previously, below Marmot Dam the Sandy River enters a gorge and is contained by high walls where land use is confined. Above Marmot Dam, water is primarily removed from the river for domestic purposes. Water right allocations in the Alder Creek and Cedar Creek drainages, however, exceed available streamflows. In Alder Creek, the city of Sandy holds the largest water right for its municipal water supply. Once the city removes its allocated supply, little water remains in the lower section of Alder Creek below the diversion. Water allocations generally do not affect flows in Cedar Creek since a large portion of the water rights in the Cedar Creek subbasin are for fisheries and may not be removed from the stream.

Below Marmot Dam, water diversions to the Bull Run River powerhouse alter the Sandy River's natural flow regime. Up to 800 cfs may be diverted from the Sandy and Little Sandy rivers in any combination for the project, with up to approximately 600 cfs taken from the Sandy River. Water diverted at Marmot Dam (RM 30) is released into the lower Bull Run River at the powerhouse and flows back into the Sandy at the confluence of the Bull Run and Sandy rivers (RM 18.5).

Before minimum streamflows were established for the river in 1973, flow diversions for power production sometimes left little water in the Sandy below Marmot Dam. Low flows in the 11-mile reach kept many spring chinook and other species from migrating upstream from early summer through early fall. Peaking operations at the facility also affected fish by causing wide fluctuations in the flow below the dam. Large daily, and sometimes hourly, changes in flow were typical (ODFW 1997).

Since 1974, minimum flows have been maintained in the Sandy River below Marmot Dam to provide fish passage and increase rearing areas. Minimum streamflow requirements for the Sandy River below Marmot Dam are:

- 200 cfs (June 16 through October 15)
- 400 cfs (October 16 through October 31)
- 460 cfs (November 1 through June 15)

The improved flows provide spring chinook and other fish with adequate water for upstream migration in summer and fall. They also create additional rearing area in the river below the dam. In addition, peaking operations at the dam are now controlled to reduce wide fluctuations in streamflows.

To provide minimum streamflows in the Sandy River but still meet hydropower needs, Portland General Electric normally diverts all the water from the Little Sandy, where the average flow is about 140 cfs. As a result, flows in the 1.7-mile stretch of the Little Sandy below the diversion drop to between 2 cfs and 14 cfs, which is provided through leakage and accretion. If more water is needed, up to 600 cfs can be diverted from the Sandy River once minimum flow requirements are met. Efforts are made not to spill any water past the Little Sandy diversion dam that might falsely attract fish to the stream. Water diverted at Marmot Dam is released into the Bull Run River about one mile below the mouth of the Little Sandy. The Bull Run River then joins the Sandy River about one mile below the powerhouse. The diversions alter flows in the Sandy River more during the months of June through October when less Little Sandy River water is available.

Before the early 1920s, streamflows from the Bull Run Basin contributed a significant volume of water to the lower Sandy River. Now most of the water produced in the basin is stored and diverted out of the basin, providing the Portland metropolitan area with high-quality drinking water. The city of Portland also sells surplus water annually to Portland General Electric for power production at its powerhouse on the lower Bull Run River. Water in the basin collects in the city's storage reservoirs through the spring and summer months. Surplus water in the basin is spilled in the fall and winter months after the reservoirs are filled. Decreased flows from the Bull Run River reduce the amount of available spawning and rearing habitat in the lower Sandy River during dry summer months. Streamflow diversions from the Bull Run River also contribute to higher water temperatures in the lower Sandy River (ODFW 1997).

WATER QUALITY

During spring and summer months, streamflows in the upper Sandy and Zigzag rivers are often turbid from the melting of either snow or glaciers on Mt. Hood. Fine suspended sediment, known as glacial silt or "flour" is particularly noticeable in the Sandy River mainstem from mid-to-late summer. This sediment results from the grinding of rocks under the weight of the glaciers. The Sandy River has one of the highest percentages of glacial melt of all major Oregon rivers. Some fish specialists believe that high levels of glacial flour in a stream reach — such as in the Muddy Fork of the Sandy River, upper Sandy River and the Zigzag River — reduce salmon and steelhead production, and that the turbid reaches serve primarily as corridors to better habitat in nearby clearwater tributaries (ODFW 1997).

Sedimentation concerns exist in several parts of the drainage, especially in those areas that contain unstable and easily erodible soils. For instance, several tributaries to the upper Sandy River flow through the unstable volcanic deposits on Mt. Hood. These tributaries, such as the Muddy Fork of the Sandy River (appropriately named) and Lost Creek gather large amounts of sediment as they carve through the steep, easily erodible drainages. The areas introduce large amounts of sediment into the stream system that settles out in lower gradient areas.

Water quality problems in some Sandy River tributaries can be attributed to land use practices. For example, turbidity, erosion and poor stream structure in the Lost and Clear creek drainages are largely attributed to landslides and debris torrents caused by road building, timber harvest and fires in the drainages (USFS 1996). Erosion from agricultural lands in the lower system also affects water quality and limits potential spawning and rearing area. Erosion and resulting turbidity weaken stream stability and reduce the quality of fish habitat. Sediment in a stream channel alters the structure and width of the streambanks and adjacent riparian zones. Spawning and rearing habitat is also affected when the sediment settles over spawning gravels.

Water temperatures in the upper Sandy and many of its tributaries remain cool most of the year because of snowmelt from the glaciers. Stream temperature readings, while limited, show that water temperatures in the upper basin typically range from 55E to 65EF in the summer (ODFW 1997). The water becomes even cooler near the headwaters where snowmelt enters the system. These temperatures favor fish production and survival in many Sandy River streams.

High summer water temperatures are evident in some upper basin streams. Data from the Storage and Retrieval (STORET) Database, which is maintained by the Environmental Protection Agency, shows that water temperatures exceed the state standard for salmonid spawning, egg incubation and fry emergence in several Sandy River tributaries, including Clear, Chance and Alder creeks, and the middle and lower sections of the Clear Fork (USFS 1996).

Stream temperatures are also higher in the lower basin. Below Marmot Dam, water in the Sandy River usually ranges from 60E to 70EF, but temperatures may exceed 70EF during summer months when long, hot weather persists. Some lower river tributaries, including Beaver Creek, also display high water temperatures in late summer. During winter months, water temperatures in the Sandy River range between 40E and 50EF.

In addition, a thermal difference sometimes occurs at the confluence of the Bull Run and Sandy rivers. For instance, in August 1993 water temperatures rose to as high as 70EF in the Sandy River just above its confluence with the Bull Run River. At the same time, flows in the lower Bull Run River only reached a temperature of 63EF. Flows in the lower Bull Run River likely remain cooler than flows in the Sandy River because they are largely made up of water diverted from the Sandy at Marmot Dam. Natural streamflows in the lower Bull Run are otherwise significantly reduced as the city of Portland stores most of the water upstream for municipal purposes. Once the water leaves the Sandy River at Marmot Dam, it enters a network of flumes and underground canals that prevent water temperatures from rising. The water is exposed to the sun for a short time in Roslyn Lake but thermal gains are minor. Water remaining in the Sandy River is exposed to the thermal effects of sunlight for a longer period (ODFW 1997).

Sodium chloride is a water quality concern in the Sandy River during certain times of the year. Sodium chloride is applied in spring and summer months at the rate of 600,000 to 1,200,000 lb per year to maintain skiing conditions on the face of Mt. Hood (USFS 1996). Chloride and specific conductance levels are elevated moderately above background levels in streams that drain the salted areas. Most of the snowfield drains into the Salmon River, and a small amount drains into Still Creek, a Zigzag River tributary. The effect of these salt concentrations on fish production is unknown. The concentrations decrease downstream as the flow is diluted with additional surface and groundwater.

SUMMARY

Generally, natural physical conditions in the Sandy River Basin provide good to excellent habitat for fish. Salmon and steelhead thrive in the river system's clear waters with ample spawning and rearing area. People have also recognized the value of the Sandy basin's natural resources. As is discussed in the coming sections, mounting demands for timber, salmon, power, water and other resources in the basin over the last 150 years have significantly impacted the Sandy River system and its salmon and steelhead runs.

A CHANGING LANDSCAPE

INTRODUCTION

In 1800, much of the Sandy River Basin remained untouched by human development. The ecosystem, as discussed in the last chapter, provided a healthy environment for salmon and steelhead production. A diverse growth of trees and understory vegetation still armored most stretches of the Sandy River and its tributaries. The river ran cool and steady through the year supporting strong populations of salmon, steelhead and resident fish. This ecosystem was not absolutely stable. As in all river systems, natural events caused regular and sporadic changes in the ecosystem over time. For example, seasonal floods often caused the stream channel to move or create meanders. Still, the channel maintained a long term balance as its overall health allowed it to recover from naturally occurring disturbances.

Human activities, especially those after the early 1800s, changed this ecosystem. As more people moved into the area, the natural landscape and river system were developed and harnessed to provide for their growing needs. They harvested riparian forests, removed instream logs and other wood, extracted sand and gravel from the stream channel, built dams, and diverted streamflows, thus altering habitat conditions that supported Sandy River salmon and steelhead populations. By changing conditions in the watershed, they contributed to a dramatic decline in salmon and steelhead production.

This section reviews settlement and development in the basin over time. It provides a context for understanding how a combination of actions through the years contributed to the degradation of wild salmon and steelhead runs in the Sandy River Basin.

USE BY INDIANS

> *"From time before history the Indians had roved the wilds, fished the rivers, garnered the natural vegetables and fruits, and hunted game for food and clothing (Lynch 1973)."*

Indians and other native people lived along the lower Columbia River as early as 10,000 years ago. Evidence found by archaeologists shows that these early residents of the area inhabited the lower Columbia floodplain, especially near The Dalles area, which lies east of the mouth of the Sandy River on the Columbia and eventually became an important trade center (USFS 1993). Signs of their presence in the northern Oregon Cascades also date back at least 8,000 to 10,000 years (Burtchard et al. 1993). These early residents were often transient, moving through the region with the different harvest seasons. They gathered huckleberries and other food on upland meadows, fished for salmon, and hunted elk and deer.

Indian people also peeled bark from trees for making baskets, clothing, bandages and other items. Research suggests that the Indians established their villages on floodplains and traveled in small groups to upland harvest areas. Thus, while no evidence exists, it is highly likely that Indians from the lower Columbia River made trips up the Sandy River (USFS 1996). Traces of these early inhabitants include the petroglyphs carved into the basaltic rocks of the Columbia River Gorge.

Within the last few thousand years, the Indians built a trail network that extended across the Cascade Range around Mt. Hood. The travel route provided access to and from the trading center, Wascopam, near The Dalles that attracted Indians from around the region, including the Willamette Valley (USFS 1993). One popular trail extended up the Sandy River and over Lolo Pass. Another early trail, which later became the Barlow Road, joined the trail to Lolo Pass near the confluences of the Zigzag, Sandy and Salmon rivers (USFS 1996). The Indians would return by the same trails to their harvest areas year after year. Large mortars, too heavy to carry, have been found at the old campsites along Cedar, Eagle and Deep creeks (Strong 1973). Indians from villages along the Columbia, Clackamas and other rivers also boated to the Sandy River area to harvest salmon, berries, nuts and roots.

SETTLEMENT AND USE BY EUROAMERICANS

The interior valley of the Columbia River Basin, including the Sandy River drainage, remained largely unexplored by Europeans and Americans until Lewis and Clark came over the Rockies in 1805. Explorers visited the Sandy River Basin periodically in the early 1800s. They would boat up the river or follow the old Indian trails into unexplored country, as they knew the best paths would have been found over the years. Trappers also visited the area, but their use was limited since trapping was more plentiful in the Willamette Valley.

Daniel Lee, son of missionary Jason Lee, made one of the first documented visits to the area. In 1838, Daniel Lee followed the existing trail over Lolo Pass when he drove cattle from a Methodist mission in the Willamette Valley to a newly established mission at Wascopam. The trail was subsequently used by other pioneers to drive their livestock over the Cascades. The first wagons arrived over the Cascades in 1840 (Lynch 1973).

In 1843, the great immigration to the Oregon Territory began. The Barlow Road, following an old trail, opened in 1846 and soon became a popular route for bringing emigrants across the Cascades. A branch of the Barlow Road followed the ridge called Devil's Backbone between the Sandy and Little Sandy basins to the northeast corner of Roslyn Lake. Most emigrants headed for the rich agricultural lands in the Willamette Valley, but some settled on lands along the Sandy River. As the area grew, many old Indian trails became roads. Some of these roads, called "corduroy" roads, were widened and covered with split logs laid crosswise (Lynch 1973).

Access to the Bull Run River[1] area improved in 1887 when the city of Portland began investigating the river as a main source for the city's water supply. A small community, "Unavilla", was established in the area around 1893. The name of the community was changed to Bull Run in 1895 (McAurthur 1982). The 1915 *Oregon Almanac* describes the community as including about 100 residents who supported themselves through timber harvest, farming, dairying and raising potatoes. The community, situated on the Bull Run River and at the terminus of the Mt. Hood division of the Portland Railway Light and Power Company railroad, had privately owned electric lighting and water systems. It is described as surrounded by rich agricultural land (including a nearby large-scale commercial flower bulb farm, the Crissey "Gladiolus Farm"), beautiful forests and river scenery (EDAW 1998). Today, the community of Bull Run remains an unincorporated town within Clackamas County.

The development of areas east of the Cascades for agricultural use spurred activities in the Sandy River Basin. Demand grew for a better transportation corridor over the mountains, and the Barlow Road was improved from a one-way, east-to-west route to allow two-way traffic. As traffic increased along the road, entrepreneurs moved into the area to provide accommodations and other services for the travelers. New settlers established homesteads along the road and in the lower Sandy River valley, particularly near the present cities of Sandy, Gresham and Troutdale. The Sandy post office was established in 1873 (McAurthur 1982).

At the turn of the century, most of the Sandy watershed remained a remote wilderness area and trails were the primary source of access to the upper basin. Thus, when the Mt. Hood Railway and Power Company began work on the Bull Run hydroelectric project in 1906, it had to develop road and then rail access to the site. Initially, it took three hours by stage to get to Bull Run from the electric interurban depot at Boring. The roads from Sandy to Bull Run, and from Bull Run to the Marmot Dam area had to be planked during periods of heavy rain to support traffic. Travel conditions improved in June 1911 when the railroad was completed, running 20 miles from Montavilla to the Bull Run powerhouse. The Portland Railway, Light and Power Company electrified the route in 1913 from Montavilla to Ruby Junction on the Troutdale line.

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1 McAurthur, author of "Oregon Geographic Names", suggests that the name Bull Run River "may have started from the presence of wild cattle on that river in the pioneer period (1849-55). Cattle escaped from immigrants . . . and ran wild a number of years".

Development of the railroad line lured more people to the area. As discussed below, regular rail service between Portland and Bull Run made it easy for residents to transport timber, farm crops, livestock and other products to city markets.

> *Cordwood, brick, fir logs, gravel, and crushed rock were imported from along the Springwater and Mt. Hood divisions, which extended to Troutdale, Gresham, Cazadero and Bull Run. Perishables — fruits, vegetables and dairy products — were soon hauled into the city this way, opening new markets for surrounding farmers. Businesses in smaller cities prospered as the system provided same-day service for supplies (PGE 1989).*

Public demand for access to recreational areas in the upper watershed led to the completion of the Mt. Hood Loop Highway by the 1920s. The road brought new recreational areas within reach of area residents. The rail line was abandoned in 1927 as more areas became accessible by roads and people began to travel mostly by auto.

The basin's population expanded rapidly after 1950. Road improvements and the expansion of the transportation network provided better access, especially to lands in the upper watershed. Forest Road 18, built in the 1950s, connected Highway 26 to Hood River County and allowed construction of the Big Eddy/Troutdale transmission line from The Dalles Dam. The road also provided better access to the Bull Run watershed. Road 18 became a primary road on the Mt. Hood National Forest, carrying visitors to campgrounds, trailheads and other locations.

Improved access also attracted new residents. People found they could live in the basin's beautiful mountainous and rural settings, and commute to jobs and city life in the close by Portland metropolitan area. As a result, the area's population continued to grow. The 1990 census data revealed a 9 percent population jump from 1980 within the Mt. Hood corridor — which stretches from Brightwood up to Government Camp. During the decade, a 41 percent increase in housing units also occurred (USFS 1996).

TIMBER HARVEST

By the mid-1800s, settlers in the Willamette Valley began looking toward the Cascades to meet increasing demands for lumber, firewood and other resources. The demand for timber, particularly in the booming Portland metropolitan area, brought extensive timber harvest to the more readily accessible parts of the Sandy watershed.

Timber harvest in the lower basin began by the late 1850s. The first mill in the basin was built on Cedar Creek in 1858 and another mill was built soon after on Deep Creek (Strong 1973). Many logged areas, such as near the community of Sandy, were later cleared and cultivated for agricultural use or as private tree farms.

Logging intensified in the early 1900s, and by 1907 many sawmill operations existed in the lower Sandy River Basin. These early sawmill operations sprung up around the areas of Sandy, Firwood, Dover, Eagle Creek, Boring, Marmot, Pleasant Home, Welches and Brightwood. In 1907, a mill built on Tickle Creek south of Sandy was one of the first large mills to be built within walking distance of the town of Sandy (Strong 1973). When possible, many early loggers floated the wood downstream to mill sites and markets.

Arrival of the railroad allowed logging activities to expand further in the lower basin and into higher elevations, including the Cedar and Badger creek drainages. Logging companies constructed railroad spurs reaching as far as the headwaters of Cedar Creek. This allowed some loggers to ship their logs by rail.

Beginning in the 1950s, the Forest Service constructed a number of roads to reach timber in the upper watershed. It built about 48 miles of road to provide access to Wildcat Creek/Wildcat Mountain, Alder Creek and other higher elevation areas. It also built roads to reach timber in the lower watershed and along the north and south forks of the Sandy River.

Road construction in the watershed continued after 1960. The Forest Service built about 26 miles of new road in the upper Sandy watershed during the 1960s, including Forest Road 2609, which provided access to Cedar Creek. It also built several secondary roads into the Lost Creek and Horseshoe Creek drainages. More roads were built in the upper watershed through the 1980s, including 25 miles of road into the middle Clear Fork drainage during the 1970s and another 16 miles near Cedar and Alder creeks and into the Wildcat and North mountains during the 1980s.

Major road development also took place after 1960 in the Bull Run watershed. During the 1960s and 1970s, the Forest Service constructed nearly two-thirds of the forest roads now existing in the Bull Run drainage — more than 170 miles. The Forest Service built most of the mainline roads in the watershed during the 1960s and expanded from them in the 1970s. It added another 12 miles during the 1980s and 1990s. Currently, the Bull Run watershed contains 320 miles of road.

Road construction and timber harvest practices over the years damaged fish habitat in the basin. In the early years, valuable timber covered much of the watershed and harvest was generally unrestricted. Consequently, harvesters located their operations along streambanks where logs could easily be floated downstream to mills. Logging in riparian areas was common until the 1970s when scientists recognized the importance of riparian vegetation in maintaining healthy river systems. Timber was also removed from many accessible sensitive slopes. In addition, downed wood and boulders were regularly removed from navigable waters to ease the driving of logs downstream.

Reports published by Oregon's Master Fish Warden describe extensive logging in the basin. An agent for the Salmon River Hatchery wrote:

> *"at one time, this station was one of the best we had, but for the past few years it has succeeded in taking but a small number of eggs. There is so much logging done on the Sandy River . . . that I am sure the salmon are kept out of the stream (Oregon Department of Fisheries, 1909)."*

Another report written in 1911 states:

> *"as a large amount of saw mills and logging camps have operated on the Sandy River for years past, preventing the salmon from entering the stream, the number of eggs secured does not justify the expense of maintaining the hatchery. Next year I will move further downstream where an eyeing station will be located (Oregon Department of Fisheries, 1911)."*

Other reports discuss the effect of such activities on water quality. In 1890, sawdust and other mill waste were common pollutants in any stream in the state (Oregon Fish Commission 1889-1890).

Extensive road construction and timber harvest in the upper Sandy watershed after 1950 damaged fish habitat in many stream reaches. The roads increased soil erosion and carried sediment to stream channels where it filled pools and clogged spawning gravels. Other damage resulted when road culverts became blocked with debris or otherwise barred fish from reaching spawning grounds. Road construction and timber harvest also altered natural hydrological conditions by increasing surface runoff.

Today, timber harvest continues to be one of the most important industries in the area. However, harvest practices have improved. Current harvest and regeneration techniques are designed to reduce impacts on the watershed. For example, the treatment of harvest areas improved in the mid-1980s when forest personnel began applying new methods to increase new tree growth and survival. These methods included using fertilizers and planting higher quality trees in harvested areas.

Still, timber-related activities over the past 100 years caused significant changes in the Sandy River watershed. Intense timber harvest and road building in the upper and middle basin created large open patches that now dominate the structure and function of the landscape. In addition, riparian areas are often smaller, contain fewer diverse vegetative communities, and provide less of a buffer against high streamflows (USFS 1996).

MINING

Sand and gravel operations, particularly along the lower Sandy River, occurred periodically for many years. Generally, these operations changed conditions within the mined stream reaches. They affected fish production and reduced habitat complexity through removal of undercut streambanks, degradation of channel stability, extraction of spawning gravels and by creating barriers to migration. Mining in the delta area stopped when it became part of the Columbia River Gorge Scenic Area.

AGRICULTURE

During the mid- to late-1800s, new settlers began cultivating the lower basin's rich stream bottom land, fertile plateaus and rolling hills. By the late 1800s agricultural use was common in the lower basin below the town of Sandy and along the plateaus of the lower Sandy River and tributaries such as Beaver Creek. Early farmers grew vegetables, berries, fruits and grain and often sold their products in Portland area markets.

Over the years, the lower basin has continued to support agricultural uses. However, in addition to producing vegetables, berries, fruits and grains, farmers also grow ornamental plants and trees. Further, many once productive parcels of agricultural land have been converted to residential or commercial use to support the area's growing population.

Cultivation of lands in the lower basin for agricultural use impacted habitat conditions along the lower river and tributaries. Conditions in the lower watershed changed as wetlands and floodplains were drained and filled. Stream stability and habitat diversity were also affected by removal of riparian vegetation and, in some drainages, streamflows for irrigation purposes. Such impacts are evident along Beaver Creek, a large lower basin tributary.

RECREATION

By the mid-1800s the peaks of Mt. Hood were already challenging early mountaineers. Government Camp, a campground for pioneers after Samuel Barlow left wagons there in 1845, became the starting point for many Mt. Hood climbers. Joel Palmer reached the top of the mountain in 1845. Many other climbers soon followed in his footsteps. During an outing in July 1896, a group of about 350 climbers from all over Oregon met at Government Camp. They traveled to the camp in four-horse-drawn coaches. Before cars, travelers to Government Camp followed Foster Road to Sandy, dropped down to cross the Sandy River, climbed up a hill on the river's other side just below the Devil's Backbone to Marmot, and then went through Cherryville, Brightwood, Wemme, Zigzag, Rhododendron and up Laurel Hill to the mountain (Lynch 1973).

Recreation continued to grow in the 1900s with expansion of the railroad. Roads generally remained in poor shape, but the railroad provided relatively quick and comfortable transportation to recreation sites. For instance, people from the Portland areas could take the trolley to Bull Run Park[2] (Dodge Park) at the confluence of the Bull Run and Sandy rivers and return home that evening. Thus, the park received heavy use, particularly on weekends. According to one report,

> *"a conservative estimate of visitors during the last summer would be thirty thousand . . . at times there was hardly room enough to accommodate the crowds that poured into the park on Sundays . . . hundreds enjoyed swimming in the hole below the bridges" (Portland Bureau of Water Works 1926).*

The turn of the century also saw more visitors to the white peaks of Mt. Hood. However, before the late 1920s — when car access improved — recreational use in the upper watershed was limited. A trip to the Government Camp area, a popular destination, remained long and tiresome until the 1920s when the Mt. Hood Loop Highway was completed. Once the highway was built, summer and weekend visitors came to picnic and explore the area. Recreation facilities improved in the 1930s when the Civilian Conservation Corps (CCC) and the Works Progress Administration (WPA) built campgrounds and trails in the watershed. Several summer cabins were also built in the forest at this time. Generally, however, activities in the upper Sandy watershed remained limited by the lack of access until after 1950 when the road network in the forest was expanded.

MUNICIPAL WATER SUPPLY DEVELOPMENT

In 1891, the city of Portland — which had grown into a thriving metropolis — began efforts to secure a continuous supply of clean water from the Bull Run River, a pristine tributary of the Sandy River. President Benjamin Harrison established the Bull Run Reserve in 1892, protecting the high-quality supply of potable drinking water for Portland. On January 1, 1895, the city finished building its first conduit and

2 The park was originally known as Bull Run Park, but was renamed Dodge Park in 1918 in honor of Frank T. Dodge of Portland's Bureau of Water Works.

water diversion at the site of the present Headworks Dam (RM 6) on the Bull Run River and started transferring water to Portland.

The city built several new structures in the Bull Run watershed in the early 1900s. In 1911 it completed a second conduit to carry Bull Run water to Portland. Then, in 1915 it built a 10-foot-high rock and log crib structure at the outlet of Bull Run Lake, a natural water body in the headwaters of the Bull Run watershed. The structure raised the lake's storage capacity to about 4 billion gallons of water. In 1922, the city built Headworks Dam, 20 feet high with no fish passage facilities. It constructed a second dam, the Ben Morrow Dam (Bull Run Dam No.1), in 1929 near the confluence of Bear Creek and the Bull Run River (RM 11). The structure, about 200 feet high, impounded about 10 billion gallons of water. The city also built a small reservoir, Boody Lake, on the North Fork of the Bull Run River near the headwaters that stored about 0.4 billion gallons of water.

Early records do not discuss whether the dam built in 1895 on the lower Bull Run River hindered salmon and steelhead migration. However, biologists generally believe that many fish could have passed over the dam, which stood less than 10 feet high. This migration ended in 1922. Since then, Headworks Dam (RM 6) has blocked all salmon and steelhead access to the upper Bull Run system, about 37 miles of high-quality habitat in the mainstem and tributaries. In addition, water diversions at Headworks Dam have damaged habitat conditions in the six miles of free-flowing river below the dam. The diversions reduce flows in the lower Bull Run River from late spring to fall, and limit recruitment of gravel and large woody materials that had once created healthy, diverse fish habitat.

HYDROELECTRIC DEVELOPMENT

Incredible population and industrial growth in the Portland metropolitan area during the early 1900s created a hunger for a larger electric power supply. Power was needed to fuel the extensive system of interurban railroads and trolleys spreading south from the Columbia River to Salem in the middle Willamette Valley. The region also needed power to bolster growing industrial and residential developments. Electric requirements increased at a rapid rate and low-cost hydroelectric generation became more attractive for bulk power supply.

Hydro developers directed their attention to the Sandy River at the turn of the century. Hydroelectric power development on the Sandy and Little Sandy rivers began in September 1906, with the incorporation of the Mt. Hood Railway and Power Company (Mt. Hood Company). Actions by this company soon ignited the competitive interest of two other companies, the Portland and Sandy River

Electric Company and the United Railways. Following the Mt. Hood Company's lead, these companies quickly began investigating potential hydropower sites on the Sandy River. The investigations led to the development of several hydropower projects on the Sandy. The projects are discussed briefly below.

Bull Run Project

In 1906, the Mt. Hood Company started work on the Bull Run project. This project included construction of a powerhouse on the lower Bull Run River (RM 1.5) and a diversion dam on the Little Sandy River (RM 1.7), a tributary of the lower Bull Run River. The Little Sandy diversion dam stood about 16 feet high and diverted water through a 17,000-foot-long wood box flume to Roslyn Lake, which covered approximately 140 acres and formed the forebay for the Bull Run Powerhouse. The Mt. Hood Company began operating the powerhouse on Little Sandy River water in 1912. That same year, it merged with the Portland Railway Light and Power Company, Portland General Electric's predecessor.

Construction and operation of the Little Sandy diversion dam reduced natural fish production in the Little Sandy River, a system that is believed to have once contained good anadromous fish habitat. The diversion dam blocked salmon and steelhead access to about 6.5 miles of habitat above the dam. It also reduced streamflows in the 1.7-mile reach between the dam's lower end and the river's confluence with the Bull Run River.

Marmot Dam

In 1913, the company completed construction of Marmot Dam on the Sandy River (RM 30). The 30-foot-high dam diverted water from the Sandy River to the Little Sandy River via a network of canals and tunnels. The longest tunnel, 4,690 feet, ran under a mountain ridge connecting the two basins.

That year, the company started diverting up to 600 cubic feet per second (cfs) of water from the Sandy River to the Little Sandy River just above its diversion dam. The combined waters were then diverted to Roslyn Lake through a wood box flume that ran along the Little Sandy River's south bank and carried up to 800 cfs of water.

Upon completion, Marmot Dam was provided with a wooden fish ladder. However, the ladder entrance was damaged by flood water during its first season of use and the company had to extend the entrance upstream. Floods in the following years repeated the damage. The company regularly repaired and improved the ladder, though it was being used extensively to trap adult salmon and steelhead for hatchery production. Correspondence between the company and state fishery managers suggests that the game warden wanted the ladder to permit fish migration over the dam, but the fish warden wanted modifications to help the capture of fish for hatchery purposes. A fish and game commission report on the repair problem, for instance, referred to a Deputy Fish Warden *"who has charge of the hatchery work below your dam."* The company received another letter from the Master Fish Warden in July 1913 that referred to *"the superintendent of our egg taking station at your dam on the Big Sandy."* However, a letter from the Fish Warden the following March commented on high water damage requiring *"that immediate steps are taken to repair this fishway . . . so that the fish will be able to reach the water above the dam (PGE 1982)."*

Between 1913 and 1933, the company rebuilt and improved the ladder often to enhance fish passage. In 1918, the company reconstructed 15 pools at the lower end of the ladder and reinforced them with concrete. It also rebuilt and improved the upper 16 wooden pools. In 1926, the company installed two concrete pools at the lower end of the ladder and raised the wall height on the previously installed 15 pools. The remaining wood sections were replaced with reinforced concrete pools in 1930. By 1933, improvements to the fishway had cost 13 times that of the original structure. While these changes improved fish passage at the dam, egg-taking operations at or below Marmot Dam until the early 1950s, ladder damage, and low flows persisted in hindering fish migration to the upper basin through the 1950s.

More changes took place in the 1970s. In 1971, the company installed an exit gate to the ladder with a submerged weir that adjusted to the rise and fall of the river level and stopped bed load from entering the ladder. Then in 1974, upon request by Oregon's fish and game commissions, the company began leaving more water in the Sandy River below Marmot Dam to improve fish passage and increase rearing area in the lower Sandy River.

Portland General Electric continued to improve the fish passage facilities. In 1983, the company upgraded the fish ladder on the south bank of Marmot Dam for upstream fish passage. It also installed a fish counter at the facility to provide daily fish counts. This counter was replaced in 1996 when the previous counter was determined unreliable. Because of these changes, Marmot Dam's fish ladder now allows adequate upstream fish passage (ODFW 1997).

Over the years, efforts have also been made to reduce impacts on downstream migrants, which were often swept into the Sandy River diversion canal. In 1948, Oregon's fish and game commissions asked the company to install screens in the diversion canal to prevent downstream migrants from reaching Roslyn Lake. The company soon began engineering and design studies. The screen became operable in 1951 and has been improved several times over the years. The downstream juvenile bypass system was further improved in the 1980s. Ten collection ports in the side walls and in the metal beams separating the screens diverted the fish into a chamber under the screens and then into a pipe. The pipe, about 36 inches in diameter and 200 feet long, emptied into a plunge pool near the shoreline of the Sandy River below Marmot Dam. Water from the plunge pool directed the fish into the Sandy River or into a trap where biologists could monitor juvenile downstream fish passage.

Today, the company continues to monitor salmonid mortality and effects on migration at the project's facilities. Because of these studies, conducted in coordination with fish managers, the bypass system has been modified several times. The company has placed baffles upstream from the screens to provide a uniform flow at the screen surface. It has also refinished the inside of the transport pipe, deepened the plunge pool, built a trap and enlarged the bypass ports to increase the flow of water through each port.

Dam operations have also been adjusted to maximize fish survival at the rotating screens and downstream juvenile bypass facility. Currently, the bypass system is operated under the following criteria:

- The fish bypass operates on a continuous basis whenever water is diverted into the canal.
- Canal screens run all year, but are rotated from March 1 through May 31 when fry are present.
- Screen wash spray pressure is kept at 30 psi from March 1 to May 31.
- Bypass flow is maintained at 60 cfs so water enters ports at 2 feet per second.
- When many smolts are observed in front of the screens, canal flows are lowered to flush fish through the bypass and back into the river.

Studies of the downstream juvenile migrant bypass facility at Marmot Dam show that survival is now high. Cramer (1993) concluded that, though the proportion of downstream migrants diverted into the canal is unknown, an estimated 95.4 percent of the fry (fish smaller than 50 mm) that enter the bypass facility survive. When biologists released hatchery smolts into the system, they found that about 97.3 percent of the steelhead test smolts and 95 percent of the spring chinook test smolts survived passage through the bypass system. Survival of wild steelhead smolts was near 99 percent, though there were not sufficient numbers for a full test. Today, the company continues to address remaining concerns to improve downstream migration through the bypass system. Most recently, in 1998 the company added a new surface collector system for fry. The effectiveness of this system is presently being evaluated.

FISH HARVEST

Salmon and steelhead runs to the Sandy River began dropping by the late 1800s with the expansion of the fishing industry. Fishing parties on the Columbia and lower Sandy rivers caught scores of fish bound for the basin's spawning grounds.

In the early days, harvest focused on spring chinook. Commercial harvest of spring chinook began on the Columbia River in the mid-1800s and grew quickly until it peaked around 1873 with a take of about 43 million pounds (Oregon Game Commission 1951). Spring chinook harvest on the Columbia then declined significantly, suggesting that the river's spring chinook run had already been weakened by overharvest. Records show that in 1877 more than 1,000 drift nets were in the Columbia, each 1,200 feet long (U.S. Commission of Fish and Fisheries 1877). Commercial gear regulations were not adopted on the Columbia until 1878.

Heavy fishing on the Columbia River persisted into the 1900s, but an important change took place. Commercial fisheries continued to harvest about 25 million pounds of fish each year until 1922, but spring chinook made up less and less of the catch. Around 1880, spring and summer chinook salmon runs started declining and harvest shifted to fall chinook salmon. By 1912 spring and summer chinook comprised 75 percent of the fish in the harvest and by 1920, the catch was estimated to be 50 percent fall chinook (Lichatowich and Mobrand 1995). Harvest emphasis also moved to steelhead (1890 to 1900) and then to coho (1920s). Peak commercial catches for chinook and coho occurred in 1883 and 1925, respectively (Lichatowich and Mobrand 1995). Generally, commercial harvest of all species declined steadily after 1923, with an average annual harvest of 15 million pounds from 1923 to 1958 (Lichatowich and Mobrand 1995). By 1945, production of all species had declined significantly.

Many other salmon and steelhead from the Sandy River were harvested in ocean fisheries. In 1912, the ocean troll fishery (towing a hook and line behind a boat) began competing with the Columbia River fishery. The troll fishery initially began off the mouth of the Columbia River. The number of boats doubled from about 500 in 1915 to about 1,000 in 1919 (Northwest Power Planning Council 1987). The ocean troll fishery expanded through the 1920s and peaked in the mid-1930s. During this time, it took a significant portion of the fall chinook, spring chinook and coho destined for the Columbia River Basin (ODFW 1997). Until 1948, there were few restrictions on the ocean fisheries.

Ocean and Columbia River fisheries expanded again in the early 1960s when the wild salmon and steelhead production of the previous decades was replaced by improved hatchery production. The fisheries climbed significantly in the 1970s, but have steadily declined since then (ODFW 1997). Some fisheries continued to affect Sandy River runs into the 1990s. Coho harvest records, for instance, show that before 1993 commercial fisheries in the ocean and Columbia River intercepted many Sandy Hatchery coho. For the 12-year period 1981-1992, total ocean commercial harvest of Sandy Hatchery coho averaged about 19,170 fish annually, about 43.5 percent of the total Sandy Hatchery coho available (ODFW 1997).

Today, fisheries outside the basin continue to harvest many Sandy River salmon and steelhead. Harvest rates and overall contribution of Sandy River spring chinook to various fisheries outside the basin are unknown, but are believed to resemble harvest rates on Willamette basin stocks. Records show that approximately 67 percent of the Willamette spring chinook harvested in ocean fisheries are caught in British Columbia and about 33 percent are caught in southeast Alaskan waters (ODFW 1997). Out-of-basin fisheries also harvest many Sandy River fall chinook. In addition, studies suggest that commercial and sports fisheries outside the basin, including ocean fisheries, may harvest up to 50 percent of the native fall chinook run destined for the Sandy River based on harvest rates reported for wild fall chinook from the Lewis River, a lower Columbia River tributary in Washington (brood years 1982-87: adult return years 1984-93) (ODFW 1997).

Salmon and steelhead runs have also been targeted for harvest in the Sandy River. While the river system has always attracted anglers, fishing for spring chinook on the lower Sandy grew in popularity during the late 1800s and early 1900s as the region's population expanded. The development of the railway, roads and easily accessible sites, such as Dodge Park, on the lower Sandy River created more fishing opportunities. Fishing pressure in the basin continued to grow for many years as the region's population expanded and the construction of new roads provided better access.

Present salmon and steelhead runs still support popular sport fisheries in the Sandy River Basin. In-river sport coho harvest data shows that sport anglers caught an estimated average of 1,263 coho annually in the Sandy River for the 12-year period 1981-1992. Sandy River spring chinook also support a substantial sport fishery in the river, primarily below Marmot Dam (RM 0-30). This fishery has increased in parallel with hatchery smolt releases in the basin over the last 15 years. Fall chinook fishing in the Sandy River Basin is generally limited by natural conditions, since by the time the adults return to the river to spawn, their condition and meat quality has deteriorated.

Winter steelhead continue to be the most popular game fish in the Sandy River. Before catch-and-release regulations were started in 1990, in-basin harvest of winter steelhead significantly affected spawning and escapement of wild winter steelhead into the upper basin. Today, hatchery winter steelhead are released at popular angling spots such as Oxbow and Dabney parks on the lower river. Such releases concentrate adult returns in the areas where most harvest takes place and protect the native stock from competition in important upper basin spawning and rearing areas.

SUMMARY

The Sandy River Basin has seen significant changes since the middle 1800s. Over the last 150 years, large amounts of timber have been removed from basin forests. Other lands have been cultivated for agricultural production or otherwise developed to accommodate increasing residential and industrial growth. The Sandy River and many tributaries have also been transformed. Since the mid-1800s, human efforts to extract and harness resources have disturbed natural stream hydrology, streamflow patterns, channel structure and water quality within the Sandy River system. Human impacts include the building of dams, removal of streamflows, stream channelization, extraction of instream gravels and downed wood, loss of riparian vegetation, and the destruction of side channels and wetlands. Together, these changes have contributed to dramatic losses of salmon and steelhead habitat and productivity. Basin salmon and steelhead runs have also been greatly reduced by harvest activities in the Columbia River, ocean and Sandy River.

The following sections discuss salmon and steelhead production in the Sandy River basin through the years. Human activities and developments discussed in this section directly influenced these runs and actions taken to improve them. Consequently, the key events that shaped conditions in the drainage during each period are often mentioned in the discussions and are summarized at the end of each section.

SALMON AND STEELHEAD RUNS BEFORE 1900

INTRODUCTION

Before the 1800s, Sandy River anadromous and resident fish populations flourished in a pristine environment full of shallow gravel beds, deep pools, and cool mountain streamflows. Winter steelhead and coho spawned and reared in most accessible reaches of the basin and spring chinook were abundant in the main Sandy, Salmon, Zigzag and Bull Run rivers. Fall chinook ranged through the lower Sandy and tributaries such as Gordon and Trout creeks and the Bull Run River, and into the upper Sandy and large tributaries including the Salmon River. A small number of chum also returned to the lower Sandy River (Mattson 1955).

As discussed previously, salmon and steelhead runs to the Sandy River and other Columbia River tributaries began to drop by the early 1870s — most likely because of overfishing on the Columbia River. Developments within the Sandy River Basin also began to affect fish production. By the late 1800s, widespread timber harvest and other developments in the lower basin had already damaged some habitat areas. Human activities also hindered salmon and steelhead migration to traditional spawning and rearing grounds. Hatchery egg-take operations on the Salmon and Sandy rivers began to impede salmon and steelhead access to upper basin spawning grounds in the late 1880s. In addition, the City of Portland's first diversion dam on the Bull Run River (RM 6), built in 1895, may have restricted some upstream fish migration to spawning and rearing grounds in the upper Bull Run system.

FISH PRODUCTION

Historically, salmon and steelhead ranged throughout most of the Sandy River Basin. Reports by Mattson, a specialist on the Sandy River system in the 1950s, estimate that 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 Sandy and tributaries (Mattson 1955). The river system may have also supported a small native summer steelhead run. Large populations of cutthroat trout, rainbow trout, mountain whitefish and other resident fish also resided in the basin.

The decline in salmon returns to the Columbia River led to the development of fish culture operations in the late 1800s. Hatchery production in the Sandy River Basin dates from 1887 when fish propagators built temporary egg-taking stations on the Sandy and Salmon rivers (Oregon Dept. of Fisheries c1990). Their efforts focused on spring chinook, the preferred fish at the time. Fish propagators knew little about spawning, hatching and growing fish and generally learned by doing. To gather brood stock, they placed racks, or fences, with long pickets across streams. The rack, placed in the stream before the fish arrived, kept the adults from passing above that point. As the fish neared the spawning period, they were driven downstream into collection traps. This method was an adaption of Indian fishing methods. Gill nets were also used to catch fish at the racks or in deep holes, such as at the base of dams.

Once caught, the female and male salmon were stripped for eggs and milt. The fish propagators then fertilized the eggs and incubated them until they hatched. However, unlike today, early hatchery operators generally hatched millions of fry and then released the unfed fry soon after they hatched. This practice resulted in high mortality. Problems with disease, water supplies, and food sources also reduced hatchery successes.

In 1892, fish propagators established a field station in the drainage with an obstruction rack and water supply for egg development. They started taking eggs in October 1893 and continued for 30 days, collecting 1,179,000 eggs from 253 fish. The eggs were transferred to a station on the Clackamas River. Egg-takes at the Sandy site intensified in 1894 when hatchery personnel stopped egg collections at the Clackamas station because of poor supply and became more dependent on eggs from the Sandy (U.S. Commission of Fish and Fisheries 1895).

Records from 1895 describe some difficulties that early propagators experienced when trying to collect eggs. In 1895 they built a rack, 400 feet long, across the Sandy River to capture migrating chinook salmon. However, operating the rack was difficult because of the large amount of wood in the river. The propagators tried to resolve the problem by constructing a gate in the rack for logs and other wood to pass through. They also built a boom 600 feet above the rack directing the logs to the gate. Once the gate was working, they built a small temporary hatchery and hatching troughs for salmon production. Their problems returned in early September when heavy rains brought down a large amount of wood and logs. The material broke the boom and carried away a large part of the rack, permitting the salmon to escape. The propagators repaired the rack and collected 23,000 eggs from six salmon in mid-September, but more rain on October 1 carried the rack away again. They suspended their egg-taking operations after all the salmon below the rack escaped and left the 23,000 eggs to hatch in a small brook that emptied into the Sandy River (U.S. Commission of Fish and Fisheries 1895).

In 1896, propagators built a more permanent facility, a small hatchery station at the mouth of Boulder Creek on the Salmon River. They collected about 2,600,000 eggs that fall from 492 females. About

1,066,600 eggs were collected at the station in September 1897 and sent to the Clackamas Hatchery. Such egg-taking operations at the hatchery often blocked migration of chinook and coho salmon and steelhead to major spawning areas in the upper Salmon River drainage.

Table 1. Egg Collection at Salmon River Hatchery (ODFW 1997)

Year[3]	Spring Chinook[4]	Winter Steelhead
1896	2,600,000	
1897	1,216,000	
1898	745,200	22,000
1899	600,000	

Success in their egg collection efforts led propagators to establish the Salmon River Hatchery in 1898. For several years this hatchery was considered one of the best in the state because of the large amount of spawn secured. It was also regarded as one of two places where chinook salmon eggs could be collected as early as July (the other site was on the upper Clackamas River). Winter steelhead eggs were also collected in 1898.

SUMMARY

Salmon and steelhead runs to the Sandy River dropped below historical levels during the 1800s. While this decline has been largely attributed to overfishing in the Columbia River, activities in the basin during the middle to late 1800s probably contributed to reduced fish production. Escalating timber harvest and related activities after 1850, such as the driving of logs downriver to mills, degraded naturally pristine habitat conditions along parts of the lower Sandy River and tributaries. In addition, many would-be spawners were captured by fishing parties and egg-take operations in the basin. Nevertheless, while below historic levels, the success of egg-takes at a station on one Sandy River tributary, the Salmon River, in the late 1890s — 2,600,000 spring chinook eggs from 492 females in 1896 — suggests that the runs remained strong.

Many key events and developments that occurred in and outside the basin before 1900 are recapped below. Together these events provide a snapshot of activities that likely caused salmon and steelhead runs in the Sandy River Basin to enter a period of decline.

3 Records of egg takes before 1896 are incomplete.

4 Some mixing of spring and fall chinook is possible.

Key Events and Developments Before 1900

1700	Explorations and settlement by Indians.
1805	Lewis and Clark explore lower Columbia River and tributaries. Other Euroamerican explorers soon begin scouting Sandy River Basin.
1838	Daniel Lee drives cattle over Lolo Pass.
1840	First wagons arrive over Cascade Mountains.
1845	Joel Palmer reaches top of Mt. Hood.
1846	Barlow Road opens, bringing emigrants across mountains.
1858	First sawmill built in lower basin on Cedar Creek. Other mills built soon after as timber harvest in area increases.
1870	Concern grows that overfishing on Columbia River may deplete salmon runs.
1873	Commercial spring chinook harvest on Columbia River peaks at 43 million pounds.
1877	More than 1,000 drift nets in Columbia River, each net about 1,200 feet long.
1887	Fish propagators build temporary egg-taking stations on Sandy and Salmon rivers.
1890	Sawdust and other mill waste common pollutants in many streams.
1890	Harvest of steelhead on Columbia River increases as spring chinook run declines.
1891	City of Portland begins efforts to secure water from Bull Run River.
1892	President Harrison establishes Bull Run Reserve to protect high-quality drinking water supply for Portland.
1892	Fish propagators build field station for egg-taking and development.
1894	Egg-taking in Sandy drainage intensifies when fish propagators at Clackamas Hatchery stop egg-takes on Clackamas and depend more on Sandy for supply.
1895	Fish propagators build 400-foot-long rack across Sandy River. Egg-take operations hindered by floating logs and high streamflows.
1895	City of Portland completes diversion bringing Bull Run water to the city.
1896	Fish propagators build small hatchery at the mouth of Boulder Creek on Salmon River. They collect 2.6 million eggs that fall from 492 females.
1898	Salmon River Hatchery established.

SALMON AND STEELHEAD RUNS, 1900 TO 1950

INTRODUCTION

The resilience of the Sandy River's salmon and steelhead runs was further tested in the early 1900s. Fishing pressure remained steady on the Columbia River and grew on the ocean and Sandy River. Inside the basin, habitat degradation in the Sandy and many lower tributary drainages escalated as timber harvest, road building, agricultural production, hydroelectric development, and other activities increased in the lower basin and slowly spread upriver. Brood stock collection for hatchery production also continued to reduce natural salmonid production. Egg-taking for hatchery production often blocked migration of chinook and coho salmon and steelhead to the upper Salmon and Sandy rivers. The building and operating of several dams in the basin during the early 1900s also seriously affected the runs.

Naturally occurring changes in watershed conditions may have also impacted fish production. According to fire history maps, at the turn of the century approximately half of Clackamas County south of the Bull Run area — including the upper Sandy area — was classified as burned (USFS 1996). Several other fires occurred in the early- and mid-1900s, burning large sections of the upper Sandy, Salmon, Zigzag and Bull Run drainages. While detailed information on the fires is not available, they would have created large openings in the forest canopy. This change may have increased peak streamflows, since exposed snow would melt more quickly. It may have also increased water temperatures in the uncovered streams. Further, the forest fires would have removed forest understory vegetation leaving soils more exposed to erosion and increasing water turbidity.

Climatic changes also occurred. As discussed previously, the area experienced cool temperatures in 1892 to 1920 and warmer temperatures in 1921 to 1946. Such large-scale climatic changes may have affected the quality of fish habitat in both freshwater and marine environments during 1900-1940 (Lichatowich and Mobrand 1995). These changes — in concert with losses due to municipal water supply development, hydroelectric power operations, hatchery egg-takes, timber harvest and agricultural uses during the early 1900s — likely contributed to a decline in fish productivity.

FISH PRODUCTION

While below historic levels, large runs of salmon and steelhead continued to ascend the Sandy River in the early 1900s. According to several people who were familiar with the river before the construction of Marmot Dam, spring chinook were quite abundant in the main river and in the Salmon and Zigzag rivers before the dam (Mattson 1955). Estimates by Mattson (1955) suggest that spring chinook spawning runs to the mainstem ranged between 3,000 and 5,000 fish per year, though no reliable data existed to calculate actual run sizes. Past residents also observed runs of at least 900 adult coho salmon and several hundred fall chinook during some years at the Salmon River Hatchery weir before construction of Marmot Dam (Mattson 1955).

Hatchery records also suggest that many salmon and steelhead returned to the basin in the early 1900s. After the turn of the century, operators of the Salmon River Hatchery experienced some of their best years. In 1903, they collected 3,551,000 spring chinook eggs, a record number at the hatchery (ODFW 1997). The next year, 1904, they collected about 1,745,000 chinook, 1,327,300 coho, and 175,200 steelhead eggs. This was the largest collection of coho eggs at the station. In 1905, their collections reached 1,230,000 chinook, 1,066,300 steelhead and 300,000 coho eggs (Mattson 1955).

Hatchery operators during this time continued to experience mixed success in their attempts at fish production. Fish culture remained more art than science, and the operators learned by experimenting with different techniques and adapting them based on their successes and failures. They encountered problems finding the right foods for the growing fish and struggled with disease outbreaks.

Fish production in the basin declined temporarily around 1904 after floodwaters deposited large amounts of sediment and debris near the Sandy's mouth. As explained in the 1913 Biennial Report of the Department of Fisheries to the 27th Oregon Legislature, *"during the flood of 1904 a great mass of sediment and drift lodged at the mouth of the Sandy, causing it to form a new channel that emptied into the Columbia in an upstream direction, making it difficult for the fish to find."*

When fish returns remained low in 1911, residents along the Sandy appealed to the Oregon Department of Fisheries for assistance in restoring the stream to its old channel. They received 500 pounds of blasting powder from the Master Fish Warden and used it to reopen the channel. The fish returned to the Sandy River in 1912 after the barrier to migration was removed (Oregon Department of Fisheries 1913).

Egg-take records reflect the decline in salmon migration. In 1911, after low adult returns for several years, hatchery operators decided to stop using the Salmon River Hatchery. They resumed operations in 1912 after fish migration was restored and spawners again ascended the river. That year, according to a Master Fish Warden report, *" . . . the take of eggs (chinook) proved a record-breaker over that of several* *years past, having secured 2,009,000 of the early variety and 417,550 spawn of the later run of chinooks."* The eggs were shipped to other hatcheries. None were planted in the Salmon River that year.

Construction and operation of several dams after 1910 created new problems for fish. On the Little Sandy River, salmon and steelhead lost access to about 6.5 miles of spawning and rearing habitat after construction of a diversion dam on the Little Sandy River (RM 1.7) in 1912. The Little Sandy River system is believed to have once supported runs of spring chinook, coho and steelhead (Mattson 1955). More fish habitat was lost in 1922 when Headworks Dam was built on the Bull Run River (RM 6) for City of Portland municipal water. The dam, 20 feet high with no fish passage facilities, blocked salmon and steelhead from about 37 miles of habitat in the upper Bull Run drainage. Flow diversions at both dams also restricted fish production in the lower river sections.

Construction of Marmot Dam on the main Sandy River (RM 30) in 1913 also influenced salmon and steelhead. The dam's wooden fish ladder was routinely used as a trap to obtain brood stock for hatchery production. Periodic damage from flood waters further restricted fish migration while the damaged ladder was being repaired. Dam operations also affected fish production in the Sandy River below the dam. During low flow periods, diversions at the dam left as little as 30 cfs in the lower river. For many years after 1913, low flows in the 11-mile reach of the Sandy between Marmot Dam and the mouth of the Bull Run River (where the water diverted at Marmot Dam was returned to the Sandy River) kept many spring chinook and other species from migrating upstream from early summer through early fall. The low flows also reduced habitat quality and availability to support fall chinook and other lower river fish populations. In addition, the diversions affected downstream migrants. Until the diversion was screened in 1951, many downstream migrants were swept into the canal and carried to Roslyn Lake, which had no outlet but through penstocks and turbines.

Operations associated with the Bull Run Powerhouse, which used water diverted from the Little Sandy and Sandy rivers, initially had little or no effect on fish production or migration in the lower Bull Run River. The volume of water released into the lower Bull Run River at the powerhouse was small compared to the much larger flow already in the Bull Run River. However, with the completion, and subsequent operation of Headworks Dam, the City of Portland began diverting large quantities of Bull Run River water at the Headworks Dam. Releases of Little Sandy and Sandy River water below the Bull Run Powerhouse then made up most of the streamflow in the lower Bull Run River during the migration season. These flows falsely attracted some salmon and steelhead into the Bull Run and delayed their migration to upriver habitat in the Sandy River.

Once Marmot Dam was completed, hatchery operators abandoned the Salmon River facility and moved to the Sandy River below the dam. That year, in 1913, fish propagators built a rack spanning the Sandy River below the dam to trap spring chinook, coho and winter steelhead. They collected chinook salmon eggs at the site in many years from 1913 to 1955. The number of spring chinook eggs collected varied from a low of 10,280 eggs in 1955 to a high of about 2.7 million eggs in 1913 (ODFW 1997). Steelhead and coho eggs were also collected between 1913 and 1946 (USFS 1996).

From 1913 to 1925, spring and fall chinook salmon were also raised at several other locations on the Sandy River. While dates and locations are unclear, records show activities at "Lower Sandy River Hatchery", "Big Sandy River Hatchery", and the "Bull Run Feeding Ponds" from 1913 to 1918. Records from 1919 to 1925 refer to the "Sandy River Hatchery" with no mention as to the location (Wallis 1962). A lack of records for the period between 1925 and 1933 suggests that possibly no hatchery production occurred on the Sandy River for 11 years after operations at the facility below Marmot Dam ended in 1925 (ODFW 1997). From 1933 through 1936, salmon fry produced at Bonneville Hatchery were released into the Sandy, Bull Run and Salmon rivers.

Table 2. Salmon and Steelhead Egg Collection in the Sandy River Basin, 1900-1950 (ODFW 1997)

Site	Year	Spring Chinook[5]	Fall Chinook	Steelhead	Coho
Salmon River Hatchery, Boulder Cr.	1896	2,600,000			
	1897	1,216,000			
	1898	745,200		22,000	
	1899	600,000			
	1900	1,260,000		250,000	
	1901	1,742,000		409,000	
	1902	1,586,600		205,000	1,327,300
	1903	3,551,000	100,000	410,100	300,000
	1904	1,745,000		175,200	412,000
	1905	1,230,000	(F+S mixed)	1,066,300	
	1906	875,000	(F+S mixed)	447,000	
	1907	565,000	(F+S mixed)	508,000	76,500
	1908	553,340			
	1909	500,936	180,400	595,091	
	1910	269,140	120,570		
	1911				
	1912	2,009,000	417,550	493,000	
Marmot Dam	1913	2,782,258	(1,430,716)	966,100	
	1914		Sandy River	449,500	
	--		3 RM above		
	1921	1,637,000	Troutdale		330,600
	1922	461,900		634,000	
	1923			832,600	
	1924	1,823,918	2,595,820		
	1925				
	--				
	1938	10,904			583,324
	1939	1,614,451		827,634	485,900
	1940	604,800		858,500	238,900
	1941			1,378,000	297,400
	1942	238,000		1,176,690	39,000
	1943	12,000		299,370	49,000
	1944			175,000	10,000
	1945	435,200			14,400
	1946	1,067,387		238,532	
	1947	43,550			
	1948	441,000			
	1949				

In 1938, fish managers began operating a small hatchery, the Sandy River Station, immediately below Marmot Dam. They produced salmon and steelhead at the station until 1948 with water supplied by

5 Some mixing of fall and spring chinook eggs is possible.

gravity from the power canal. The station's success prompted staff with the Oregon Fish Commission to send Portland General Electric the following report in November 1939:

> *"During the year there were collected 583,324 silver salmon eggs, 1,514,451 chinook and 827,634 steelhead eggs. The resulting fingerlings are being released into the river below the dam, where they apparently find, in the reduced flow of water in the river's channel, ideal nursery conditions. It is now felt that the migratory fishes will be preserved, and I trust the numbers increased through uninterrupted operation of the hatchery. Further, there will be nothing gained by screening the diversion above the dam, now that fishes of a migratory nature are not permitted to proceed to the upper reaches of the Sandy River."*

State fish managers decided to change their program in the late 1940s when production at the facility began to fall. Records show that the number of coho eggs collected at the facility dropped steadily from 500,000 eggs in 1939 to less than 15,000 eggs in 1945 (ODFW 1997). The records do not indicate whether a decline in the coho run triggered the drop in egg collections or if some coho were allowed to continue upstream to spawn (ODFW 1997). Faced with recurring problems, in 1947 staff with the fish commission reported:

> *"The water supply at the Sandy River Station is not considered satisfactory. There are also detrimental features which make the operation of this station difficult and uncertain. Studies are being conducted on other sites, and it is expected that the present location will be abandoned for one more favorable to fish culture operations."*

By 1948, the state was operating the station strictly for egg collection. Fish propagators gathered about 441,000 spring chinook eggs at the station in 1948 and shipped them to Bonneville Hatchery. They collected nearly 600,000 eggs at the site in 1950 and transferred them to Bonneville as well.

SUMMARY

By the late 1940s, Sandy River salmon and steelhead had lost access to several once important habitat areas and the remaining runs had declined significantly. Spring chinook escapement to the main Sandy River and tributaries was estimated at the time to have fallen to no more than 1,500 adults. Coho salmon runs had declined to about 2,000-3,000 adult fish, and winter steelhead escapement to areas above Marmot Dam had dropped to about 2,200 fish (Mattson 1955). Fall chinook production had also declined significantly.

In many ways, the decline of these runs was linked to the region's growth in population and to a subsequent demand for more timber, power, water, salmon and other resources. Habitat changes generated by fires in the upper watershed and by a shift in climate conditions may have added to the decline. Key events that shaped conditions in the Sandy River Basin during this time are recapped below.

Key Events and Developments From 1900 to 1950

1903	About 3,551,000 spring chinook eggs collected at Salmon River Hatchery.
1904	Floodwaters deposit material at Sandy River mouth, hindering fish passage.
1904	About 1,327,300 coho eggs spawned at Salmon River Hatchery.
1905	More than 1 million steelhead eggs spawned at Salmon River Hatchery.
1906	Hydropower development on the Sandy and Little Sandy rivers begins.
1907	Many sawmills operate in the lower Sandy River Basin, logging escalates.
1908	Operator of Sandy River Hatchery reports that "there is so much logging on the Sandy River that I am sure the salmon are kept out of the stream."
1908	Forest fires burn much of the upper watershed from late 1800s to 1920.
1911	Salmon River Hatchery operations stop.
1911	Railroad operates 20-mile line from Montavilla to Bull Run powerhouse.
1911	Residents of Sandy restore lower river channel and reopen fish passage.
1912	Anadromous fish runs return to river after barrier near mouth is removed.
1912	Operations at Salmon River Hatchery resume. About 2,009,000 spring chinook eggs and 417,550 fall chinook eggs taken at station. Hatchery is abandoned after the season, operations are moved below Marmot Dam.
1912	Marmot Dam completed. Facility includes fish ladder, but flood damage and egg-take operations at the ladder hinder fish passage to upper basin.
1912	Little Sandy diversion dam completed. Dam blocks fish passage to areas above dam and water diversions affect production below the dam.
1913	About 2.7 million spring chinook eggs collected below Marmot Dam.
1913	Railroad line electrified from Montavilla to Ruby Junction. Logging companies expand line, building spurs into headwaters of Cedar Creek.
1915	City of Portland builds 10-foot high structure at outlet of Bull Run Lake.
1918	Ladder at Marmot Dam rebuilt and improved after repeated flood damage.
1918	Trolley line brings many visitors from Portland to areas along Sandy River, including Dodge Park at confluence of Sandy and Bull Run rivers.
1920	Construction under way on Mt. Hood Loop Highway.
1922	City of Portland builds Headworks Dam, 22 feet high, creates fish barrier.
1926	Ladder at Marmot Dam improved and new pools installed.
1927	Rail line to Bull Run Park abandoned as people travel more by auto.
1929	City of Portland builds Ben Morrow Dam (Bull Run Dam No. 1) on Bull Run.
1930	Several campgrounds and trails constructed in watershed.
1938	Small hatchery (Sandy River Station) built immediately below Marmot Dam.
1939	Egg-takes at station include 583,324 coho eggs, 1,514,451 chinook eggs, and 827,634 steelhead eggs. Fingerlings are released in river below dam.
1940	Production at Sandy River Station begins to decline.
1948	Sandy River Station operated strictly for egg collection.

SALMON AND STEELHEAD RUNS, 1950 TO PRESENT

INTRODUCTION

In 1950, salmon and steelhead runs to the Sandy River faced many obstacles to production. Operations at Marmot Dam continued to hinder upstream and downstream migrations and limit production in the lower Sandy River. Salmon and steelhead access to significant historic habitat areas in the Bull Run drainage — possibly exceeding the Salmon River in fish production potential — remained blocked by Headworks Dam on the Bull Run River and a diversion dam on the Little Sandy River. Water withdrawals in the lower Bull Run and Little Sandy rivers curbed fish production in the lower river reaches. In addition, hatchery operators continued to collect large numbers of salmon and steelhead eggs in the basin.

Portland General Electric made several improvements at Marmot Dam after 1950 to improve fish passage. In 1951, the company began operating screens in the Sandy River diversion canal at the Oregon Fish and Game Commission's request. The screens were designed to prevent downstream migrants from entering the canal and being carried to Lake Roslyn, which had no outlet for fish except through the penstock and turbines. Studies by the Oregon State Game Commission in the early 1950s indicated that the screens were effective with regard to fish several inches in length — and had considerably reduced losses of seaward migrants — but were less successful in diverting fry or small fingerlings (Mattson 1955). This system was improved repeatedly during the following years. The fish ladder at Marmot Dam was also rebuilt several times after 1955 to ease upstream migration. Other gains for salmon and steelhead came in 1973 when the company began maintaining minimum streamflows below Marmot Dam. Then, in 1989 the company eliminated many remaining fish passage problems when it rebuilt Marmot Dam, a 60-year-old wood crib rock-filled structure, with a new concrete dam.

Fish returning to upper basin spawning and rearing grounds during this period, however, did not necessarily find the pristine conditions that had supported their ancestors. Timber harvest, road construction, urbanization, mining and other activities continued to spread along the lower Sandy and tributaries. After 1950, road construction and timber harvest in the upper Sandy watershed escalated and remained heavy through the 1980s. Other habitat damage resulted after the 1964 flood.

Fishing pressure also continued to affect salmon and steelhead production. Ocean and Columbia River harvest began climbing again in the 1950s, and expanded through the 1960s and 1970s as the declining wild runs were replaced by hatchery production. Sport fishing on the Sandy River also rose steadily through the years.

FISH PRODUCTION

Generally, by 1950 salmon and steelhead runs in the Sandy River Basin had fallen to low levels. The following excerpts from Chester Mattson's report, *The Sandy River and Its Anadromous Salmonid Populations*, which was written for the Oregon Fish Commission in 1955 (Mattson 1955), may best describe the status of the runs in the early 1950s.

Spring Chinook "*During recent years the escapements into the mainstem and tributaries have not exceeded 1,500 spring chinook salmon. The calculated run up to the Marmot Dam during the spring of 1954 was in the neighborhood of 400 fish according to an Oregon State Game Commission report. In addition possibly 200 to 300 salmon had remained in the main river below. The range in recent years has been between 750 and 1,500 adult fish.*"

Coho *"At present the (coho) runs probably do not exceed 2,000 to 3,000 adult fish, of which only a small and undetermined proportion spawn in the mainstem. Several hundred fish ascend annually above Marmot Dam and utilize areas of the upper watershed."*

Fall Chinook *"(Fall chinook spawning and rearing) has been limited in the lower 12 to 15 miles, more so with the dewattering of the main stem for 12 miles below Marmot Dam. Prior to the construction of this dam, several hundred fish had been observed within the lower several miles of the Salmon River. The maximum spawning escapement within the last eight years has been estimated at approximately 500 to 2,500 fish."*

Winter Steelhead *"In recent years considerable numbers (of steelhead), 2,200 fish in 1954, have ascended Marmot Dam and spawned in available areas above. Perhaps an equal number have utilized the suitable areas of the lower river below Marmot Dam."*

Data collected from a fish trap installed at Marmot Dam in 1953 provides further information about the runs after 1950. This data suggests that winter steelhead escapement above the dam increased after passage facilities were improved and egg-taking operations declined. Records from 1954 to 1958 show a five-year cumulative escapement of 11,241 winter steelhead passing Marmot Dam from March to June. About 97 percent (10,913) of the fish were determined to be wild (ODFW 1997). Winter steelhead escapement at Marmot Dam continued to increase in the early 1960s. From 1961 to 1965, the five-year cumulative escapement of winter steelhead passing Marmot Dam was 19,903 fish, of which about 75 percent migrated at the end of February (ODFW 1997).

Marmot Dam data, however, indicates that the basin's spring chinook and coho runs continued to drop for several years. Records show that spring chinook passage to the upper basin declined after 1950, sometimes dwindling near zero. A minimum of 336 adult spring chinook escaped annually to the Sandy River during the 1950s. This estimate reflects harvest in the lower basin and escapement at Marmot Dam. It does not include adult spring chinook that spawned in the lower river below Marmot Dam during this period. The dam counts fell to an average of 168 adults in the 1960s (ODFW 1997).

As discussed earlier, several factors contributed to these low returns. Trapping of adult spring chinook at Marmot Dam for hatchery brood stock continued through the 1950s. Many other adults were caught in commercial and sport fisheries in the ocean, Columbia River and lower Sandy River. In addition, reduced flows in the Sandy River below Marmot Dam until the 1970s may have restricted some adult spring chinook migration (ODFW 1997).

Conditions along the Sandy River and many tributaries — often already altered by road construction, timber harvest and other activities — changed again during and after the flood of 1964. At the flood's peak, the Sandy River contained about 82,000 cfs of flow at its confluence with the Columbia River. These high flows scoured and altered stream channels as they gushed through the watershed.

Post-flood channelization efforts boosted the damage. After the flood, the Army Corps of Engineers and local communities joined efforts and channelized several miles of the lower reaches of the Salmon, Zigzag and Sandy rivers and Still Creek. They channelized the Sandy River from the confluence with Clear Fork to the Sleepy Hollow area just upstream from the confluence with Alder Creek. The workers used heavy equipment to reconfigure and straighten the stream channels and remove most large obstructions and boulders from the streambeds. They built berms with rocks to contain the streambanks, destroying riparian vegetation along the streams and blocking many side channels.

While well intended, the channelization projects affected the timing, variability and duration of floodplain and wetland inundation in the area. They reduced biological productivity along the channelized stream corridors, and significantly degraded the quality of spawning and rearing habitat for native winter steelhead, coho, spring chinook, fall chinook, cutthroat and resident trout. The instream channelization work also lowered habitat complexity in the stream channels and blocked fish passage into many side channels that historically had provided substantial rearing and spawning habitat. These side channels and backwater areas had been especially important for winter-rearing juvenile anadromous fish, including juvenile steelhead, which would seek the slower velocities found in these areas and hide under large logs, undercut banks and other protected areas. The projects also increased flow velocities within the channelized reaches, which scoured spawning gravels from the streambed (ODFW 1997).

As natural salmon and steelhead production dropped, however, hatchery production increased. In the 1950s and early 1960s, hatchery production programs became more successful as the operators acquired new knowledge about fish culture. Fish propagators began feeding fish better diets and using improved fish rearing and release strategies. They also learned more about disease prevention and treatment. As a result, the hatchery fish were healthier and had a better chance of surviving than those released in the early 1900s.

In 1950, the Sandy River Hatchery was constructed on Cedar Creek, about ½ mile above its confluence with the Sandy River. The hatchery prevented fish passage to about five miles of habitat in upper Cedar Creek, but boosted artificial production in the Sandy basin. Initially, the hatchery's operators relied heavily on eggs shipped in from Bonneville and other hatcheries for their production. The facility began operating in 1951 with 2,009,000 fall chinook eggs and 250,000 coho eggs from the Bonneville Hatchery, and 530,530 spring chinook eggs collected near Marmot Dam. In 1952, hatchery operators collected 135,030 spring chinook eggs near Marmot Dam and brought in nearly 8.5 million fall chinook eggs from the Bonneville and Oxbow hatcheries. It also received 294,000 coho eggs from Bonneville Hatchery (Mattson 1955).

From 1954 until the early 1960s, hatchery personnel worked to rebuild the runs using primarily Sandy River stock and reduced shipments of other stocks into the system. During the next few years, they continued gathering spring chinook eggs below Marmot Dam. In 1954, they collected fall chinook at a rack near the mouth of the Bull Run River at Dodge Park. Coho eggs were gathered at Cedar Creek (Mattson 1955). Hatchery operators again started receiving fall chinook eggs from other hatcheries in the 1960s. Coho and spring chinook production continued to rely primarily on Sandy River brood stock through the mid-1960s. Winter steelhead were also raised at the hatchery for several years to support an early winter sport fishery.

Table 3. Egg collection in the Sandy River Basin, 1950-1960[6] (ODFW 1997)

Site	Year	Spring Chinook[7]	Fall Chinook	Steelhead	Coho
Marmot Dam	1950	597,520			
	1951	530,530			
	1952	135,030			
	1953	175,105			
Cedar Creek	1953				196,425
Marmot Dam	1954	502,480			
Bull Run River	1954		92,865		
Cedar Creek	1954			118,765	716,000
Marmot Dam	1955	10,280			
Bull Run River	1955		134,220		
Cedar Creek	1955			119,711	
Cedar Creek	1956	84,385	(F+S mixed)	108,245	
Bull Run River	1956		438,485		
Cedar Creek	1957	1,619,650	(F+S mixed)	404,800	
Bull Run River	1957		290,810		
Bull Run River	1958		126,872		
Cedar Creek	1958			116,567	
Cedar Creek	1959	81,256	184,237		
Cedar Creek	1960		494,078	29,000	
Gordon Creek	1960		16,457		

Since the late 1970s, the state has used the Sandy Hatchery exclusively to raise coho. Production of fall chinook, spring chinook and steelhead at the hatchery ended in 1976, 1975 and 1974, respectively. Spring chinook production at the hatchery was hindered because low flows in Cedar Creek during the migration period kept many adult spawners from returning to the station (ODFW 1997). Coho releases at the facility grew from a release of 250,000 smolts the first year to about 500,000-800,000 smolts, and then stabilized at 1 million smolts until 1995 (ODFW 1997). Today the Sandy Hatchery is used to raise early-run coho with brood stock gathered from adult hatchery returns. Most of the coho are released on-station as smolts.

As discussed earlier, several actions initiated after 1970 improved fish production in the basin. In 1973, Portland General Electric began maintaining minimum streamflows in the Sandy River below Marmot Dam to provide spring chinook and other fish with adequate water for upstream migration in summer and fall, and to support spawning and rearing below the dam. The company also adjusted flow diversions to reduce wide fluctuations in lower river streamflows and continued improving conditions at the dams to

6 Table includes data from several reports (Mattson 1955, Wallis 1966, Collin 1974, Pirtle 1953, Craig and Suomela 1940). Some discrepancies between reports exist.

7 Some mixing of fall and spring chinook eggs is possible.

enhance upstream and downstream fish migration. Further, the Forest Service, Bureau of Reclamation and others began improving habitat conditions and otherwise undoing damages caused by past timber harvest and by channelization efforts following the 1964 flood.

Larger releases of hatchery fish contributed to the growth of sport fisheries in the Sandy River Basin and on the Columbia River. Fish managers boosted hatchery releases of winter steelhead in the late 1960s as natural steelhead escapement to the basin dropped and interest in sport harvest increased. Then they introduced summer steelhead to the Sandy River in 1975, creating a very popular fishery in both the upper and lower river. They also raised hatchery releases of spring chinook and coho during the 1970s. Spring chinook releases expanded again in the 1980s when state fish managers launched an aggressive program to supplement the declining native spring chinook run with Willamette stock from the Clackamas Hatchery. Portland General Electric and the City of Portland provided funds for this program to compensate the state for fish losses at the dams.

CURRENT RUNS

Today, large numbers of winter steelhead, spring and fall chinook, coho, and summer steelhead still return to the Sandy River. However, the proportion of wild fish in these runs has dropped considerably over the years. The current runs are discussed briefly below.

Winter Steelhead

The Sandy River consistently rates as one of Oregon's top 10 winter steelhead producers. In recent years about 10,180 winter steelhead returned each year to the Sandy River. This average run, including both hatchery and wild fish, was estimated at 10,179 for run years 1987-1988 to 1991-1992 based on harvest in the lower river and escapement over Marmot Dam. During this period, anglers caught an average of 7,563 winter steelhead and about 2,616 adult winter steelhead escaped annually to upper basin spawning grounds. More recently, the number of adults passing Marmot Dam has ranged from a high of 2,918 fish for the 1991-1992 run year to a low of 537 fish for the 1995-1996 run year. Winter steelhead passage at the dam then increased, reaching 1,426 fish in the 1996-1997 run year (ODFW 1997).

Virtually every passable reach of the basin contains winter steelhead spawning habitat. In the upper basin, good winter steelhead production exists in the Salmon River system below Final Falls, and in Still Creek and many small upper basin tributaries. Production also occurs in turbid stream reaches such as the Muddy Fork of the Sandy River, the upper Sandy River and the Zigzag River where glacial flour is evident. Many steelhead also spawn and rear in the lower basin. Recent surveys show significant spawning in the lower Sandy River. However, little is currently known about winter steelhead populations in the lower basin (Cramer, personal communication 1998).

Information collected at Marmot Dam and from anglers suggests that the basin's wild winter steelhead run has declined over the years. Consequently, the National Marine Fisheries Service recently listed the stock as "Threatened". The Oregon Department of Fish and Wildlife manages wild Sandy River winter steelhead as a Stock of Concern.

Fish managers are currently addressing factors that might be limiting wild winter steelhead production in the basin. Their concerns include the possibility that introductions and straying of hatchery fish above Marmot Dam may be influencing the wild run. Until 1963, primarily wild winter steelhead escaped over Marmot Dam. However, in 1964 hatchery operators started releasing hatchery steelhead above the dam and hatchery stock escapement to the upper river increased. From the early 1980s to the early 1990s, the percentage of natives in the Sandy's total winter steelhead run declined from 28 percent to 18 percent. This suggests that introductions and straying of earlier returning hatchery stocks may be influencing the wild run (USFS 1996; ODFW 1994). Releases of summer steelhead since 1975 to provide a summer fishery above Marmot Dam may also be affecting winter steelhead production if summer steelhead smolts compete with native winter steelhead for space and food. Further, increased trout angling pressure in the upper basin may have increased mortality of incidentally caught juvenile winter steelhead. Currently, hatchery managers are releasing hatchery-produced winter steelhead below Marmot Dam to reduce mixing between the stocks and competition for habitat in the upper basin.

Coho Salmon

The Sandy River Basin supports two coho stocks: a native late-spawning stock (November-February) and an early-spawning hatchery stock (September-November). The basin's native coho population generally spawns and rears in the clearwater tributaries above Marmot Dam, though some production also occurs in the lower basin. Studies show that coho salmon prefer areas with low water velocities, such as low gradient small and medium-sized streams, side channels and the margins of mainstem rivers (ODFW 1997).

The upper watershed contains many miles of suitable coho habitat, particularly in the Wild and Scenic River segments of the basin and/or within the bounds of wilderness areas. Primary habitat exists in the Salmon River and tributaries below Final Falls, and in Still Creek. The mainstem Sandy River and side channels also support some coho production (ODFW 1997).

Coho counts at Marmot Dam suggest that the native run is stable, but has recently declined. The counts averaged 1,201 adults and jacks annually for the 10-year period 1985 to 1994. However, estimated coho escapement at the dam declined to an average of 794 fish for the five-year period 1991 to 1995, ranging from a high of 1,492 fish in 1991 to a low of 220 fish in 1993 (ODFW 1997). Native Sandy River coho are listed as sensitive by the State of Oregon. The National Marine Fisheries Service considers the native Sandy River coho stock a candidate species for listing and plans to review its status in 2001.

The basin's early returning coho run is produced at the Sandy Hatchery from native Sandy stock. Hatchery operators release about 700,000 hatchery coho smolts annually into the Sandy River. These releases support commercial and sport harvest in the ocean and Columbia River fisheries and sport angling in the Sandy River.

Spring Chinook

The Sandy's spring chinook population has increased significantly over the last 15 years, primarily due to hatchery releases in the watershed. In the early 1970s, fish managers started supplementing natural spring chinook production with hatchery releases of Willamette stock smolts and pre-smolts. They expanded the releases in the 1980s. Currently, they release about 460,000 hatchery spring chinook smolts annually in the Sandy River. The estimated five-year average return for run years 1990 to 1994 was 5,118 fish.

Presently it is unknown whether the indigenous stock of Sandy River spring chinook has sustained itself as a separate subpopulation from the introduced Willamette stock (ODFW 1997). Genetic research is currently under way to learn if a wild Sandy River spring chinook stock exists. Meanwhile, since 1994 fish managers have tried to promote natural spring chinook production in the upper basin by releasing all hatchery spring chinook below Marmot Dam. Currently, the National Marine Fisheries Service is considering listing all wild lower Columbia River chinook, including wild Sandy River spring chinook, as Threatened.

Most naturally producing Sandy River spring chinook spawn in the upper watershed above Marmot Dam. Primary spawning areas include the Salmon River up to Final Falls (RM 14) and the lower three miles of Still Creek. Spring chinook also spawn in the Zigzag River, upper Sandy River and the lower reaches of several tributaries when flows permit. Generally, chinook salmon prefer large pools in low gradient areas within the mainstem and large tributaries. They are not usually found in smaller tributaries or side channels (ODFW 1997).

Summer Steelhead

In 1975, fish managers began releasing summer steelhead in the basin, creating a popular sport fishery. Past observations suggest that a small native run may have existed prior to these releases. For instance, in the 1950s (before hatchery releases were initiated) a few steelhead were found in the Bull Run River during September and October. A few steelhead were also counted passing Marmot Dam during these same months in the 1960s and 1970s. Managers do not know whether the fish were native to the Sandy River, strays from other lower Columbia River tributaries, or late-returning winter steelhead that had stayed in pools below the dam until flows for migration improved. Angling reports from the 1950s also show some steelhead being caught in the Sandy River (ODFW 1997).

Today, the summer steelhead run provides angling opportunities from April to December. The fish are currently released in the Zigzag, Salmon, and Sandy rivers. Until recently, they were also released in Still Creek. During the five-year period from 1989-1990 to 1993-1994, an average of 4,544 summer steelhead returned annually to the Sandy River. The run ranged from a high of 6,994 fish in 1992-1993 to a low of 3,142 fish in 1993-1994. These returns reflect angler punch card data and Marmot Dam counts (ODFW 1997).

Fall Chinook

Sandy River fall chinook are divided into two runs — a wild late-maturing run and an early-maturing "tule" run. The wild late-maturing population is the dominant fall chinook run to the Sandy. The run is considered depressed but stable, and like all lower Columbia River chinook, is regarded as a sensitive species by the State of Oregon. The National Marine Fisheries Services is considering listing all lower Columbia River chinook, including wild Sandy River spring and fall chinook, as Threatened. The early-maturing tule run consists of a few to several hundred fall chinook that return each year to the Sandy River to spawn. These fish are believed to be remnants of hatchery releases made before 1977 or strays from other systems. No hatchery fall chinook have been released in the Sandy or its tributaries since 1976 (ODFW 1997).

Between 1984 and 1994, an average of at least 1,503 fall chinook returned to the Sandy River. This estimate, based on redd counts and sport harvest data, is considered a minimum run size. Actual spawning escapement to the basin was probably higher in most years since some spawning also occurs outside the standard survey areas. Fall chinook spawn in the lower Sandy River near Oxbow Park and in lower tributaries, including Gordon and Trout creeks. Like spring chinook, they generally prefer large pools in low gradient areas within the mainstem and large tributaries.

Resident Fish

The Sandy River Basin also contains several resident fish populations, including cutthroat trout, rainbow trout, whitefish, and brook trout. These populations are discussed briefly below.

Cutthroat trout are the most common trout species in the basin and are native to the Sandy River. Currently, the basin supports both resident and anadromous forms of cutthroat. Resident cutthroat trout are generally abundant in the Sandy's smaller and average-sized tributaries. Production of anadromous cutthroat in the basin is now believed to be very low, but reports by past anglers suggest that sea-run cutthroat once provided a significant sport fishery in the lower basin (ODFW 1997). Currently, fish managers only release hatchery cutthroat in the basin's isolated high mountain lakes.

Rainbow trout are also native to the Sandy River Basin. They are currently found in the mainstem and many larger tributaries throughout the watershed, including the Bull Run River. Rainbow usually reside below barriers to anadromous fish, but some tributaries also contain small populations above barriers. Until 1997, hatchery rainbow were released in several tributaries of the Sandy to provide angling opportunities. Since 1997 these releases have been limited to standing water bodies to protect the wild rainbow population.

Studies in the basin show that rainbow occasionally mate with cutthroat trout. During a genetics study conducted in 1994 and 1995, researchers documented hybridization between resident cutthroat and rainbow trout in some upper basin tributaries (ODFW 1997).

Mountain whitefish are indigenous to the Sandy River Basin. They reside in the Sandy River and most large tributaries. The basin's mountain whitefish population is considered healthy and stable.

Brook trout are not native to Oregon. They entered the basin during the late 1800s when they were released in several high mountain lakes and a few streams to provide angling opportunities. Recently, brook trout have been observed in Mud Creek above and below Trillium Lake. They are believed to be descendants from early hatchery releases in Trillium Lake. They have also been documented in the upper Salmon River and in the lower reaches of Ghost Creek. These populations probably originated from hatchery releases made in the upper Salmon River near Highway 26. In the past, brook trout have also been found in Camp Creek, a tributary of the Zigzag River, and in the Little Sandy River above RM 13.3. These brook trout populations are not being encouraged. Currently, flowing waters in the basin are managed to enhance native trout production (ODFW 1997).

SUMMARY

At the turn of the century, the Sandy River supported runs of spring chinook, fall chinook, coho, steelhead and chum. Today, except for chum, these fish still return to the river — though the runs are far below historic levels. Comparisons of records from an old hatchery within the Salmon River watershed, along with recent spawning surveys in the Salmon and Zigzag watersheds, suggest that current spawning returns are only 10-25 percent of 1890s levels, which were already reduced by decades of heavy fishing (USFS 1996). In addition, hatchery-produced fish now make up a large percentage of the basin's winter steelhead, coho and spring chinook runs.

As discussed previously, many factors have influenced salmon and steelhead production in the Sandy River Basin during the last 150 years, including;

- Overharvest in commercial and sport fisheries
- Habitat degradation from logging, agricultural practices, mining and road development
- Lost natural production from egg-take operations at various sites in the basin since the late 1800s
- Loss of historically significant habitat due to municipal water supply development in the Bull Run Basin
- Flow and fish passage restrictions from hydroelectric operations and diversions at Marmot Dam and the Little Sandy dam
- Habitat losses during and after the 1964 flood
- Competition from introduced hatchery fish.
- Habitat alterations due to naturally occurring fires and large climatic changes.

Now, efforts are under way to restore the basin's native fish populations while maintaining fishing opportunities inside and outside the Sandy River Basin. Fish managers are reviewing releases of hatchery winter steelhead, spring chinook, and coho to reduce competition between hatchery and wild fish. They are also restricting some angling opportunities, primarily in the upper basin, to protect the wild runs. At the same time, various public and private interest groups are working with basin habitat managers to improve spawning and rearing conditions in the upper basin above Marmot Dam. Projects are also ongoing to improve upstream and downstream fish migration past Marmot Dam and to reopen side channels and other lost historic habitat areas. Further, managers are examining opportunities to restore salmon and steelhead access to the upper Little Sandy River and Cedar Creek drainages and are weighing potential gains of such actions against the impacts on existing programs.

Several key events influenced the basin's salmon and steelhead runs after 1950, including the following:

Key Events and Developments After 1950

1950	Road development increases in upper basin to provide access to potential timber harvest areas.
1950	Sandy River Hatchery completed.
1951	Sandy river Hatchery begins operating.
1951	PGE screens Sandy River diversion canal and constructs juvenile bypass facility in the Marmot Dam diversion canal.
1955	Egg-taking operations at Marmot Dam cease. Salmon and steelhead runs regain access to upper basin habitat.
1960	Road development continues in the upper basin.
1961	Hatchery releases increased to rebuild coho runs in the upper watershed.
1964	Floodwaters scour and alter stream channels as they gush through the watershed. Channelization projects on the lower Salmon, Zigzag and Sandy rivers and Still Creek further reduced fish habitat in the basin.
1965	Winter steelhead escapement drops after rebounding since 1950. The drop is largely attributed to the flood and channelization efforts and/or overharvest.
1970	Spring chinook production in the basin increases substantially after fish managers start an aggressive hatchery production program.
1974	Minimum streamflows are maintained in the Sandy River below Marmot Dam to provide fish passage and increase rearing areas.
1983	PGE rebuilds the fish ladder at Marmot Dam and installs a fish counter.

figure 2 insert

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