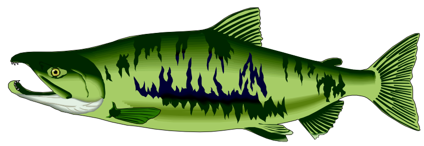
PORT ORFORD

WATERSHED ASSESSMENT



Prepared for

The Port Orford Watershed Council

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June 2001

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ABSTRACT

The *Port Orford Watershed Assessment* was prepared for the Port Orford Watershed Council whose members are dedicated to sustaining the health of their watershed. This document contains detailed information about the Port Orford watershed and follows guidelines described in the *Governor's Watershed Enhancement Board's 1999 Draft Oregon Watershed Assessment Manual*. Funding was provided by the Oregon Watershed Enhancement Board, Oregon Department of Environmental Quality, United States Bureau of Land Management, Oregon Department of Agriculture, Curry County Soil and Water Conservation District and Oregon State University Extension Service.

ACKNOWLEDGEMENTS

The completion of the *Port Orford Watershed Assessment* was accomplished through the combined effort of private citizens, watershed council members, contracted technical specialists, and local state and federal government agencies. The South Coast Watershed Council would like to thank the following people who generously provided time and energy to improve the quality of this assessment. Additional people helped whose names are not included below. We also acknowledge them.

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INTRODUCTION & PURPOSE

The *Port Orford Watershed Assessment* contains technical information about past and present watershed conditions. This document updates and expands on information presented in the *South Coast Watershed Action Plan (1995)*. It is a resource to promote better understanding of the Port Orford watersheds. The assessment was conducted in response to a need for more detailed information on salmonid fish and their habitat as well as water quality within the watersheds. Particular emphasis was placed on private lands within the basins. The *Port Orford Watershed Assessment* is based on current information and should be periodically updated, as new information becomes available.

The assessment methodology followed guidance provided by the *Governor's Watershed Enhancement Board's 1999 Draft Oregon Watershed Assessment Manual*. In some instances, diversions were made from this manual based on discussions with technical specialists and/or limitations pertaining to the time and scope of the project. The assessment examined ecoregions, channel habitat types, salmonid fish and their habitat, water quality, wetland conditions, hydrology and water use. Among the components addressed in the Oregon Watershed Assessment Manual that were not included in this assessment were evaluations of sediment sources, riparian conditions, and channel modifications.

The purpose of this assessment was to compile, summarize and synthesize existing data and information pertaining to the Port Orford watersheds' conditions. Near completion of this document an interdisciplinary team, comprised of twelve technical specialists, reviewed the individual assessment's components. The interdisciplinary team later met to discuss key findings, issues and/or concerns related to each of the components. This information was then synthesized to provide a foundation for the prioritization of projects outlined in the *Port Orford Watershed Action Plan (August, 2001)*. The action plan is a complementary document that addresses site specific and watershed wide recommendations for achieving restoration, enhancement and protection goals.

I WATERSHED CHARACTERIZATION

A INTRODUCTION

The Port Orford watersheds, as referred to in this document, include three distinct basins that drain directly into the Pacific Ocean. They include Garrison Lake, Hubbard Creek, and Brush Creek. In total, these three watersheds drain approximately 13,339 acres or 20.8 square miles of land. The Port Orford watersheds, situated entirely within Curry County, are among the smaller basins on the southern Oregon coast. Garrison Lake and certain portions of Hubbard Creek are located within the vicinity of the Port Orford community. Brush Creek, located a few miles south of Port Orford, empties into the Pacific Ocean near Humbug Mountain. Elevations in the Port Orford watersheds range from sea level to approximately 3,040 feet on Rocky Peak, located in the Brush Creek basin. Land uses include urban, forestry, agriculture, range and rural residential development. A reservoir, located on the North Fork of Hubbard Creek, serves as the primary water source of the City of Port Orford. In total, approximately 69% of the watersheds are in private ownership. Table 1 lists the total area for each watershed.

Table 1 Port Orford Watersheds

Watershed	Watershed Area (square miles)	Watershed Area (acres)
Brush Creek	11.0	7,053
Garrison Lake	3.14	2,010
Hubbard Creek	6.7	4,276
Totals	**20.8**	**13,339**

C LAND USE AND OWNERSHIP

Land Ownership

Approximately 69% of the land in the Port Orford watersheds is in private ownership. Private lands are divided into industrial and non-industrial lands. Industrial private lands account for approximately 18% of the basins whereas non-industrial private lands comprise about 52 % of the total area. Non-industrial private lands are divided among a large number of stakeholders that own relatively small parcels of land. In contrast, industrial private lands are divided among a small number of stakeholders that own relatively large tracts of land. The major industrial private landowners in the basins include Georgia Pacific Co., Crook Estate, and Westbrook Timber Co. Public ownership in the Port Orford watersheds is most abundant in the Brush Creek watershed and is estimated at about 30.5%. Public lands, managed by the Bureau of Land Management (BLM) account for approximately 14% of the Port Orford watersheds' area whereas the United States Forest Service (USFS) manages roughly 7% of the basins. State lands comprise about 8% of the area while county lands account for approximately 1.5%.

Table 2 Land Ownership by Watershed (acres)

Watershed	BLM	Private Non-Industrial	Private Industrial	USFS	State	County	Total Acres
Brush Creek	1,849	1,508	1,761	936	999		7,053
Garrison Lake		2,010	0				2,010
Hubbard Creek	35	3,392	591	26	31	201	4,276
Total Acres	1,884	6,910	2,352	962	1,030	201	13,339

Land Use

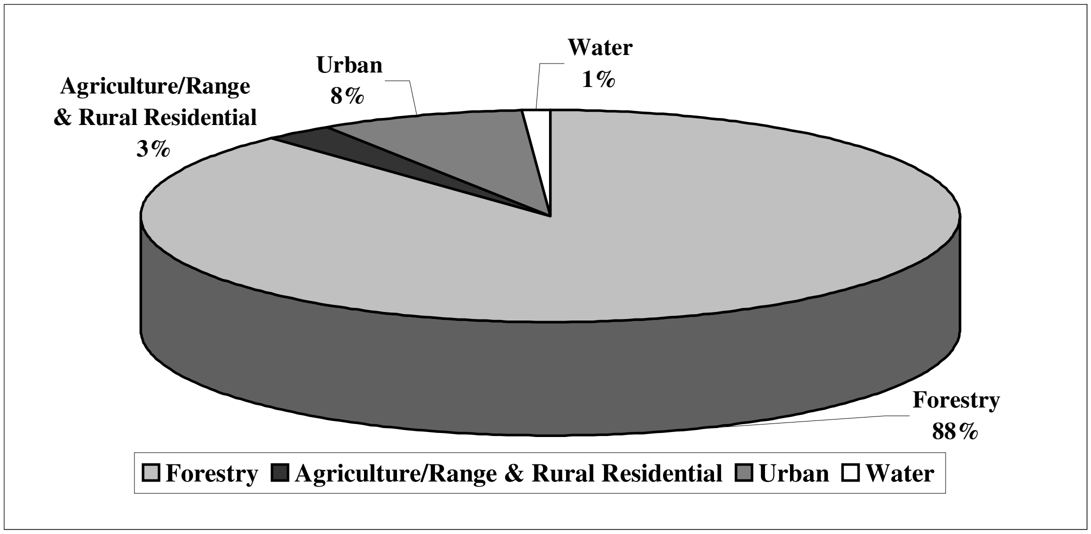
Land use in the Port Orford watersheds is divided into three types including (1) forestry and (2) Agriculture/range or rural residential and (3) urban. **Note:** Distinguishing between agriculture/range and rural residential was beyond the scope of this assessment and therefore the two are lumped into one land use.

(1) Forestry, the most dominant land use in the Port Orford watersheds, accounts for 81% of the total area and includes private industrial and private non-industrial lands in forestry use as well as those lands managed by the USFS and BLM. Forestry use varies greatly between each of Port Orford's watersheds. For example, within the Brush Creek watershed, forestry accounts for nearly 100% of the land use. However, in the Garrison Lake watershed, forestry use is estimated at less than 40%. Forestry use in Hubbard Creek is estimated at more than 90% and is most prevalent in the middle and upper portions of the basin.

(2) Agriculture/range and rural residential areas account for 3% of the watersheds' total area. These lands are located primarily in the Garrison Lake watershed and lower Hubbard Creek basin. Range lands are primarily managed for livestock grazing whereas agricultural lands are often managed for cranberries and Christmas trees. Major types of livestock include sheep and cattle. **Note:** Cranberries and Christmas trees are grown within the Garrison Lake watershed however, it was beyond the scope of this assessment to determine the extent of acreages for each use.

(3) Urban areas in the Port Orford watersheds account for about 8% of the total area, all of which is situated within the Garrison Lake watershed. Due to the limitations of this assessment, all agricultural areas within the Garrison Lake watershed were considered urban.

Figure 1 Watershed Land Use Summary



II WATERSHED ISSUES

A BACKGROUND (GWEB 1999)

The issues to be addressed in a watershed assessment typically arise from local efforts to address concerns that often begin at federal and state levels. Listing of fish populations under the federal Endangered Species Act, for example, immediately focuses attention on evaluating habitat quality or hatchery production in the watershed. Likewise, water quality limited stream segments, listed under authority of the federal Clean Water Act, require that watershed management plans or Total Maximum Daily Loads (TMDLs) be developed at the state or local level.

B INTRODUCTION

The identification of watershed issues was intentionally conducted early in the process to help direct the watershed assessment. The purpose of identifying watershed issues was primarily to gain an understanding of the Port Orford Watershed Council's perspective on those practices that may potentially impact salmonid fish habitat and water quality. Critical issues were identified by watershed council members during a council meeting held at the Port Orford City Hall on April 21, 1999. The council listed significant land uses within the watershed and their associated impacts to fish habitat and/or water quality. Specific practices were then identified as the primary driver for each issue. The issues addressed reflect both present and legacy practices.

C RESULTS

The Port Orford watershed issues are summarized in two tables: Table 3, Port Orford Regulatory Issues and Table 4 Port Orford Watershed Council Issues.

Table 3 Port Orford Regulatory Issues

<table>
<tr><td rowspan="8">Aquatic Resource Issues
(Based on federal and state law)</td><td colspan="3">Endangered Species Act</td></tr>
<tr><td colspan="2">Species</td><td>Status</td></tr>
<tr><td colspan="2">Coho Salmon</td><td>Threatened</td></tr>
<tr><td colspan="3">Clean Water Act – 303 (d) List</td></tr>
<tr><td>Tributary / Reach</td><td>Boundary</td><td>Parameter</td></tr>
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REFERENCES

GWEB 1999. Oregon Watershed Assessment Manual. Governor's Watershed Enhancement Board, July 1999

Table 4 Port Orford Watershed Council Issues

Land Use	Practice	Issue
Urban (All Watersheds)	I Lack of a stable, long term source of drinking water	1) Quality and quantity of municipal drinking water is currently at risk
	comments: this is clearly the most important issue to the watershed council	
Urban (Garrison L.)	II Storm run-off	1) Runoff of pesticides, chemicals, car oil, etc.
	comments:	
Urban (Garrison L.)	III Urban Sprawl	1) Development of subdivisions and associated roads could effect water quality
	comments:	

Land Use	Practice	Issue
Forestry (Hubbard Creek)	I Timber harvest (primarily clear cuts in North Fork Hubbard Creek)	1) Increased sedimentation of fines: (increased turbidity, siltation and elevated stream temperatures) 2) Increased soil erosion 3) Low summer flows
	comments: 1) The North Fork of Hubbard Creek is currently the primary source of the city's municipal water supply. General concern was expressed by the council regarding the adverse effects that the timber harvests (clear cuts) have on water quality. 2) The watershed council would like to see tighter controls on forestry.	

Land Use	Practice	Issue
Dams (Hubbard Creek)	I Dam on North Fork Hubbard Creek at the reservoir	1) Impedes fish passage and greatly alters fish habitat
	comments: the fish ladder at the dam has been in place for about four years and there is a need to monitor its effectiveness	

Land Use	Practice	Issue
Agriculture (Garrison L.)	I Cranberry bogs	1) Water rights and irrigation - are the cranberry bogs properly managed? 2) Are herbicides and/or pesticides being applied? If so are they affecting water quality?
	comments:	
Agriculture (Hubbard Creek)	II Christmas tree farms	1) Are herbicides and/or pesticides being applied? If so are they affecting water quality?
	comments:	

Land Use	Practice	Issue
Natural Processes (Garrison L.)	I Winter storms - wind, waves, dune migration, etc.	1) Salt water intrusion affecting the secondary source of municipal drinking water 2) Death to fish in lake 3) Overflow of septic tanks affect water quality in lake
	comments:	

III HISTORICAL CONDITIONS

A INTRODUCTION

This chapter summarizes available information on historic and current land use effects on the natural watershed. While the Port Orford watersheds have been altered and restoration to a pristine condition is not an option, knowledge of historic conditions and the cumulative effects of land use can help guide restoration actions and improve chances for success (HRWA 1999). Documenting how natural, unmanaged streams interacted with the streamside forest allows us to see how far we have deviated from optimum fish habitat requirements (Sedell and Luchessa 1981).

The following historical narratives and timelines were researched and prepared by three Port Orford residents and dedicated members of the Port Orford Watershed Council. They include Pat Rhoades, Carren Copeland and Steve Taylor.

B GARRISON LAKE HISTORICAL NARRATIVE

As with all of the northwest coastal areas, the known history of the waters we know as Garrison Lake began with the arrival of "the White Man" - Euro-Americans - in the late 1700's and early 1800's. Even though human beings - Native Americans - resided in and traveled through these areas for perhaps 8,000 years before that, there is no written record of their time here. While agreeing that the overall impact the indigenous people had on the environment was generally minimal, historians differ on the reasons. Many believe this was because the Native Americans' ways were founded on a respect for the plants, fish and animals that sustained their lives. Others cite the small native populations and their relative lack of technology as being at least as important.

Whatever the reason, all we know indicates that the changes occurring to these watersheds before were primarily the result of natural causes, such as landslides, floods, fires, and in the case of Garrison Lake, dune movement affecting its outlet. Our known history of these areas began when the Euro-Americans came - and with them, the ability to impact and alter these areas on a scale previously impossible.

While in hindsight these impacts were as drastic as they were detrimental, it's important to look at them in the context of what was known *at the time*. The Euro-Americans may have been greedy, (a failing that remains alive today), but most of their mistakes were made in ignorance. These early settlers, and those that followed, weren't fundamentally bad people; they simply didn't understand the long-range consequences of their actions. When it came to logging, they saw the forests as being so vast and so fertile that whatever trees were cut then were just a handful of those available. The connection between logging and streamside development with fisheries never occurred to them. As to fisheries, the popular view was that there were so many salmon that it was impossible to ever seriously reduce their populations. As one old-time Port Orford fisherman sadly stated to the writer some twenty-five years ago, "we thought it would never end."

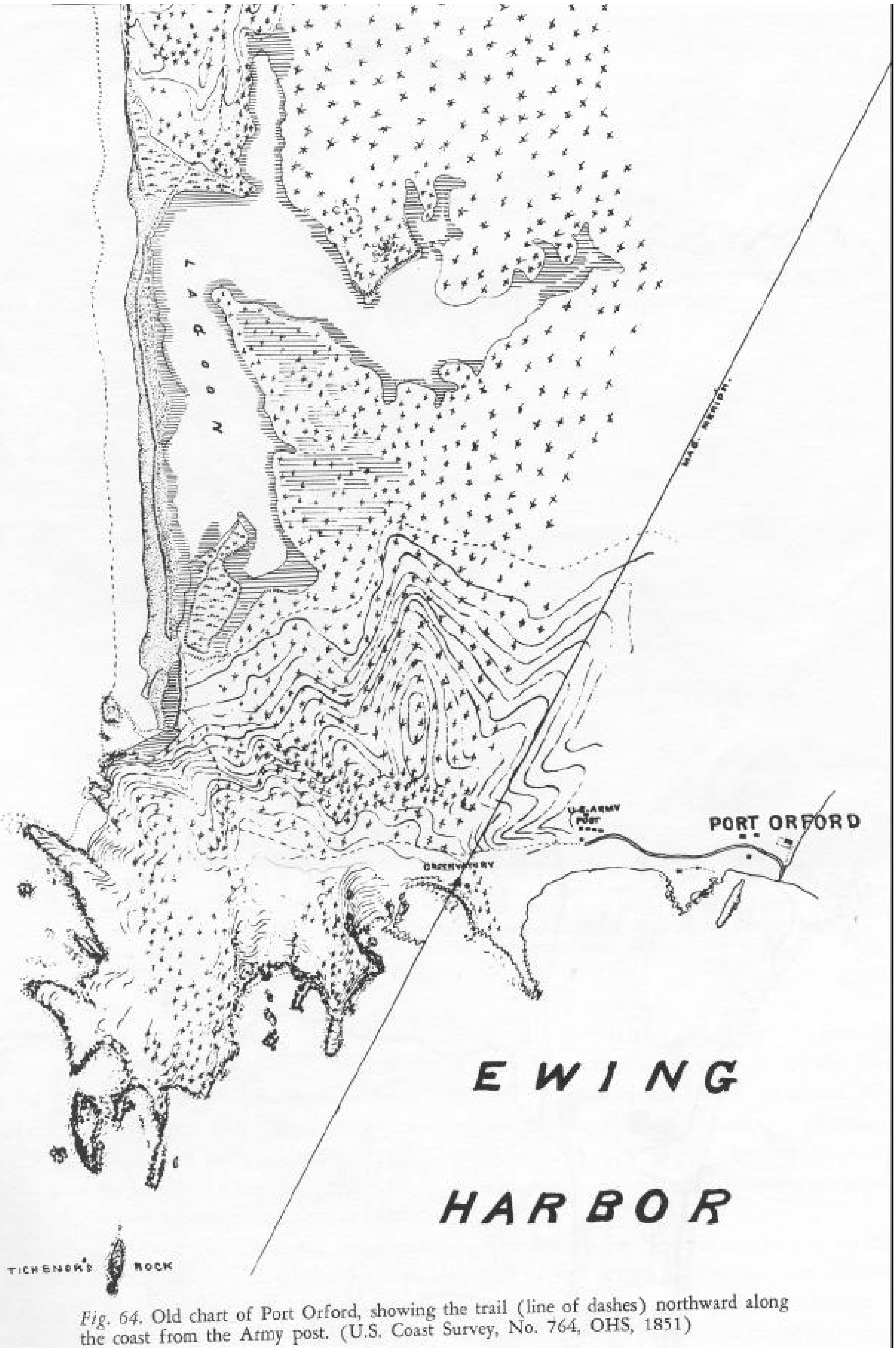

Fig. 64. Old chart of Port Orford, showing the trail (line of dashes) northward along the coast from the Army post. (U.S. Coast Survey, No. 764, OHS, 1851)

The first known impact of the Euro-Americans around 1780 perhaps foreshadowed what would follow. The white settlers unknowingly carried diseases to which they themselves had long since built immunities; native populations had never before been exposed to them, and had no natural resistance. Virulent illness swept through Indian camps and villages with epidemic swiftness, killing half or more of the native population (source: *Oregon Coast* Magazine, July-August, 1992; "Centuries of Clam-bakes on the Oregon Coast).

Next came the trapping party of famed "mountain man" Jedediah Smith (for whom both California's and Oregon's Smith Rivers, among others, are named) in 1828. This expedition hardly improved the image of Euro-Americans among the natives, given their activities in trapping and killing game that the natives properly regarded as rightfully "theirs." But that wasn't all. Word of Smith's journey had preceded him, and the Tututni Indian villages on both sides of the Rogue had evacuated before his arrival. Smith's journals briefly described the villages, then went on to describe how he and his men built rafts which they would use to cross the Rogue. The rafts, unfortunately, were constructed from lumber they obtained by tearing down several of the Indians' wickiups (houses). This was not atypical of the treatment Native Americans received in their encounters with Smith, but it eventually caught up with his party a little further north, near the Umpqua River, when an Indian raid cost the lives of 14 of his men.

Even though history won't exactly label him as a "good will ambassador," Smith's journals were in many cases the first written reports of the country along the Oregon coast. Among these was his recording of the first sighting of a small lake with a creek outlet some ways south of Cape Blanco. That lake is now known as Garrison Lake.

Whether Garrison Lake was "fresh" or "salt" at the time of Smith's visit is unknown, but the settlement of the Port Orford area began in 1851, with the town spreading to the north and west from the landing point by Battle Rock. At about the same time, a map was produced as part of the U.S. Coast Survey that labeled Garrison as "Lagoon" - not definitive, perhaps, but certainly
implying that it was at least brackish with saltwater. And therein lies perhaps the most - to turn a phrase - salient point about Garrison Lake: it is now thought likely that Garrison has cycled back and forth between fresh and brackish for centuries, as dunes shifted between it and the ocean, thereby impacting its outlet stream... and sometimes making it an inlet.

Long-time local residents tell of Garrison Lake water being too brackish to make coffee as recently as fifty years ago or so. This suggests that any fish present then were of salt-tolerant species, such as flounder, possibly saltwater perch, and conceivably sea-run cutthroat trout and even Coho salmon. This is speculation, however; we have found no records to tell us with certainty.

Although it is not known exactly when or how the shift occurred, sometime around the middle 1900's, the outlet had naturally stabilized to prevent infiltration by ocean waters and the lake gradually changed to fresh water. Vegetation changed to varieties habituated to fresh water, and fish species did, too, although the species present in this most recent fresh water phase were introduced by man. They included rainbow and cutthroat trout, largemouth bass, and yellow perch. Sport fisheries became fairly popular and the lake enjoyed a reputation for producing good-sized bass. No doubt the hatchery-planted trout and perch provided a forage base for the bass that contributed to their growth. However, all of these species, and particularly the bass, continued to require hatchery supplementation; there is no evidence that bass successfully reproduced in Garrison Lake.

Nature asserted itself in the winter of 1998-99 (and again in 1999-2000), and the dunes shifted anew, blocking the lake outlet and threatening to flood lakefront homes built around its perimeter. Rather than waiting for a natural correction (with attendant flood damage), the dunes were breached by bulldozer under emergency permitting. The unintended result was that the opening to outflow also allowed inflow, and the lake became progressively more saline as each high tide allowed ocean water to rush in through the bulldozed outlet channel. Most fish present were killed by the new salinity of the lake, but at least some rainbow trout seem to have survived.

But we must return to the 1800's to resume our look at the history of Garrison Lake.

William Tichenor, who led the effort to settle Port Orford, stood to profit from its success, and heavily promoted the area in San Francisco and Portland. The lure of gold was one inducement, and miners who had missed out on the California Gold Rush of a few years earlier saw a second chance here; they began to flood into the area in 1853. Most of the good claims - primarily along beaches - were quickly grabbed up, however, and the late-comers went elsewhere.

Loggers anxious to harvest the vast stands of cedar and fir soon took their place. The first of many sawmills that would eventually be built here was constructed between what is now 18th and Jackson Street and the edge of the "lagoon," and the first shipment of processed lumber was made in 1853.

The end of the Indian Wars in 1856 removed one more impediment to the progress of Euro-American exploitation of the natural resources surrounding Port Orford and Garrison Lake. Essentially all the local Native Americans - primarily from the Quo-to-mah tribe in this area - were forcibly relocated to the Siletz and Grande Ronde reservations, and suddenly the settlers had it all to themselves.

Nature reasserted its authority in 1868, when massive fires swept the coast, from the Port Orford area north to Yaquina Bay. The Port Orford area was among the worst hit; there remained only two houses in town after it passed. Miraculously, the people of Port Orford managed to survive on the beach as the fire raged through town. A photograph from 1920 shows the standing dead trees that were left by it, more than 50 years later.

Another photo - this one an aerial shot dating to 1926 - shows essentially no development on the lake, and no evidence of clear-cuts close by. By the late 1930's, however, the Trans Pacific Lumber Company had constructed a large sawmill at what is now

Buffington Park, which used the wetland area in the southeast arm of the north basin of the lake as a mill pond. No doubt a lot of detritus from those logs sank to the bottom, adding a great deal of organic material to the lake.

Yet another aerial photo of the lake - this one by the U.S. Army Corps of Engineers in 1939 - shows the lake to be virtually the same as it is now with respect to shape, size and shoreline edge.

World War Two came and went, and a returning generation of soldiers wanted homes. To help provide them, a new surge of logging took place in the 1950's and 60's; one example was the large clear cut area on the west side of Hensley Hill. The impact of this and other logging on the lake is not clearly known, but surely there was some increased sedimentation.

Then in October, 1962 came a devastating wind storm that swept over all of western Oregon, blowing down thousands of trees not yet cut by man and wind burning countless others. Even for the Port Orford area, always known for a lot of wind and spectacular winter storms, the Columbus Day Storm (as this one came to be called) was extraordinary, with peak gusts of 190 m.p.h. Long-time residents all over western Oregon remember it vividly even now.

Next, 1964 brought the filling of a former wetland arm of the lake that extended parallel to Arizona Street and north of Paradise Point Road. This, coupled with a minor amount of filling resulting from the construction of the Highway 101 bridge across Mill Creek around 1976, and a few other less significant fills (including the Arizona Street crossing itself, which even though it included a culvert, disturbed the flow from the adjacent wetland) have somewhat reduced the wetlands associated with the lake. A weir was installed in 1996-97 on Mill Creek, with the intent of slowing the waters coming from that source and allowing them to be more thoroughly filtered by the wetlands through which it flows, but most of the other development has not been mitigated. Still, Garrison's associated wetlands remain extensive relative to other south coast lakes.

Also in the mid '60's, sewers and a primary/secondary treatment plant were constructed in Port Orford, at least theoretically reducing pollution of lake and ground water. City boundaries do not include the entire lake, however, so only residences on the south end are connected to the sewer. The remainder are still using septic systems, possibly impacting groundwater reaching the lake. Studies have indicated that groundwater probably provides as much as 50% of the water to Garrison (source: *Garrison Lake Watershed Condition Assessment*, December 1994, Port Orford Watershed Council), so this is a serious concern. Septic systems also impact Mill Creek, where unacceptably high levels of fecal coliform have regularly been measured, particularly in winter.

Even though it was given primary and secondary treatment, the sewage treatment plant's discharge into the lake was part of the problem, too, adding the equivalent of liquid fertilizer - nitrates and phosphates - to a lake already high in organic matter as a result of the earlier sawmill activity, and the inflow from Mill Creek and septic systems near the lake. All of these sources combined to promote very high concentrations of phytoplankton, which reduced water clarity and oxygen levels, particularly in the summer months. Aquatic weed growth, including the exotic waterweed *Elodea densa* and Eurasian water-milfoil, *Mycrophyllum spicatum,* was also promoted. Both the excessive phytoplankton and aquatic weed growth adversely impacted the fisheries and the recreational uses of the lake, as well as its suitability as a backup water source for the city.

In 1994, these problems forced construction of a new outfall system for the sewage treatment plant, piping the treated effluent out to a tank just inside the foredune, from which it was then pumped through multiple drain fields located in the foredune separating the lake from the ocean. It was calculated that the sand in the dune would act as a final filter, and that the pressure and directional flow of the lake waters also seeping through the dunes and out to sea would carry the treated effluent safely away. However, storms shifted the dune and first undermined, then swept away the outfall tank in the winter of 1998-99. A new system is planned in which the effluent will be pumped through a buried pipe going straight out to sea approximately 1500 feet to a water depth of 40 feet, where it would then be exhausted and dispersed safely by currents. Construction of this replacement system currently awaits Department of Environmental Quality approval of the plans submitted.

Garrison Lake has been used as a backup source of domestic water for the city for the last twenty years. From 1977 to 1981, a water treatment plant was built near the Mill Creek inlet which provided for the use of lake water for this purpose, primarily in winter when the city's primary water source from a reservoir in the Hubbard Creek watershed became turbid from storm runoff. However, the current salinity of the lake precludes its use as domestic water. How long this problem will remain is anybody's guess.

By 1981, cranberry bogs had been constructed on the north side of the drainage, raising concerns about possible further impacts to the lake's groundwater sources. Meanwhile the landfill north of the lake also became a source of concern, and was eventually closed in 1996-97; a transfer station remains. Tests conducted around that time confirmed that nearby wells had been affected to varying degrees by the landfill, although impacts to the lake are still not well understood and may change as time goes on. Meanwhile, continued logging, grading and development in several east side areas, including along 18th and 25th Avenues, are further changes impacting Garrison.

So the history of Garrison Lake raises as many questions as it answers. Will the lake continue to be periodically infiltrated by salt water - and should attempts be made to stop it? Can ways be found to reduce or eliminate the effects of septic systems from areas within the watershed not presently served by the sewer - and will the new sewer outfall system withstand the sometimes severe tests of nature? Wetlands - both associated with Mill Creek and others - are clearly an especially important aspect of Garrison Lake; should ways of expanding existing - or even constructing new - wetlands be considered? What about the historical cycling from fresh to brackish water; should steps be taken to intervene and maintain Garrison as strictly fresh water in the future, or should nature be allowed to take its course? And based on that decision, what should be done about fisheries in Garrison Lake? In the recent past, trout, perch and bass were planted and did well, but if the lake is to be allowed to continue as brackish, should fish like sea-run cutthroat and Coho salmon be considered? These are just a few of many questions that need to be answered. One thing is clear, however: Garrison Lake is among the most important water resources on the south coast, and the decisions we make about it need to be well thought out indeed.

C GARRISON LAKE HISTORICAL TIMELINE

1780	European introduced epidemic diseases swept through Native American coastal villages reducing population by half or more. (Or. Costal Mag. 1992 p 39 July/Aug).
1828	Jed Smith trapping party described small lake with creek outlet.
1851	Settlers arrive. Town (Port Orford) builds from Battle Rock beach to north and west.
1853	Beach gold mining, logging, flood of miners to area.
1854	First sawmill from 18th and Jackson to edge of "lagoon"
1856	End of Indian wars (55-56) Surviving native Amer. Moved to Siletz & Grand Ronde reservation
1868	Forest fire sweeps coast
Early 1900's	Narrow gauge railroad transports lumber through town to beach from Elk River mill. (see VI)
1920	Photo shows still standing dead trees from 1868 fire
1926	Aerial photo shows no development at lake, no evidence clear-cutting. Town contained to south.
Late 1930's	Large sawmill established (now Buffington Park) Trans Pacific Lumber Co. millpond created in wetland area Logs in SE arm of north basin of lake
1950's-60's	Heavy logging west side (Hensley Hill area) clear-cut
Mid 1960's	Town "sewered"
1962	Columbus Day storm devastated area

1964	Increased fill of a former wetland arm of the lake that extended parallel with Arizona and north of paradise point Rd.
1970	Port Orford cedar disease spreading
1977-81	Water treatment plant built on Buffington Pond. Used lake water
1981	Aerial photo shows considerable settlement around lake and some north (Port Orford Loop/ old highway) Only south side of lake sewered and south end Port Orford Loop Continuous filling of lake and creek wetlands. Cranberry bogs on north side of drainage .New pumps installed Hubbard Creek but sporadic use of lake water in winter.
1996-97	Water quality testing done lake and wetlands. Weir installed Mill Creek. Landfill closed. Leaching into nearby wells. Wetlands north endangered?
Late 90's	Bulldozing/logging for development in several east side areas (18th, 25th) turbidity in creek and wetlands. Final effluent disposal through dune filtration
1999-00	Dune dike and creek outlet destroyed by ocean action. Lake becomes saline. Need for artificial outlet to lake required frequently in winter as flooding low-lying areas occurring

D HUBBARD CREEK HISTORICAL NARRATIVE

Hubbard Creek may not be as well known as some of the more famous creeks and rivers of the southern Oregon Coast, but its well-being is of critical importance to residents of Port Orford, since its north fork has provided the city's domestic water since 1968. With Garrison Lake (the city's backup water supply) recently reverting to brackish, saline water, the importance of Hubbard Creek has become even greater.

Much of the history of Hubbard Creek is the history of the area as a whole, which has been discussed at some length in the Garrison Lake Historical Conditions Assessment, published concurrently with this report. For the sake of brevity, those conditions will be incorporated herein by brief reference.

Our factual historical knowledge of these watersheds begins with the arrival of Euro-American explorers and settlers in the late 1700's and early 1800's. It is believed that all of the south coast watersheds existed in a basically natural state prior to that time.

Captain George Vancouver reported on the area from his voyage of 1792. There were friendly contacts with local Native Americans, who came out to the ships in canoes and were thought by Vancouver to have "settled along the shores...in the small nooks that are protected from the violence of the westerly swell by some of the larger rocky islets, so abundantly scattered along the coast." Vancouver described "Cape Orford" as being "covered with wood as low as the surf will permit it to grow."

In 1828, the Jedediah Smith party was the first group of Euro-Americans to come up the Oregon Coast in any numbers. While the primary purpose for their expedition was trapping and hunting, the Smith party kept written records, and reported an Indian village at the mouth of Hubbard Creek. This village was one of three populated by the "Quo-to-mah" band of the "Tututni" or Rogue Tribe; the other two villages of the Quo-to-mahs were near the mouths of the Elk and Sixes Rivers, and in total they numbered 143. The village at Hubbard Creek was the smallest, and by 1851 was reported to have only 27 people. No trace of the village remains today; the remnants were probably lost with construction of a sawmill there in 1875.

Captain William Tichenor led the first permanent settlement of the area in 1851 with a military encampment erected on the bluff over the present port of Port Orford, where the Castaway Motel now stands. The discovery of gold on the beach and, to a lesser degree, in area rivers (primarily the Sixes) led to an influx of prospectors and miners in 1853. Soon after, the timber wealth of the south coast began to attract loggers as well, and the first "white cedar" - soon to be called "Port Orford cedar" - was processed and shipped to San Francisco in 1853.

Prior to settlement, the entire area around Port Orford was characterized by wooded bottom lands next to the creeks and rivers, with "limby" spruce trees providing shade to these waters. The hinterlands were covered with huge stands of fir, hemlock, alder and cedar. The unique qualities of Port Orford cedar were well-known to the Indians, who built their wickiups from it as well as using it for canoes and arrow shafts. The settlers would soon learn about the cedar for themselves, and it quickly became the most prized of all woods found locally.

A major forest fire ravaged the area from Port Orford all the way north to Newport in 1868, but records are incomplete as to the degree of damage to the Hubbard Creek watershed. With most forest fires, many trees are charred and killed but still salvageable for lumber. Some of these were probably processed at the Port Orford Cedar Co. mill, which was built near the mouth of Hubbard Creek in 1875, and operated until 1884. This was a large mill for the day, and had many buildings and a good-sized mill pond created when the creek was dammed; it was located on Knapp Field, an area along the creek just north of the present-day Highway 101 bridge. The sand pile on the south side of the creek today is the remains of the old dam. In its last year, this mill was reported as producing 17,000 board feet per day. Tramways to transport the logs to the mill ran up both the middle and south forks of Hubbard Creek to the Forty Ranch. There was another tramway of approximately 1,000 yards to carry the mill products out to the "mill rocks" (one of which had been blasted to make it flat on top) from which they were loaded onto barge-like devices called "lighters," which in turn delivered them to waiting schooners for loading and delivery to market.

Logging continued throughout the region for many years, but the return of our service men and women from World War Two and the resulting "baby boom" fueled a renewed demand for timber in general beginning around 1946. This was reflected by the logging of the south fork of Hubbard Creek by Smith and Stone Logging Co. in 1949. Logging continued through the '50's and '60's throughout the area; most of Cedar Terrace, later a major residential development, was logged around this time.

The Columbus Day Storm in 1962, which carried winds up to 150 m.p.h. and gusts to 190 m.p.h., uprooted and downed thousands of trees on the southern Oregon coast, and severely wind-burned many more. Fortunately, the topography of ridges around Hubbard Creek affords more wind protection to it than most of the Port Orford area has, so the damage here was somewhat less.

Hubbard Creek's usage as a source of water for the City of Port Orford began in 1968, with the construction of a .85 acre reservoir on the north fork. Prior to that time, Gold Run Creek had been the source. The reservoir holds up to 1.1 million gallons, and the city has a water right to 1.25 cubic feet per second. No doubt winter rains bring water into the reservoir at a considerably higher rate. Although almost the entire watershed had been logged at one time or another by then, the second growth of conifers, primarily Douglas fir and cedar, were by that time large and well-established.

In 1970, concerns began to grow about a root disease that was attacking and killing Port Orford cedar trees. While new strains have been developed that are thought to be resistant to it, Port Orford cedar throughout the region has been in a state of decline ever since.

Cedar Terrace was platted and subdivided for development in the late 1970's and with that, coupled with less concentrated development elsewhere in the watershed, came the potential for impact on Hubbard Creek due to wells and septic systems, as well as erosion.

Consistent with the limited knowledge of the kinds of habitat needed for resident and anadromous fish of the time, woody debris was removed from the creek mouth and at other places along the creek at various times, most recently in the 1980's. Such woody debris is now understood to be essential to healthy native fish populations, and is now in the process of being restored to many creeks in the area, at considerable expense.

In 1981, new pumps were installed at the reservoir. Fish passage at the reservoir was still impeded, a situation that persisted until 1998, when a fish ladder was built.

Logging continued to impact Hubbard Creek in the 1990's. Extensive logging occurred along the middle fork in 1991, again in 1994 and once again this year, currently by the Moore Lumber Co. Power lines maintained by Coos Curry Electric Co-op run along the middle fork for much of its length, and in 1994 this right-of-way was cleared of all brush and trees, exposing the stream and no doubt increasing mean water temperatures and siltation.

In 1994, a parcel of about 80 acres immediately adjacent to the reservoir parcel was clear-cut, and siltation and turbidity increased significantly. Just this spring, the City of Port Orford has acquired this property, a good first step toward restoring the watershed.

In 1996, logging activity in the watershed continued, with selective logging of two separate tracts, one of them being the 140 acre parcel now belonging to Sorenson Logging, which was clear cut in 1999. That parcel, after the 80 acres just purchased this year, likely has the most impact on the city's reservoir. Discussion is currently underway about the possibility of the City of Port Orford acquiring it and other properties near the reservoir, or possibly obtaining conservation easements of some sort, to afford at least some additional protection to the reservoir.

Fish populations in Hubbard Creek offer a mixed bag. There are resident cutthroat trout in each of the forks, although their current status in the middle fork is thought to have been impacted by the logging activity and brush removal discussed earlier. Steelhead and Coho have been reported in the lower mainstem as well as the south and middle forks, with Coho reported as recently as last fall. Oregon Department of Fish and Wildlife personnel state that they believe the presence of salmon probably varies from year to year. Hubbard Creek has little good habitat for Coho and the creek's access upstream from the ocean is difficult for these fish; there probably never was a natural, self-sustaining run. Attempts were made in the '70's to start one with a small planting of hatchery fish, and those returning fish today are either remnants of that effort or strays from nearby rivers. Chinook salmon do not appear to have ever populated Hubbard Creek.

Progress has been made on removing some of the obstacles to fish. In addition to the city's fish ladder at the reservoir in 1998, a bridge replaced a fish-blocking culvert and an off-stream alcove was created on the south fork in 1996, and a wooden road bridge replaced a failed culvert on the mainstem in 1997.

Pollution to the Hubbard Creek system has been under study recently by the Department of Environmental Quality, with a Source Water Assessment Report due soon.

Without intending to criticize individuals, it must be noted that until recently, those involved in city government and, for that matter, the environmental community, missed some golden opportunities to avoid problems with Hubbard Creek that have become much more expensive to solve now.

Those opportunities included the opportunity to acquire portions of the watershed most directly impacting the city's reservoir *before* the logging and development and resultant damage to the city's water supply... and at a small fraction of its cost now, after a lot of damage has been done. Hopefully, a lesson has been learned, and such a failure of vision and foresight will not be repeated.

Much of what can be logged has already been logged, so the worst is probably over. The land can begin to heal itself, and stream conditions resulting from the logging will gradually improve even if we do nothing... at least, until the next timber harvest cycle begins. It seems clear that while there remains a lot of potential and reason for optimism, a considerable amount of effort and money will be needed to protect and preserve Hubbard Creek, not only as the source of Port Orford's water but also as a good home for fish.

E HUBBARD CREEK HISTORICAL TIMELINE

1780	European introduced epidemic diseases decimate Native American coastal villages by half or more (Oregon coast magazine J-A 1992 p.39)
1828	Jed Smith party the first, in numbers, to come up Oregon coast from California. Indian camp/village at mouth of Hubbard Creek
1851	Port Orford first settled by whites.
1853	Gold discovered on beach caused influx of miners.
1854	First major sawmill resulted in beginning of serious logging
1856	At the end of Indian wars of 1855-56 remaining Native Americans shipped to Siletz and Grandel Ronder Reservation (Masterson p.78)
1868	Forest fire ravaged south coast
1875	Mill (Port Orford Cedar Co.) built at mouth of Hubbard Creek, obliterating remains of Indian village (Knapp's field). Tramways ran up both branches of Hubbard Creek
1949	South Fork logged by Smith and Smith Logging Co. (HC Watershed Asses. 1995 p.14)
1950's-60's	Extensive logging. Cedar Terrace logged meadows at Mij's were hayfield (3/4 mi. up middle fork)
1962	Columbus Day storm devastates area
1968	Water impoundment reservoir (.85 A.) built North Fork Hubbard Creek; prior to that city water from Gold Run Creek
1970	Gradual destruction Port Orford cedar by root disease.
Late 1970s	Cedar Terrace platted and development started wells and septics.

1980's	Woody debris cleared from creek mouth (not for first time) to detriment of migrating fish.
1981	New pumps installed at reservoir. Sporatic use of lake in winter continues.
1991 & 1994	Middle fork logged in 1991,1994 & 2000 ("Moore Lumber Co. currently)
1994	Extensive clearing of trees and brush under Coos-Curry power lines that run along most of middle fork HC (assessment p.8)
1994	Clear cut logging on Bussman's approximately 80acres in watershed.
1995	ODFW found steelhead in main stem and south fork.
1996	Selective logging in watershed (Lee and Wilken); stream sediment from latter. Fish passage blocked above reservoir on two tributaries by culvert. Bridge replaced fish blocking culvert south fork Hubbard Creek and off stream alcove created (Harvey/Kelso) Stream habitat survey by youth corps (raw data)
1997	Fir road bridge replaced failed culvert main stem (ref. Clayton Barber ODFW)
1998	Fish ladder installed at city reservoir
1998-99	Hubbard Creek became Port Orford's only source of drinking water.
1999	More extensive clear cut logging in watershed (Wilken/Sorenson) 140 acres
2000	Peter Mijs, property owner on middle fork Hubbard Creek, reported that he saw salmon and steelhead in middle fork over 20 years ago for 2 years prior to removal of brush and trees from stream. Since the removal of brush he has only noticed cutthroat.

E BRUSH CREEK HISTORICAL NARRATIVE

Anyone driving along the lovely little stream known as Brush Creek as it flows through Humbug Canyon would likely conclude that it got its name from the abundant brush along it. At times through its history, though, its name has been slightly different; for a time through at least the late 1920's, it was known as "Brushes Creek" and before that is said to have been called “Brushy Creek.” Actually, though, the name probably came from a less obvious source. According to respected local historian Walt Shroeder, it was in fact named for a man named Gilbert Brush. This would tie in with the old name, “Brushes Creek” being later changed to “Brush Creek,” since the U.S. Geological Service has a long-standing policy of not allowing possessive names for streams (e.g., Jack’s Creek becomes Jack Creek). If the name did derive from Gilbert Brush, the naming could hardly have been more appropriate, even though unintentionally so.

The original trail along Brush Creek was pretty tough going. The stream had to be forded in 17 places along its length, and doing battle with the dense brush made it an arduous journey. Early Curry County resident Fred S. Moore wrote on March 28, 1927: “every old-timer who traveled up and down the coast never questioned its right to be so named. I carried the mail between Gold Beach and Port Orford about 45 years ago *(that would make it about 1882. -ed.).* At that time there was not a bridge in Curry County. The trails along the coast were narrow and unimproved, following the ridges and often dropping down to creek beds. Many of those trails were old elk trails, for in early times elk ran in bands of hundreds and in traveling they always followed each other in single file. The result was deep trails where they had trod and, of course, they broke out some of the brush as they went through. Indians and pioneers who came afterward, naturally, followed these trails. The coast trail dropped down to the creek south of Humbug Mountain and one was met with such a dense growth of brush that in places it was necessary to dismount and lead the horse.”

Much of the history of Brush Creek is the history of the area as a whole, which has been discussed at some length in the “Garrison Lake” and “Hubbard Creek” Historical Conditions Assessments, published concurrently with this report. For the sake of brevity, those conditions will be incorporated herein by brief reference.

Our factual historical knowledge of all of these watersheds begins with the arrival of Euro-American explorers and settlers in the late 1700’s and early 1800’s. It is believed that all the south coast watersheds existed in a basically natural state prior to that time.

The Jedediah Smith party of 1828 reported in their early journals about their route through what came to be known as Humbug Canyon on Indian trails, crossing Brush Creek repeatedly. They camped at the mouth of the creek, just north of what we call Humbug Mountain. That was the first written record specific to what is now Brush Creek.

Not much beyond that is known of Brush Creek until well into the 1900’s. Sometime before 1920, the south end of China Mountain Road joined the main coast highway (then the “Roosevelt Highway”) at what would become Humbug Mountain State Park.

There are reports that there was a mill and log pond somewhere in the canyon sometime in the early 1900’s, but we found no recognizable evidence of it now. There was clear cutting of the headwaters area of the creek sometime years ago, and you can still see large stumps from it, but we could find no written records that could give us dates. It appeared the land had simply been allowed to reforest itself, as was common in the early days. The amount of public land around Brush Creek has saved much of it from logging and other impacts in more recent times.

Brush Creek is a fast-flowing freestone stream for most of its length, well-suited to trout in places, but less so to salmon. There has been a small but healthy run of steelhead trout for as long as anyone remembers, and until this and other streams were closed to the taking of wild fish, a few were caught each winter, usually in the short segment through the park. Salmon are not thought to have used the creek with much regularity. An attempt was made by the Fisheries Department sometime in the '60's or early '70's to plant Brush Creek with hatchery Coho and Chinook; the Coho didn't survive, but the Chinook have either survived in very small numbers, or strays have come into Brush, as juvenile Chinook have been found there, some of them just last year. It's thought that the salmon may not return every year to Brush Creek, but just in years when conditions are most ideal. The Game Department (when the "Game" and "Fisheries" Departments were separate agencies) operated a small hatchery on Brush Creek in the 60's that raised cutthroat trout for planting here, but it soon ceased operations and no one seems to remember much about it. The remaining trout in Brush Creek are natives, and consist of cutthroat and of pre-migratory steelhead, which are visually the same as rainbow trout.

Over the years, Brush Creek has been straightened and re-routed in places, mostly in connection with the highway through the canyon. Yet, we found no good records of these changes, and apparently these operations weren't considered nearly as consequential as they would be now. The Highway Department has provided some old photographs from the area for this report, and they help somewhat in seeing what it might have been like in earlier times.

A little more is recorded about the development of Humbug Mountain State Park, which is by far the most important development along Brush Creek. The original purchase of land for the park was made from Carl White in 1926, and consisted of 30.6 acres near the mouth of the creek. A total of 16 other tracts were acquired at various times between 1930 and 1975, bringing the total for the park to 1842.16 acres today. The original park was developed with Civilian Conservation Corps labor in 1934. In 1952, overnight camping was first developed. In 1958, a forest fire burned much of the northern end of the park. The fire's impact on Brush Creek is not known, but is thought to have been minimal.

Recently, the portion of Brush Creek that parallels Highway 101 through Humbug Canyon had begun to undermine the road, so in 1998-1999 a major project was performed that stabilized the west bank and installed a proper guard rail between it and the highway. Care was taken to minimize the impact of the construction on the stream, and the water carrying capacity of the stream was increased somewhat. Meanwhile, the creek by-pass, which channels water directly out to a waterfall into the ocean to control potential flooding through the canyon, was modified to reduce the amount of water going over the cliff and keep more of it in the stream.

For a piece of water as visible as Brush Creek is to thousands of motorists, both locals and tourists, along Highway 101, you would expect that more would be known about this pretty little stream. It has no doubt benefited from flowing through Humbug Mountain State Park, which is among the largest and most beautiful in the state; just the relative lack of logging keeps it running cold and clear when other rivers are swollen and muddy from winter rains. Even though anglers can no longer keep a steelhead caught from Brush Creek, it's still fun to see them, and they really stand out in the clear and shallow water. Hopefully, they'll be there for all to see for many years to come.

F BRUSH CREEK HISTORICAL TIMELINE

1780	European introduced epidemic diseases which swept Native American coastal villages reducing population by half or more (Or. Coast Mag. 1992 p.39 July/Aug)
1828	Jed Smith party route through canyon via Indian trail repeatedly crossing Brush Creek. Camped at mouth of creek.
1851	First white settlement on Southern Oregon Coast. Pt. Orford Quo-ta mah Indian band occupied area from New River to Brush Creek.
1856	Indian survivors of war of 1855-56 transported north to reservations
1882	The "Brushy Creek" trail in area of extremely dense growth. Sometime necessary to lead horse.
Before 1920	South end of China Mountain Road (old road) joined highway In Humbug Mtn. State Park
19__	Mill and log pond in Humbug Canyon (where)?
____	Clear-cutting of creek source area south part of canyon (Large stumps seen of earlier logging) no obvious replanting.

Late 1990's

- New viaduct built at mouth of Brush Creek (ODFW) reported illegal fill storage at the creek by highway contractor (POWC, 8/21/966)
- Highway realigned over portion of Brush Creek through canyon.
- Spillway created south end baffles in culvert to slow water speed
- Stream has been straightened over the years (H. Witt BLM)

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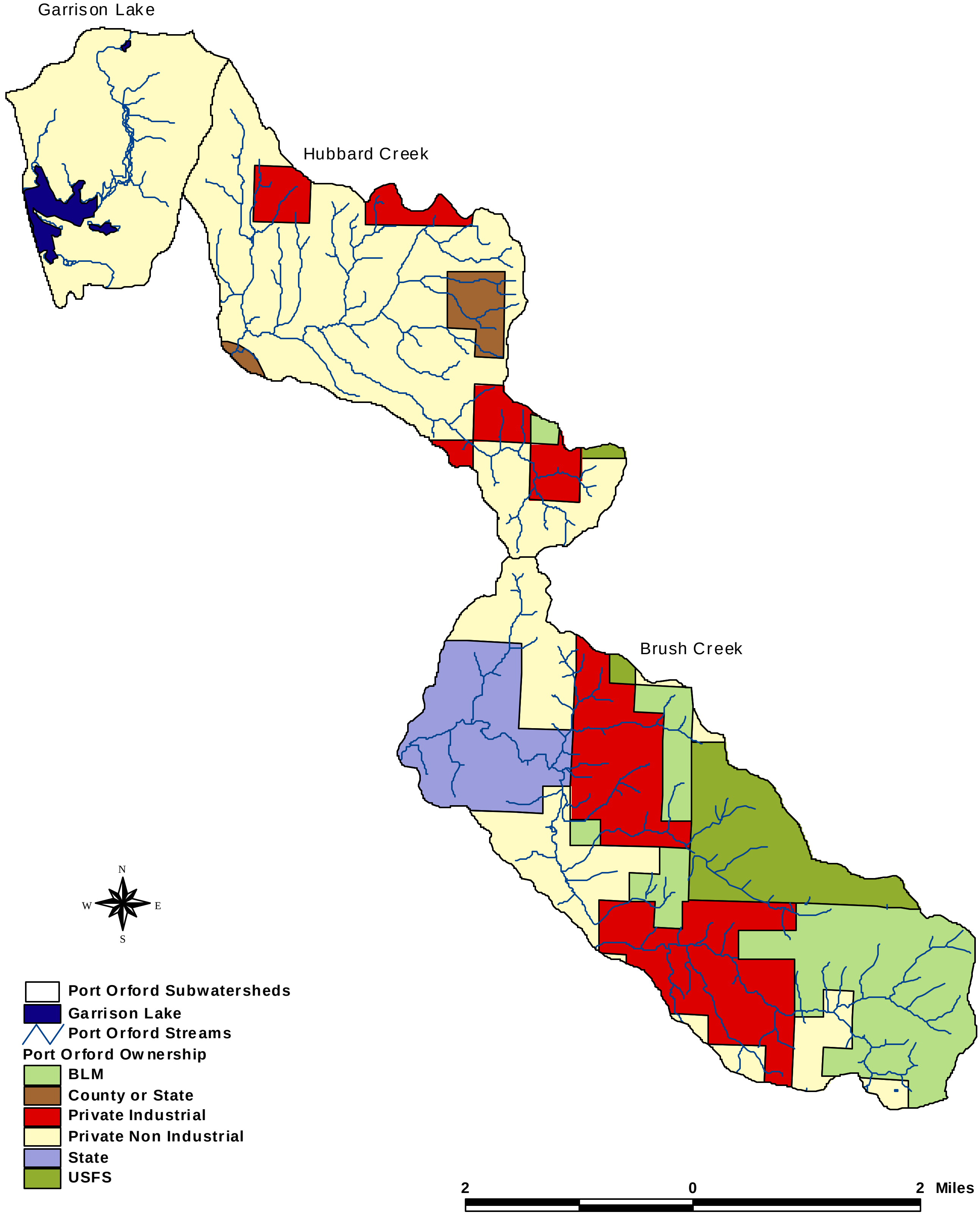
Additional Information was obtained from the following sources, among others:

Walt Shroeder, Gold Beach, Oregon.
Todd Confer, ODFW, Gold Beach, Oregon.
Allen Wagner, Port Orford Public Works Superintendent, Port Orford, Oregon.
Toby Dillingham, Port Orford Realtor and Developer, Port Orford, Oregon.

Port Orford Watersheds

Ownership
(Port Orford Watersheds)



IV ECOREGIONS

A BACKGROUND (GWEB 1999 and USEPA, 1996; Omernik, 1987)

The State of Oregon is divided into ecoregions that have been identified based on climate, geology, physiography, vegetation, soils, land use, wildlife, and hydrology. Each ecoregion has characteristic disturbance regimes that shape the form and function of watersheds in the region. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. Ecoregions are directly applicable to the immediate needs of state agencies, including the development of biological criteria and water quality standards, and the establishment of management goals for nonpoint-source pollution. They are also relevant to integrated ecosystem management, an ultimate goal of most federal and state resource management agencies. The following table illustrates the hierarchy of ecoregions characterized for North America. Level I is the coarsest level, dividing North America into nine ecological regions, whereas at Level II the continent is subdivided into 32 classes. Level III contains 98 subdivisions in the continental United States whereas Level IV is a subdivision of Level III. Level IV Ecoregion descriptions provide the most detail and are therefore, the focus of this assessment.

Hierarchical Scheme of Ecoregions

Level I	9 Ecological Regions of North America
Level II	32 Ecological Regions of North America
Level III	98 Ecological Regions of North America
Level IV	>98 Ecological Regions (Subdivision of Level III)

(USEPA, 1996; Omernik, 1987)

B INTRODUCTION

The Port Orford watersheds are situated within one Level-III Ecoregions that is subdivided into three Level-IV Ecoregions. The Level-III Ecoregion is titled the **Coast Range**. A brief description of this broad ecoregion is provided in the following paragraph. More detailed descriptions of the three Level-IV Ecoregions are provided in the following pages.

<u>Coast Range</u>

The Coast Range contains highly productive, rain drenched coniferous forests that cover low elevation mountains. Sitka spruce forests originally dominated the fog-shrouded coast, while a mosaic of western red cedar, western hemlock, and seral Douglas-fir blanketed inland areas. Today Douglas-fir plantations are prevalent on the intensively logged and managed landscape. Within the Coast Range exist several Level IV Ecoregions. All of the Port Orford watersheds are situated within three Level IV Ecoregions. They include the **Coastal Uplands**, the **Southern Oregon Coastal Mountains**, and the **Coastal Lowlands**. The Coastal Uplands include portions of the coastal area extending up to 30 miles inland, from Astoria to Brookings. The Southern Oregon Coastal Mountains include the southern coastal area from Bandon to Brookings, extending inland from 5 to 20 miles. The Coastal Lowlands include portions of the coastal fringe from Seaside (Oregon) in the north to Gold Beach in the south.

Table 5 Ecoregions by Subwatershed (acres)

Subwatershed	Coastal Uplands (acres)	%	Southern Oregon Coastal Mountains (acres)	%	Coastal Lowlands (acres)	%	Total Acres	Total Square Miles
Brush Creek	3,025	42.9	4,027	57.1		0.0	7,052	11.0
Garrison Lake		0.0		0.0	2,010	100.0	2,010	3.1
Hubbard Creek	604	14.1	2,062	48.2	1,609	37.6	4,275	6.7
Total Acres	3,629	27.2	6,089	45.7	3,619	27.1	13,337	20.8

C LEVEL IV ECOREGION DESCRIPTIONS

(1) Coastal Uplands (27.2% of Port Orford Watersheds)

Overview

The Coastal Uplands ecoregion extends to an elevation of about 500 feet. Its climate is marine-influenced with an extended winter rainy season, enough fog during the summer dry season to reduce vegetal moisture stress, and a lack of seasonal temperature extremes. The ecoregion roughly corresponds with the historic distribution of Sitka spruce. The extent of the original forest has been greatly reduced by logging.

Physiography &Topography

Coastal headlands and upland terraces with medium to high gradient, black-water streams are common. Medium and large streams and some small streams are low gradient; few waterfalls exist. Headwater small streams are often steep gradient and usually bordered by steep slopes. Other streams are bordered by a variety of flat to steep slopes. Watersheds in this ecoregion have a high stream density.

Geology & Soil

Geology is weak sandstone. Soil is mostly deep silt loam.

Climate

Precipitation	Frost Free	Mean Temperature	
Mean Annual (Inches)	Mean Annual (Days)	January Min/Max (°F)	July Min/Max (°F)
70-125	190-240	36/48	52/68

Wind

Summer	North winds prevail. East wind events associated with extreme high temperatures (>100° F) and high wind speeds (>35 mph) create extreme fire hazard conditions that may result in catastrophic wildfires
Winter	South winds prevail. Extreme high wind events (>100 mph) result in catastrophic wind storms.

(Wiggins, 2001)

Precipitation and Runoff Patterns

Wet winters, relatively dry summers and mild temperatures are typical characteristics of the climate in this ecoregion. The highest monthly precipitation occurs in November, December, and January. Heavy precipitation results from moist air masses moving off the Pacific Ocean onto land. Peak streamflows occur in the winter months. The peak flow generating process in this ecoregion is rainfall. Snowpack development is minimal except during unusual storms, which bring very cold, moist air to the region. The 2-year 24 hour precipitation ranges from 3.5 to 5.5 inches. The peak flow magnitude (2 year recurrence interval) is 50 cfs/square mile to 150 cfs/square mile.

Erosion & Peak Flows

Erosion rate is high due to abundant precipitation, high uplift rates, steep slopes, weak rock, and high landslide occurrence. Landslides are deep-seated earth flows in lower gradient areas or are shallow landslides (often triggering debris slides) in steep headwater channels.

Stream Channel Characteristics

Characteristic	**Gradient**	**Stream Size**		
		Small	**Medium**	**Large**
Substrate	Low	gravel / fines	fines	fines
	High	gravel / bedrock	fines / bedrock	bedrock
Beaver Dams	Low	many year round	many year round	some in summer
	High	some in summer	few in summer	none

Natural Disturbances

Fires tend to be infrequent in Sitka spruce forests, although they are usually stand-replacing fires since the typical species are not tolerant of fire. Catastrophic fires occur about 50 years (Wiggins, 2001). Fires are more frequent in Douglas-fir/western hemlock forests, although the interval between fires is quite variable. Native Americans and ranchers both used fire to maintain pastures. Large wildfires during late summer and fall once burned large areas of central Coast Range, killing most trees in its path. The Coastal Uplands ecoregion was sometimes skipped over by wildfire because of coastal fog influence. Fire suppression has now eliminated most large wildfires.

Extreme windstorms capable of toppling large patches of trees occur about every 35 to 100 years. Young hemlock trees are particularly susceptible to wind damage if located along cutting lines or within streamside buffers. Extreme flood events are triggered by high intensity rainfall. High intensity rainfall and steep slopes trigger landslides. Catastrophic earthquakes capable of triggering numerous landslides occur about every 300 years.

Upland & Riparian Vegetation (Wiggins, 2001)

Conifers	shore pine, Sitka spruce, grand fir, Douglas-fir, western hemlock, Port Orford cedar, western red cedar, Monterey cypress, and bishop/Monterey pine
Hardwoods	red alder, big leaf maple, myrtle, and madrone
Shrubs	Rhododendron, holly, wax myrtle, willows spp., ceanothus spp., and manzanita,
Understory	azalea, ribes spp., iris, sea watch, huckleberry, salal, salmonberry, thimbleberry, skunk cabbage, rushes, sedges, grasses, and ferns
Noxious	scotch broom, gorse, blackberry, tansy, and thistles spp.

Current riparian conifer regeneration is common, especially if an organic substrate exists for hemlock and spruce seed regeneration. Competition from non-conifers can be intense, especially where salmonberry, huckleberry, and alder become established.

Potential riparian vegetation will vary according to channel confinement. Confined channels include a narrow band of hardwoods (red alder or others) and brush. Situated behind the hardwoods are conifers (western hemlock, Sitka spruce, western red cedar, Douglas-fir) and some alder. Few conifers are present where slopes are unstable or perpetually wet.

Moderately confined channels differ primarily in their width of streamside vegetation, which is considered moderately wide rather than narrow. Well-drained streamside areas are mostly dominated by conifers. Few conifers are present where slopes are unstable or perpetually wet. Also, there are usually no conifers on low terraces. Beaver browsing sometimes modifies vegetation.

Unconfined channels differ again in their width of streamside vegetation, which is considered wide rather than narrow or moderately wide. Well-drained streamside areas are mostly dominated by conifers. Few conifers are present where slopes are perpetually wet. Also, there are usually no conifers on low terraces. Beaver browsing sometimes modifies vegetation.

Land Use

Land use is mostly forestry, rural residential development or agriculture/range. Rangelands include livestock grazing (cattle, sheep, goats and llamas). Other land uses include light industrial, utility infrastructure (power/communication lines and underground cables), recreation (hunting, fishing, hiking, etc.), floral and greenery, rock quarries, and possibly mining. Many streams in agricultural and residential settings have been diked or channelized.

(2) Southern Oregon Coastal Mountains (45.7% of Port Orford watersheds)

Physiography

The Southern Oregon Coastal Mountains is a mountainous ecoregion with an ocean-modified climate. It is a transitional area between the Siskiyou Mountains and the Coast Range and is underlain by Jurassic sandstone, metamorphosed sediments, granite, and serpentine. Overall, the geology is complex, like that of the Siskiyou Mountains, but its mountains are lower and not as dissected. The distributions of northern and southern vegetation blend together and species diversity is high. Streams are usually high gradient with steep side-slopes. Watersheds in this ecoregion typically have a high stream density due to the high precipitation, moderately steep gradients and fractured geology.

Geology & Soil
Geology is a complex mix of highly-fractured siltstone, shale, sandstone, gray wackie, granite and serpentine. Soils range from very deep to shallow, silt loam to very gravelly loam.

Climate

Precipitation	**Frost Free**	**Mean Temperature**	
Mean Annual (Inches)	Mean Annual (Days)	January Min/Max (°F)	July Min/Max (°F)
70 – 140	170 – 220	36/52	52/76

Wind

Summer	North winds prevail. East wind events associated with extreme high temperatures (>100° F) and high wind speeds (>35 mph) create extreme fire hazard conditions that may result in catastrophic wildfires
Winter	South winds prevail. Extreme high wind events (>100 mph) result in catastrophic wind storms.

(Wiggins 2001)

Runoff

Spring	Partially uniform; rainstorms create periods of higher runoff
Summer	Uniform; runoff gradually declines
Fall	Mostly uniform; runoff gradually increases; higher runoff during late fall rains
Winter	Not uniform; high runoff during rainstorms, especially when snow on ground

Erosion & Peak Flows
Erosion rate is high due to abundant precipitation, high uplift rates, earthquakes, steep slopes, fractured geology, and high landslide occurrence. Landslides are deep-seated earth flows in lower gradient areas or are shallow landslides (often triggering debris slides) in steep headwater channels. Peak flows (50-year recurrence interval, cfs per square mile) are 300 in northern portion to 550 in southern portion of ecoregion.

Stream Channel Characteristics

Characteristic	**Gradient**	**Stream Size**		
		Small	**Medium**	**Large**
Substrate	Low	Gravel	Gravel	Gravel / cobbles
	High	Gravel / cobbles	Gravel / cobbles	Cobbles / bedrock
Beaver Dams	Low	Some year-round	Few year-round	None
	High	Few in summer	None	None

Natural Disturbances
Fires are more frequent in Douglas fir / western hemlock forests than in their neighboring Sitka spruce forests, although the interval between fires is quite variable. Catastrophic fires occur about 50 years (Wiggins 2001). Large wildfires during late summer and fall once burned large

areas within the southern Coast Range. Fires sometimes skipped over streamside areas. Native Americans and ranchers both used fire to maintain pastures. Fire suppression has now eliminated most large wildfires.

Extreme wind storms capable of toppling large patches of trees occur about every 35 to 100 years. Smaller earthquakes capable of triggering landslides occur every decade or so and catastrophic earthquakes occur about every 300 years. Extreme flood events are triggered by high intensity rainfall. High intensity rainfall and steep slopes trigger landslides.

Upland & Riparian Vegetation

Conifers	Douglas-fir, western hemlock, white fir/grand fir, Port Orford cedar, incense cedar, Brewer's spruce, and Sitka spruce
Hardwoods	red alder, big leaf maple, myrtle, madrone, tanoak, cascara–buckthorne, Oregon white oak, Oregon ash, and cottonwood
Shrubs	ceonothus spp., elderberry, manzanita, hazelnut, wax myrtle, and vine maple
Understory	huckleberry, ferns, salmonberry, thimbleberry, skunk cabbage, rushes, sedges, grasses, herbaceous (flowers etc.), fireweed, and poison oak
Noxious	gorse, scotch broom, blackberry, tansy, and thistles spp.

(Wiggins 2001)

Current riparian conifer regeneration is uncommon unless streamside areas are intensively disturbed, followed by control of competing hardwoods and brush. Potential riparian vegetation will vary according to channel confinement. Confined and moderately confined channels may include a narrow band of hardwoods (tanoak, myrtle, red alder) and brush nearest the stream with mainly Douglas fir and hardwoods beyond. Unconfined channels may consist of similar riparian communities although the band of vegetation may be considered moderately wide. Coniferous dominated sites along unconfined channels often occur on infrequently disturbed higher terraces.

Land Use

Forestry, ranching, rural residential development, recreation, rock quarries, greenery, mushrooms and some mining are the predominant land uses (Wiggins 2001).

Other

Irrigation withdrawals result in the partial dewatering of a number of streams during the summer.

(3) Coastal Lowlands (27.1% of Port Orford watersheds)

Physiography

The Coastal Lowlands are characterized by estuarine marshes, meandering streams, shallow coastal lakes, black-water streams, marine terraces, and sand dunes. Streams are very low gradient and often meander widely. Some streams are directly influenced by the tide while others enter shallow coastal lake before entering an outlet(s) to another stream or directly into the ocean. Elevation in this ecoregion ranges from sea level to 300 feet.

Geology & Soil
Geology consists predominantly of quaternary marine and non-marine terrace deposits, beach and dune sands, and alluvium. Soils are deep, silty clay loams to sandy loams.

Climate

Precipitation	**Frost Free**	**Mean Temperature**	
Mean Annual (Inches)	Mean Annual (Days)	January Min/Max (°F)	July Min/Max (°F)
60 – 85	200 – 240	36/50	52/68

Wind

Summer	North winds prevail. East wind events associated with extreme high temperatures (>100° F) and high wind speeds (>35 mph) create extreme fire hazard conditions that may result in catastrophic wildfires
Winter	South winds prevail. Extreme high wind events (>100 mph) result in catastrophic wind storms.

(Wiggins 2001)

Runoff

Spring	Partially uniform; rainstorms create periods of higher runoff
Summer	Uniform; runoff gradually declines
Fall	Mostly uniform; runoff gradually increases; higher runoff during late fall rains
Winter	Not uniform; high runoff during rainstorms

Erosion & Peak Flows
Erosion rate is low due to the low gradient of stream channels. However, the extent of streambank erosion, as a result of channel incision and loss of riparian vegetation, is not addressed by the Level IV Ecoregion description. These are mostly depositional areas. Peak flows (50-year recurrence interval, cfs per square mile) are 150 to 200.

Stream Channel Characteristics

Characteristic	**Gradient**	**Stream Size**		
		Small	**Medium**	**Large**
Substrate	Low	Fines	Fines	Fines / Gravel
Beaver Dams	Low	Many year-round	Many year-round	Some in summer

Natural Disturbances
Extreme windstorms capable of toppling large patches of trees occur about every 35 to 100 years. Catastrophic earthquakes capable of causing the coastal fringe to subside 5 to 20 feet occur about every 300 years. Extreme flood events are triggered by high intensity rainfall. High intensity rainfall and steep slopes trigger landslides.

Fires in the Sitka spruce forest, while infrequent, are usually stand replacing; dominant tree species are not fire tolerant. Catastrophic fires occur about every 50 years (Wiggins 2001). Fires are more frequent in Douglas fir/western hemlock forests, although the interval between fires is quite variable. Native Americans and ranchers both used fire to maintain pastures.

Upland & Riparian Vegetation

Conifers	Sitka spruce, shore pine, grand fir, Douglas-fir, western hemlock, Port Orford cedar and Monterey Cypress
Hardwoods	red alder, big leaf maple, myrtle, and madrone
Shrubs	rhododendron, holly, wax myrtle, willows spp., and ceonothus spp.
Understory	azalea, ribes spp., iris, sea-watch, huckleberry, salal, ferns, skunk cabbage, rushes, sedges, and grasses
Noxious	gorse, blackberry, tansy, scotch broom, European beach grass and thistles spp.

(Wiggins 2001)

Current riparian conifer regeneration is common in areas with good drainage. Sitka spruce can also regenerate in wetter areas where downed logs create an elevated seed bed. Black cottonwood may be found in riparian areas (Agee 1993).

Potential riparian vegetation may include thickets of wind-stunted shore pine, Sitka spruce, and brush (both native and introduced) sometimes alternating with bare sand. Beaver browsing and dam building may modify some vegetation. In unconfined channels, beaver dams may divide the stream into many channels, creating extensive wetlands.

Land Use

Agricultural land uses include cranberry, blueberry, and organic produce. Rangelands include dairy farms and livestock grazing (sheep, cattle, goats and llamas). Other land uses include rural residential development, tourism, recreation (hunting, fishing, boating, camping, hiking, etc.), forestry, Christmas trees, floral and greenery, rock quarries, light industrial, utility infrastructure (power/communication lines and underground cables, water treatment, etc.) and mining (Wiggins 2001). Many streams in agricultural and residential settings have been diked or channelized.

Other: Fog is common in summer.

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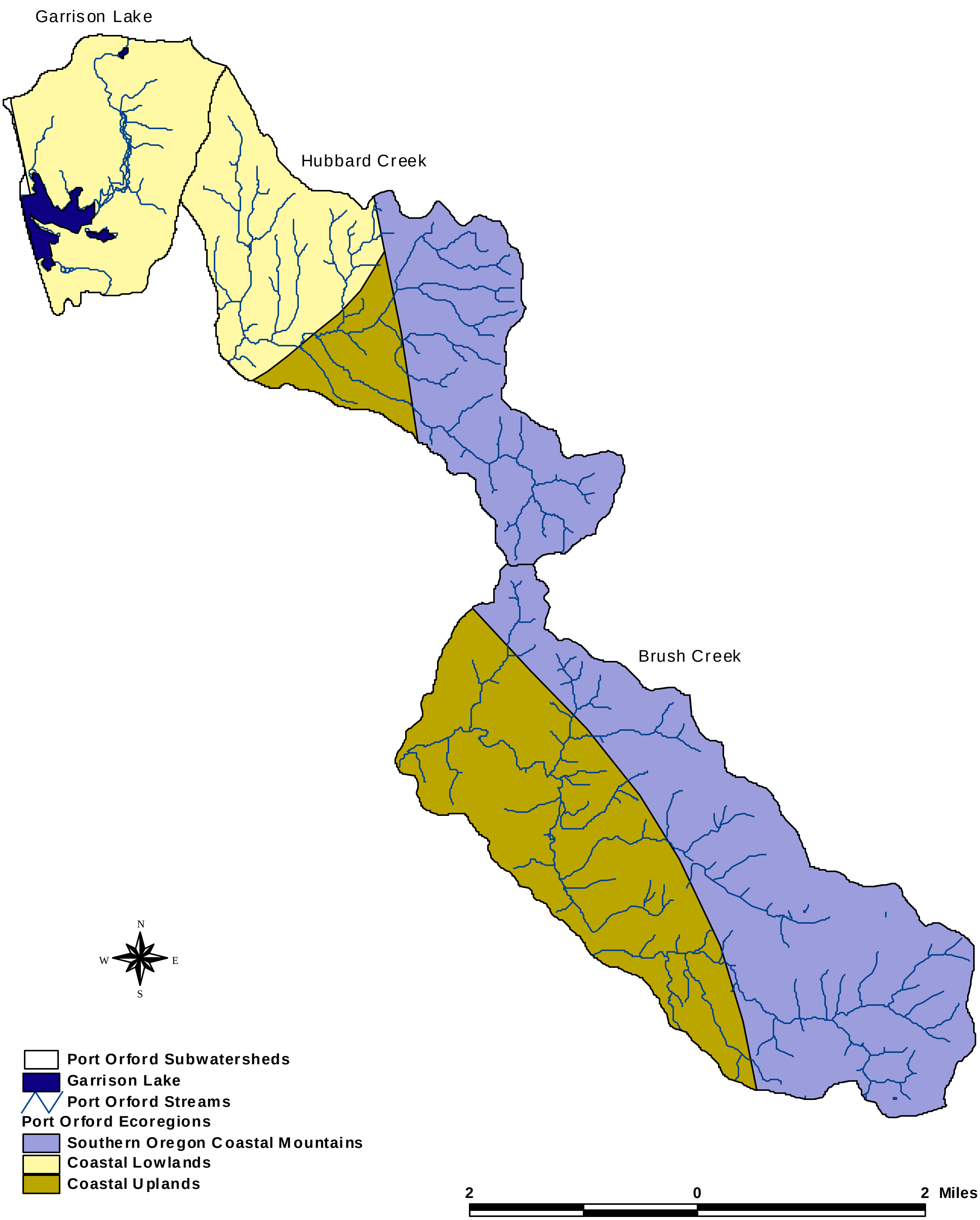
Agee, J.K. 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Covelo, CA. 493 pp.

GWEB 1999. Oregon Watershed Assessment Manual. Governor's Watershed Enhancement Board, July 1999

U.S. Environmental Protection Agency, 1996. Level III ecoregions of the continental United States (revision of Omernik, 1987): Corvallis, Oregon, U.S. Environmental Protection Agency – National Health and Environmental Effects Research Laboratory Map M-1, various scales.

Wiggins 2001. Personal communication with Katherine L. Wiggins, Forest Practices Forester, Oregon Department of Forestry - Coos District, Coos Bay, Oregon.

Ecoregions
(Port Orford Watersheds)



V CHANNEL HABITAT TYPES

A BACKGROUND (GWEB 1999)

Stream classification systems can be organized on different scales within a watershed: from as large as the entire channel network down to individual pools or microhabitats within those pools. The Oregon Watershed Assessment Manual (OWAM) provides a classification system centered in the middle of this hierarchy and incorporates landscape features such as valley type and stream reach features such as gradient. The variables selected to describe each channel type remain relatively constant within time scales of concern to land management. The scale of channel features is small enough to predict patterns in physical characteristics, yet large enough to be identified from topographic maps and limited field-work.

The following classification system, titled Channel Habitat Types (CHT), is based on several existing stream classification systems including Rosgen and Montgomery & Buffington (Rosgen 1993; Montgomery and Buffington 1993). The CHTs will enable users to make inferences about how land use impacts can alter physical channel form and process and, therefore, fish habitat.

Bankfull Width, Confinement & Modern Floodplain

Bankfull width is the width of the channel at the point at which over-bank flooding begins (unless the stream is incised), and often occurs as flows reach the 1.5 year recurrence interval level. *Confinement* is defined as the ratio of the bankfull width to the width of the modern floodplain. *Modern floodplain* is the flood-prone area (Rosgen 1996); it may or may not correspond to the 100-year floodplain.

Confinement Class	Floodplain Width
Unconfined	>4x Bankfull Width
Moderately Confined	>2x Bankfull Width but <4xBankfull Width
Confined	<2x Bankfull Width

Management Considerations

It is important to remember that CHTs cannot be managed as isolated segments. Stream reaches in one part of a watershed can be affected by activities taking place in a different part of the watershed, either up-stream, down-stream, or on adjacent land areas.

B INTRODUCTION

The Port Orford watersheds contain a diversity of Channel Habitat Types. Table 6 Channel Habitat Type Attributes provides a comparison of 15 different channel types that potentially occur in a watershed. Each of these stream channels provides unique functions and significant values to both anadromous and resident fish. Nine of these CHTs (see list below) were identified throughout approximately 27 miles of streams, primarily within private lands, in the Port Orford basins (Garrison Lake, Hubbard Creek, and Brush Creek). A description of each Channel Habitat Type identified in the Port Orford watersheds is presented in Section E of this component.

Table 6 Channel Habitat Type Attributes (GWEB 1999)

CHT Code	Type	Gradient	Valley Shape	Channel Pattern	Channel Confinement	OR Stream Size	Position in Drainage
ES	Small Estuarine Channel	0 to 1%	broad	sinuous single or multiple	unconfined	small-med	bottom, mouth of stream
EL	Large Estuarine Channel	0 to 1%	broad	sinuous single or multiple	unconfined	large	bottom, mouth of stream
FP1	Low Gradient Large Floodplain Channel	0 to 1%	broad floodplain	sinuous single or multiple	unconfined	large	bottom, low in drainage
FP2	Low Gradient Floodplain Channel	0 to 2%	broad, flat or gentle landforms	sinuous single or multiple	unconfined	med-large	middle to lower end of drainage
FP3	Low Gradient Small Floodplain Channel	0 to 2%	broad	single or multiple	moderate to unconfined	small-med	variable
AF	Alluvial Fan Channel	1 to 12%	where hillslope opens to broad valley	single or multiple spread like a fan	variable	small-med	lower end of small tributaries
LM	Low Gradient Moderately Confined Channel	0 to 2%	broad, generally much wider than channel	single w/ occasional multiple channels	variable	variable, usually med-large	variable, often mainstem & low end of main tribs.
LC	Low Gradient Confined Channel	0 to 2%	low-mod gradient hillslope w/ limited floodplain	single channel, variable sinuosity	conifined by hillslope/terrace	variable, usually med-large	variable, generally mid to lower in large basin
MM	Moderate Gradient Moderately Confined	2 to 4%	narrow valley w/ flood-plain or narrow terrace	single, low to moderate sinuosity	variable	variable, usually med-large	middle to lower portion of drainage
MC	Moderate Gradient Confined Channel	2 to 4%	gentle to narrow V-shaped valley, little to no floodplain	single, relatively straight or conforms to hillslope	confined	variable	middle to lower portion of drainage
MH	Moderate Gradient Headwater Channel	1 to 6%	open, gentle V-shaped valley	low sinuosity to straight	confined	small	upper, headwater
MV	Moderately Steep Narrow Valley Channel	4-8%	narrow, V-shaped valley	single channel, relatively straight	confined	small-medium	middle to upper
BC	Bedrock Canyon Channel	>4%	canyons, gorges, very steep side slopes	single channel, straight	tightly confined by bedrock	variable	variable
SV	Steep Narrow Valley Channel	8 to 16%	steep, narrow V-shaped valley	single, straight	tightly confined	small, small to medium	middle upper to upper
VH	Very Steep Headwater	>16%	steep, narrow V-shaped valley	single, straight	tightly confined	small, small to medium	middle upper to upper

Shaded CHT Codes = Found in Port Orford Watersheds

1. Small Estuarine Channel (ES)
2. Low Gradient Small Floodplain Channel (FP3)
3. Low Gradient Moderately Confined Channel (LM)
4. Low Gradient Confined Channel (LC)
5. Moderate Gradient Moderately Confined Channel (MM)
6. Moderate Gradient Confined Channel (MC)
7. Moderately Steep Narrow Valley Channel (MV)
8. Steep Narrow Valley Channel (SV)
9. Very Steep Headwater Channel (VH)

C METHODOLOGY

1. US Geologic Survey (USGS) maps at the 7.5-minute or 1:24,000 scale were compiled and utilized as base maps for the Port Orford watersheds. Perennial streams and landscape features such as valley type were analyzed for consideration of stream classification.
2. Stream reaches were delineated on mylar overlays based on channel gradient and channel confinement. Stream reaches were then evaluated based on valley shape, channel pattern, stream size, position in drainage and dominant substrate.
3. Preliminary CHTs were assigned to each reach using a CHT Guide to Identification (Table 6) as well as CHT Descriptions provided in the GWEB Oregon Watershed Assessment Manual.
4. CHT lengths were measured on USGS maps using a map wheel.
5. A labeling system was developed for purposes of subwatershed characterization.

D CHANNEL SENSITIVITY / RESPONSIVENESS

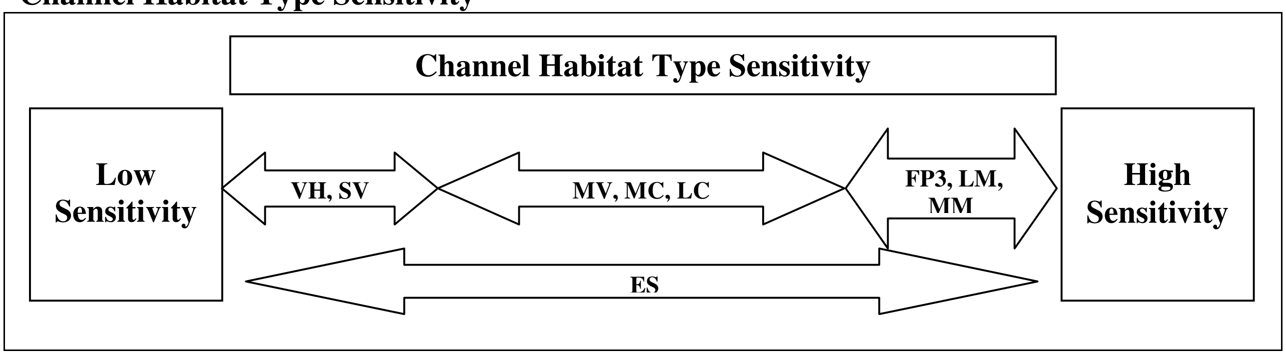
In general, responsive portions of the channel network are those that lack the terrain controls which define confined channels. Unconfined or moderately confined channels display visible changes in channel characteristics when flow, sediment supply, or the supply of roughness elements such as large woody debris are altered. These areas are commonly referred to as response reaches, and usually possess an active floodplain. At the other end of the responsive spectrum would be those channels whose characteristics and form are not easily altered, such as Bedrock canyon.

Differences in gradient, confinement, and bed morphology suggest that different channel types are more or less responsive to adjustment in channel pattern, location, width, depth sediment storage, and bed roughness (Montgomery and Buffington 1993). These changes in channel characteristics will in turn trigger alterations of aquatic habitat conditions. The more responsive or sensitive areas are more likely to exhibit physical changes from land management activities, as well as restoration efforts.

Channel Sensitivity/Response Descriptions

Rating	LWD	Fine Sediment	Coarse Sediment	Peak Flows
High	Critical element in maintenance of channel form, pool formation, gravel trapping/sorting, bank protection	Fines are readily stored with increases in available sediment resulting in widespread pool filling and loss of overall complexity of bed form	Bedload deposition dominant active channel process; general decrease in substrate size, channel widening, conversion to planebed morphology if sediment is added	Nearly all bed material is mobilized; significant widening or deepening of channel
Moderate	One of a number of roughness elements present; contributes to pool formation and gravel sorting	Increases in sediment would result in minor pool filling and bed fining	Slight change in overall morphology; localized widening and shallowing	Detectable changes in channel form; minor widening, scour expected
Low	Not a primary roughness element; often found only along channel margins	Temporary storage only; most is transported through with little impact	Temporary storage only; most is transported through with little impact	Minimal change in physical channel characteristics, some scour and fill

Channel Habitat Type Sensitivity



E DESCRIPTION OF CHANNEL HABITAT TYPES (GWEB 1999)

(1) Small Estuarine Channels (ES) (1% of Channels Assessed)

These channels are found at the mouths of drainages along outer coastal beaches or bays. They are intertidal streams that occur exclusively within estuary landforms, usually draining a small, high-relief or moderate-sized watershed. They are associated with saltwater marshes, meadows, mudflats, and deltas.

These streams are predominantly sediment depositional channels associated with low-relief coastal landforms. Stream energy is low due to nearly flat gradients, with substrate material consisting mainly of small gravels, sand, and silt. Channel morphology is strongly influenced by tidal stage. Fine-grained streambanks are highly sensitive to erosion. Beach erosion processes often have a dominant influence on deposition and erosion in the outer coastal estuarine streams.

The original boundary of an estuary may be difficult to determine due to modifications associated with marinas, highways, or reclamation. Many coastal estuaries have been delineated through county, state, or municipal planning processes and may include the predevelopment boundaries.

Channel Sensitivity / Responsiveness

These channels are low-energy areas where sediment deposition is a dominant process. While channel sensitivity in estuaries can vary, the unconfined nature of these areas tends to attenuate changes over space and time. Abandonment and reoccupation of relic channels commonly occurs, but it may be a slow process.

Input Factors	Sensitivity/Responsiveness Rating
Large Woody Debris	Moderate
Fine Sediment	Moderate to High
Coarse Sediment	Low to Moderate
Peak Flows	Low

Fish Use

Anadromous – Important rearing and migration corridor for chinook, coho, steelhead and sea-run cutthroat trout

Resident - Unknown

Riparian Enhancement Opportunities

Many enhancement efforts in estuaries are related to long-term preservation of the area. As these channels harbor unique biological communities, limiting development is a common strategy. Structural enhancement activities often involve dike breaching or removal to reconnect wetlands or sloughs.

(2) Low Gradient Small Floodplain Channel (FP3) (10% of Channels Assessed)

FP3 streams are located in valley bottoms and flat lowlands. They frequently lie adjacent to the toe of foot slopes or hill slopes within the valley bottom of larger channels, where they are typically fed by high-gradient streams. They may be directly downstream of small alluvial fan and contain wetlands. FP3 channels may dissect the larger floodplain. These channels are often the most likely CHT to support beavers, if they are in the basin. Beavers can dramatically alter channel characteristics such as width, depth, form, and most aquatic habitat features.

These channels can be associated with a large floodplain complex and may be influenced by flooding of adjacent mainstem streams. Sediment routed from upstream high-and-moderate gradient channels is temporarily stored in these channels and on the adjacent floodplain.

Channel Sensitivity / Responsiveness

Floodplain channels can be among the most responsive in the basin. The limited influence of confining terrain features and fine substrate allows the stream to move both laterally and vertically. Although often considered low-energy systems, these channels can mobilize large amounts of sediment during high flows. This often results in channel migration and new channel formation.

Input Factors	Sensitivity/Responsiveness Rating
Large Woody Debris	High
Fine Sediment	Moderate to High
Coarse Sediment	High
Peak Flows	Low

Fish Use

Anadromous – Important spawning, rearing, and migration corridor
Resident – Important spawning, rearing, and overwintering

Riparian Enhancement Opportunities

Floodplain channels are, by their nature, prone to lateral migration, channel shifting, and braiding. While they are often the site of projects aimed at channel containment (diking, filling, etc.), it should be remembered that the floodplain channels can exist in a dynamic equilibrium between stream energy and sediment supply. As such, the active nature of the channel should be respected, with restoration efforts carefully planned. The limited power of these streams offers a better chance for success of channel enhancement activities than the larger floodplain channels. While the lateral movement of the channel will limit the success of many efforts, localized activities to provide bank stability or habitat development can be successful.

(3) Low Gradient Confined Channels (LC) (11% of Channels Assessed)

LC channels are incised or contained within adjacent, gentle landforms or incised in uplifted coastal landforms. Lateral channel migration is controlled by frequent high terraces or hill slopes along stream banks. They may be bound on one bank by hill slopes and lowlands on the other. They may also have a narrow floodplain in places, particularly on the inside of meander bends. Streambank terraces are often present, but they are generally above the current floodplain. Channels confined by hill slope or bedrock are often stable and display less bank erosion and scour compared to incised channels that are often unstable and confined by alluvial terraces.

High flow events are well-contained by the upper banks. High flows in these well-contained channels tend to move all but the most stable wood accumulations downstream or push debris to the channel margins. Stream banks can be susceptible to landslides in areas where steep hill slopes of weathered bedrock parent materials meet the channel.

Caution: Caution should be used in interpreting channels that have downcut into alluvial material set in a wide flat valley. If streambanks are high enough to allow a floodplain width less than two times the bankfull width, then the stream meets the definition of confined.

However, some streams meeting this definition may have recently down-cut, effectively reducing floodplain width as the channel deepens. It is beyond the scope of this assessment to address technical issues such as the rate of channel incision. However, for the purpose of interpreting Channel Sensitivity / Responsiveness, it should be noted that these channels may have transitioned from LM to LC channels.

Channel Sensitivity / Responsiveness
The presence of confining terraces or hill slopes and control elements such as bedrock limit the type and magnitude of channel response to changes in input factors. Adjustment of channel features is usually localized and of a modest magnitude.

Input Factors	Sensitivity/Responsiveness Rating
Large Woody Debris	Low to Moderate
Fine Sediment	Low
Coarse Sediment	Moderate
Peak Flows	Low to Moderate

Fish Use
Anadromous - Important spawning, rearing and migration corridor for chinook, coho, steelhead and sea-run cutthroat trout
Resident - Important spawning, rearing and overwintering for cutthroat trout

Riparian Enhancement Opportunities
These channels are not highly responsive, and in channel enhancements may not yield intended results. In basins where water-temperature problems exist, the confined nature of these channels lends itself to establishment of riparian vegetation. In nonforested land, these channels may be deeply incised and prone to bank erosion from livestock. As such, these channels may benefit from livestock access control measures.

(4) Low Gradient Moderately Confined Channel (LM) (9% of Channels Assessed)

These channels consist of low-gradient reaches that display variable confinement by low terraces or hill slopes. A narrow floodplain approximately two to four times the width of the active channel is common, although it may not run continuously along the channel. Often low terraces accessible by flood flows occupy one or both sides of the channel. The channels tend to be of medium to large size, with substrate varying from bedrock to gravel and sand. They tend to be slightly to moderately sinuous, and will occasionally possess islands and side channels.

Channel Sensitivity / Responsiveness
The unique combination of an active floodplain and hill slope or terrace controls acts to produce channels that can be among the most responsive in the basin. Multiple roughness elements are common, with bedrock, large boulders, or wood generating a variety of aquatic habitat within the stream network.

Input Factors	Sensitivity / Responsiveness Rating
Large Woody Debris	Moderate to High
Fine Sediment	Moderate to High
Coarse Sediment	Moderate to High
Peak Flows	Moderate

Fish Use
Anadromous - Potential spawning and rearing for chinook, coho, steelhead and sea-run cutthroat trout
Resident - Potential spawning, rearing and overwintering for cutthroat trout

Riparian Enhancement Opportunities
Like intact floodplain channels, these channels can be among the most responsive of channel types. Unlike floodplain channels, however, the presence of confining landform features often improves the accuracy of predicting channel response to activities that may affect channel form. Additionally, these controls help limit the destruction of enhancement efforts common to floodplain channels. Because of this, LM channels are often good candidates for enhancement efforts.

In forested basins, habitat diversity can often be enhanced by the addition of wood or boulders. Pool frequency and depth may increase, and side-channel development may result from these efforts. Channels of this type in non forested basins are often responsive to bank stabilization efforts such as riparian planting and fencing. Beavers are often present in the smaller streams of this channel type. Fish habitat in some channels may benefit from beaver introduction through side-channel and scour pool development. Introduction of beavers, however, may have significant implications for overall channel form and function, and should be thoroughly evaluated by land managers, as well as biologists, as a possible enhancement activity.

(5) Moderate Gradient Confined Channel (MC) (9% of Channels Assessed)

MC streams flow through narrow valleys with little river terrace development, or are deeply incised into valley floors. Hill slopes and mountain slopes composing the valley walls may lie directly adjacent to the channel. Bedrock steps, short falls, cascades, and boulder runs may be present; these are usually sediment transport systems. Moderate gradients, well contained flows, and large-particle substrate indicate high stream energy. Landslides along channel side slopes may be a major sediment contributor in unstable basins.

Channel Sensitivity / Responsiveness
The presence of confining terraces or hill slopes and control elements such as bedrock substrates limits the type and magnitude of channel response to changes management. Adjustment of channel features is usually localized and of a modest magnitude.

Input Factors	Sensitivity / Responsiveness Rating
Large Woody Debris	Low
Fine Sediment	Low
Coarse Sediment	Moderate
Peak Flows	Moderate

Fish Use

Anadromous - Potential steelhead and coho spawning and rearing; may have pockets of suitable chinook habitat depending on site-specific factors
Resident - Potential spawning, rearing and overwintering for cutthroat trout

Riparian Enhancement Opportunities

These channels are not highly responsive, and in-channel enhancements may not yield intended results. Although channels are subject to relatively high energy, they are often stable. In basins where water-temperature problems exist, the stable banks generally found in these channels lend themselves to establishment of riparian vegetation. In nonforested land, these channels may be deeply incised and prone to bank erosion from livestock. As such, these channels may benefit from livestock access control measures.

(6) Moderate Gradient Moderate Confined Channel (MM) (5% of Channels Assessed)

This group includes channels with variable controls on channel confinement. Altering valley terraces and/or adjacent mountain-slope, foot-slope, and hill-slope landforms limit channel migration and floodplain development. Similar to the LM channels, a narrow floodplain is usually present, and may alternate from bank to bank. Bedrock steps with cascades may be present.

Channel Sensitivity / Responsiveness

The unique combination of a narrow floodplain and hill-slope or terrace controls acts to produce channels that are often the most responsive in the basin. The combination of higher gradients and the presence of a floodplain set the stage for a dynamic channel system. Multiple roughness elements such as bedrock, large boulders, or wood may be common, resulting in a variety of aquatic habitats within the stream network.

Input Factors	Sensitivity / Responsiveness Rating
Large Woody Debris	High
Fine Sediment	Moderate
Coarse Sediment	Moderate to High
Peak Flows	Moderate

Fish Use

Anadromous - Potential steelhead and coho spawning and rearing; may have pockets of suitable chinook habitat depending on site-specific factors
Resident - Potential spawning, rearing and overwintering for cutthroat trout

Riparian Enhancement Opportunities

Like floodplain channels, these channels are among the most responsive of channel types. Unlike floodplain channels, however, the presence of confining landform features improves the accuracy of predicting channel response to activities that may affect channel form. Additionally, these controls help limit the destruction of enhancement efforts, a common problem in floodplain channels. Outcome of enhancement efforts are a bit more uncertain than in LM channels. MM channels, however, are often good candidates for enhancement efforts.

In forested basins, habitat diversity can often be enhanced by the addition of roughness elements such as wood or boulders. Pool frequency and depth may increase as well as side-channel development as the result of these efforts. Channels of this type in nonforested basins are often responsive to bank stabilization efforts such as riparian planting and fencing.
Beavers are often present in the smaller streams of this channel type, and fish habitat in some channels may benefit from beaver introduction through side-channel and scour pool development. Introduction of beavers, however, may have significant implications for overall channel form and function, and should be thoroughly evaluated by land managers as well as biologists as a possible enhancement activity.

(7) Moderately Steep Narrow Valley Channel (MV) (21% of Channels Assessed)

MV channels are moderately steep and confined by adjacent moderate to steep hill slopes. High flows are generally contained within the channel banks. A narrow floodplain, one channel width or narrower, may develop locally.

MV channels efficiently transport both coarse bedload and fine sediment. Bedrock steps, boulder cascades and chutes are common features. The large amount of bedrock and boulders create stable streambanks; however, steep side slopes may be unstable. Large woody debris is commonly found in jams that trap sediment in locally low-gradient steps.

Channel Sensitivity / Responsiveness

The gradient and presence of confining terraces or hill slopes and control elements such as bedrock substrates limit the type and magnitude of channel response to changes in input factors. Adjustment of channel features is localized and of a minor magnitude.

Input Factors	Sensitivity / Responsiveness Rating
Large Woody Debris	Moderate
Fine Sediment	Low
Coarse Sediment	Moderate
Peak Flows	Moderate

Fish Use

Anadromous - Potential steelhead, coho and sea-run cutthroat spawning and rearing
Resident - Potential spawning, rearing and overwintering for cutthroat trout

Riparian Enhancement Opportunities

These channels are not highly responsive, and in channel enhancements may not yield intended results. Although channels are subject to relatively high energy, they are often stable. In basins where water-temperature problems exist, the stable banks generally found in these channels lend themselves to establishment of riparian vegetation. In nonforested land, these channels may be deeply incised and prone to bank erosion from livestock. As such, these channels may benefit from livestock access control measures.

(8 & 9) Steep Narrow Valley Channel (SV) & Very Steep Headwater (VH)
(SV = 24% & VH = 8% of Channels Assessed)

These two channel types are very similar and are thus presented together. However VH channels are steeper. SV channels are situated in a constricted valley bottom bounded by steep mountain or hill slopes. Vertical steps of boulder and wood with scour pools, cascades, and falls are common. VH channels are found in the headwaters of most drainages or side slopes to larger streams, and commonly extend to ridge-tops and summits. These steep channels may be shallowly or deeply incised into the steep mountain or hill slope. Channel gradient may be variable due to falls and cascades.

Channel Responsiveness

The gradient and presence of confining terraces or hill slopes and control elements such as bedrock substrates limit the type and magnitude of channel response to changes in input factors. Adjustment of channel features is localized and of a minor magnitude. These channels are also considered source channels supplying sediment and wood to downstream reaches, sometimes via landslides.

Input Factors	Sensitivity / Responsiveness Rating
Large Woody Debris	Moderate
Fine Sediment	Low
Coarse Sediment	Low to Moderate
Peak Flows	Low

Fish Use

Anadromous (SV) - Lower gradient areas provide limited rearing (if accessible)
Resident (SV) - Limited resident spawning and rearing / **Resident** (VH) - Very limited rearing

Riparian Enhancement Opportunities

These channels are not highly responsive, and in-channel enhancements may not yield intended results. Although channels are subject to relatively high energy, they are often stable. In basins where water temperature problems exist, the stable banks generally found in these channels lend themselves to establishment of riparian vegetation. This may also serve as a recruitment effort for large woody debris in the basin.

F RESULTS

Table 7 Channel Habitat Types by Subwatershed (miles)

	Channel Habitat Types									
Subwatershed	**ES**	**FP3**	**LC**	**LM**	**MC**	**MM**	**MV**	**SV**	**VH**	**Totals**
Brush Creek	0.1	0.1	2.2	1.4	1.4	0.7	3.5	5.1	1.5	16.0
Garrison Lake	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Hubbard Creek	0.2	1.7	0.8	1.2	0.9	0.8	2.1	1.5	0.8	9.9
Totals	0.3	2.7	2.9	2.7	2.4	1.4	5.6	6.6	2.3	26.9

Figure 2 Miles of Channel Habitat Types by Subwatershed

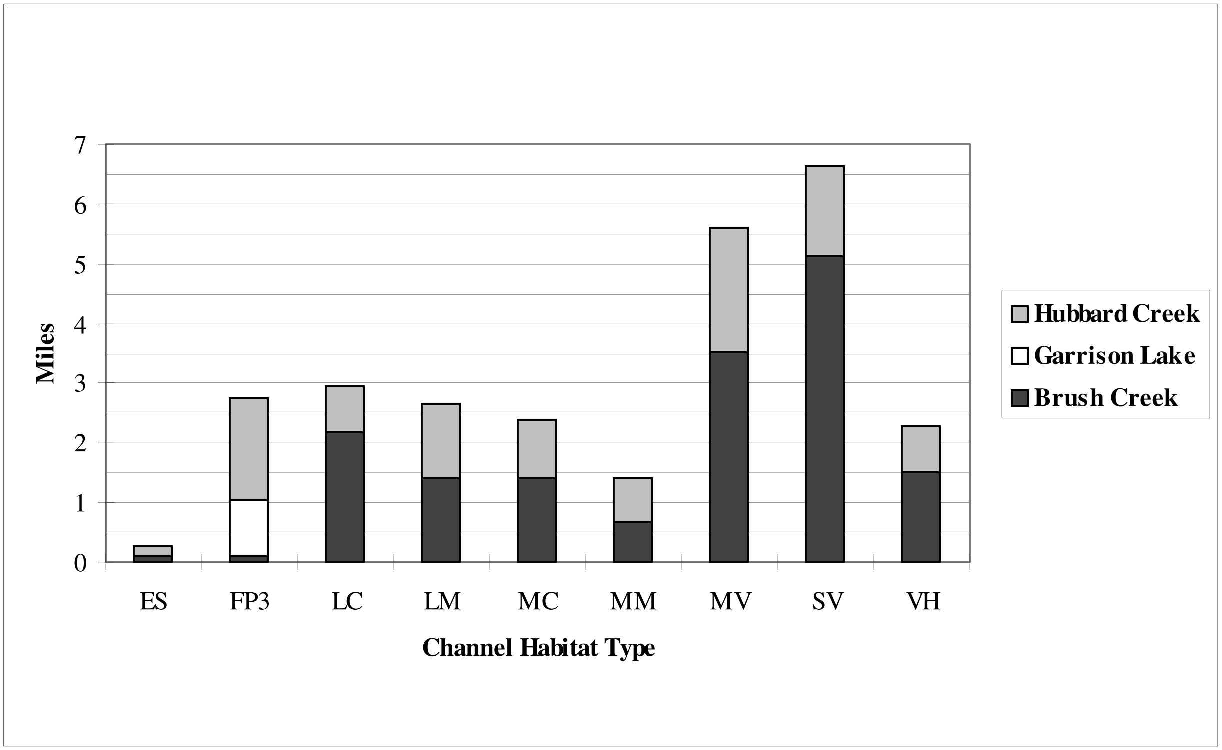


Table 8 Port Orford Basins' Channel Habitat Type Summary

CHT	Channel Description	Percent of Miles	Response to Disturbance	Riparian Treatment Opportunities
ES	Small estuarine	1	Moderate	Limit human structures
FP3	Low gradient small floodplain	10	High	Respect lateral movement
LM	Low gradient moderately confined	10	High	Good candidates
LC	Low gradient confined	11	Low Mod	Manage livestock access
MM	Moderate gradient moderately confined	5	High	Good candidates
MC	Moderate gradient confined	9	Mod	Manage livestock access
MV	Moderately steep narrow valley	21	Mod	Manage livestock access
SV	Steep narrow valley	24	Low	Few opportunities
VH	Very steep headwater	9	Low	Few opportunities

G KEY FINDINGS

- Of the 27 stream miles evaluated in this assessment, 33 percent are classified as steep (SV) to very steep (VH) narrow valleys. These are typically the small headwater streams in the Brush Creek and Hubbard Creek subwatersheds. The channels are stable, not highly responsive to either disturbance or restoration, but their stable banks support riparian vegetation, making them good candidates for riparian planting or thinning.

- Moderate gradient confined and headwater streams (MC and MV) comprise 30 percent of the channels, and low gradient confined channels (LC) are 11 percent, for a total of 41 percent. These are typically located in small to medium size streams in the Brush Creek and Hubbard Creek subwatersheds. Channels are fairly stable, moderately responsive to disturbance, and not highly responsive to restoration activities except for riparian planting or thinning. In nonforested areas, channels may be deeply incised and prone to erosion by livestock, so they may benefit from livestock access control measures.

- Moderate gradient, moderately confined channels (MM) characterize 5 percent and low gradient streams that are moderately confined (LM) characterize 10 percent of the channels. These 15 percent of the channel miles in the Brush Creek and Hubbard Creek subwatersheds are among the most responsive to both disturbance and restoration activities. Habitat diversity can be enhanced by adding structure such as boulders and large wood; banks can be stabilized by planting and fencing.

- Low gradient streams with small (FP3) flood plain channels comprise 10 percent of the stream network. All of the Garrison Lake subwatershed streams have this type of channel, plus some of Hubbard Creek and a short segment of Brush Creek. They are among the most responsive to disturbance, and channels often migrate. Attempts to control channel migration may not be effective and may cause problems elsewhere. In localized areas where lateral movement is slow, restoration or enhancement activities may be successful.

- One percent of the channel length inventoried was classified as small estuarine channel (ES), the 0.1 mile of Brush Creek and 0.2 mile of Hubbard Creek. This channel type is unconfined and responds to variations in sediment and weather patterns from both upstream and ocean. Restoration and enhancement activities often focus on long-term preservation of habitat for unique biological communities through techniques such as limiting future development and reconnecting wetlands isolated by manmade dikes.

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VI FISH & FISH HABITAT

A BACKGROUND

<u>Salmonid Life Cycles</u> (OSU 1998)
Salmonid is the group name for salmon, trout, and char. These fish share a common life history pattern. Many are anadromous, i.e., they spawn in fresh water, migrate to sea as juveniles, grow to maturity, and return to their freshwater stream to reproduce.

Adult salmonids spawn by burying their eggs in nests called redds. Spawning site selection depends on the species, gravel size, and flow pattern of the stream. A common spawning location is the "tail-out" of a pool – the area where a pool becomes shallow before entering a downstream riffle. The eggs remain in the gravel for 45 – 70 days depending on water temperatures. Hatching alevins (fry with yolk sacs for nutrients) remain in the gravel until the yolk sac is absorbed. They then work their way through the gravel and emerge into the stream channel as feeding fry. This is a critical stage for all salmonid species. During this part of their life, fry need adequate food and sediment-free water that contains a lot of oxygen.

Natural mortality of juveniles is high during the first month. Many fry are eaten by birds, amphibians, reptiles, and other fish. Depending on the species, juvenile anadromous salmonids grow 1-3 years before migrating to sea as smolts. Smolts need to adapt from freshwater to saltwater by spending transition time in the estuary. After maturing in the ocean, they return to the stream to spawn.

Life cycles vary greatly from river to river and among species (e.g., winter vs. summer steelhead, spring vs. fall chinook, sea run vs. resident cutthroat trout). Where several salmonid species coexist in a river system, each species has its own schedule for rearing, spawning, and migration, although it is not uncommon for juveniles and adults to occupy the same stream areas throughout the year. Adult anadromous salmonids find their way back from the ocean to the streams where they were born. This life cycle feature is called homing and is one of the least understood yet most wonderful aspects of salmon ecology.

<u>Chinook salmon</u>
Chinook (king) salmon are the largest and longest lived of the Pacific salmon. They average 20-25 pounds as adults, although individuals as large as 100 pounds have been reported. There are two basic life-history patterns of chinook in Oregon – fall and spring. Fall chinook return from the ocean in late August through December. They spawn in main river channels and low-gradient tributaries. Since chinook are large, they can dig redds deep in the gravel, thus protecting the eggs from channel scouring during winter storms. If an unusually heavy storm does scour the eggs and a year is lost, successive generations can replace the stock because adult chinook spawn from 3-6 years of age. All chinook can spawn once but they then die.

Juvenile fall chinook emerge from the gravel in February or March. They stay in the stream only about 90 days. Peak downstream migration in south coast streams (excluding the Rogue River) is typically early to mid July. They generally spend the next 3-4 months in the estuary and then migrate to the ocean with fall rains. Spring chinook adults return to rivers in the spring and spend the summer in deep pools. They spawn in early fall. The life histories of these juveniles are more variable than those of all chinook.

<u>Coho salmon</u>

Coho (silver) salmon historically were the most abundant salmon on the Oregon Coast. Adults average 6-12 pounds and have a strict 3-year life cycle. Because coho spawn mostly at age 3 with no year class overlap, their survival is susceptible to catastrophic events. If a year is lost, a population is likely to remain depressed for a long time. Coho can recolonize tributaries from highly populated source areas. However, this species can be eliminated from a basin quickly if these source areas deteriorate.

Coho spawn from November to March with two dominant life-history patterns. “Early” coho enter streams on the first major storm of the year, usually in mid-November. If they are successful at spawning, their fry have the advantage of getting the first shot at the food resources. These fry also become the largest individuals, providing additional survival advantage.

Coho are not as large as chinook, they spawn in smaller gravel, and their redds are not as deep as those of chinook. Thus, their redds are likely to be scoured out during winter storms. Therefore, a second stock of “late” coho has evolved to delay spawning until most major winter storms have passed, often as late as March or April. These two groups provide important genetic variation to the species and help coho withstand natural climate variations.

Coho juveniles generally emerge from the gravel from February through April. They prefer to live in pools with slow flow or in beaver ponds. Juveniles remain in the stream for a full year and then migrate to the ocean in April or May. Some coho return as 2-year-old jacks (males), but most return as 3-year-old adults.

<u>Steelhead</u>

Steelhead are seagoing rainbow trout. Adults average 8-12 pounds, and some adults live as long as 7 years. Winter steelhead return from the ocean from November through April, allowing them to move into headwaters of stream during winter flows. Some spawning occurs in May Like salmon, they deposit their eggs in gravel. However, not all steelhead die after spawning. About 30 percent survive to spawn again in the stream of their birth.

Juveniles emerge as late as early July. During the first year they live in riffles and along the edges of stream channels. Therefore, low water conditions can severely affect steelhead. They spend 1-3 years in a stream before migrating to the ocean. This long freshwater residence time also makes them more vulnerable to habitat degradation.

Summer steelhead adults enter river systems from April through August. Unlike winter fish, but like spring chinook, these steelhead need deep, cool pools to reside in until spawning in January or February. The juvenile life history of summer steelhead is similar to that of winter steelhead.

Cutthroat trout

Cutthroat trout have variable life history patterns. Some migrate to the ocean while others remain in the same area of a stream all of their lives. Anadromous and fluvial forms use estuarine, mainstem, and lower portions of the system for adult holding and juvenile rearing, and use small headwater streams for spawning. The resident form of cutthroat are also typically found in headwater areas, but can be found in low gradient backwater areas lower in the system. Cutthroat spawn in the spring or fall, usually in very small tributaries, and the juveniles emerge by June or July. Sea-run cutthroat rarely exceed a length of 20 inches or a weight of 4 pounds. (ODFW, 1995)

Salmonid Spawning Habitat

Successful spawning and development from eggs to fry stages require the following:

- No barriers to upstream migration for adults
- Spawning areas (usually in a riffle or at the tail-out of a pool) with stable gravel, free of fine sediment
- A combination of pools and riffles that provides both spawning areas and places to hide nearby
- A constant flow of clean, well oxygenated water through the spawning gravel

Salmonid Rearing Habitat

Fry are vulnerable to predators and must endure high stream flows and food shortages. They need pools for rearing, temperature regulation, and cover. Good juvenile-rearing habitat exhibits the following characteristics:

- Low to moderate stream gradient (slope) and velocity
- A good mix of pool and riffle habitats
- Clean, oxygenated water and cool stream temperatures
- A variety of bottom types to provide habitat for juvenile fish and food organisms
- Overhanging vegetation, large woody material, and stream cutbanks, which provide protection for juvenile fish and leaf litter for aquatic insect food
- Sufficient nutrients to promote algal growth and decomposition of organic material

As young fish grow, they seek increased summer flow, moving from the edge of a stream to midstream to take advantage of insect drift. In winter, all species seek areas of lower water velocity where they can conserve energy while food and growing conditions are limited.

Salmonid Habitat Use

Although their basic requirements are the same, salmonid species differ in the types of habitat they use. For example, juvenile coho prefer pool areas of moderate velocity in the summer, especially those with slack water current near undercut stream banks, root wads, or logs. In winter, they seek slow, deep pools or side channels, utilizing cover under rocks, logs and debris.

Conversely, juvenile steelhead spend their first summer in relatively shallow, cobble-bottomed areas at the tail-out of a pool or shallow riffle. During winter, they hide under large boulders in riffle areas.

In summer, older steelhead juveniles prefer the lead water of pools and riffles where there are large boulders and woody cover. The turbulence created by boulders also serves as cover. During winter, these steelhead juveniles are found in pools, near streamside cover, and under debris, logs or boulders.

Cutthroat trout habitat requirements are similar to those of steelhead with the exception that they spend the summer in pools. Chinook juveniles tend to rear in large tributaries, and their habitat requirements are different than those of coho. For example, estuarine residence and growth are key elements in a chinook life-history pattern. Coho salmon require backwaters, beaver ponds, or side-channel rearing habitats to survive high winter flows and low summer flows.

Salmonid Limiting Factors

The quantity and quality of spawning and rearing habitat limit the success of spawning and production of smolts. These limiting factors establish the carrying capacity of a stream. Carrying capacity is the number of animals a habitat can support throughout the year without harm to either the organisms or the habitat. Depending upon the limits of available habitat, ocean factors, escapement, etc., salmonid populations fluctuate annually as a result of varying environmental factors (e.g. extreme high and low stream flows, high stream temperatures in the summer, or ice). A stream does not necessarily reach its carrying capacity each year because of these factors.

Salmonid Fish Passage

Stream channel crossings by roads have been the cause of serious losses of fish habitat due to improperly designed culverts. Assessment of migration barriers is important, because anadromous salmonids migrate upstream and downstream during their lifecycles. In addition, many resident salmonids and other fish move extensively upstream and downstream to seek food, shelter, better water quality, and spawning areas. Where these barriers occur, fish can no longer reach suitable habitats. Because of reduced accessible habitat, fish populations may be limited.

Culvert road crossings can create barriers to fish migration in the following ways:

- The culvert is too high for the fish to jump into.
- The water velocity in the culvert is too fast for the fish to swim against.
- The water in the culvert is not deep enough for the fish to swim, or has a disorienting turbulent flow pattern, making it difficult for fish to find their way through.
- There is no pool below the culvert for the fish to use for jumping and resting, so they cannot access the culvert, or there are no resting pools above the culvert, so the fish are washed back downstream.

A combination of these conditions may also impede fish passage. It is not always clear when a culvert blocks fish passage. Some culverts may be velocity barriers during high flows but pass fish successfully during low flows. Other culverts may not be deep enough during summer low flows to pass fish, but fish can pass successfully during higher flows. Large, adult anadromous fish may be able to pass through culverts that are total barriers to smaller juvenile or resident fish. For these reasons it is important to understand what fish species occur in the watershed and when they will be migrating.

Culverts can be round, square, elliptical, or other shapes. Culverts can be made of various materials, including concrete, but metal pipe is the most common material. Because of the variability in culvert type and design, it is often difficult to definitively determine if a culvert blocks fish passage.

Other fish passage concerns can include impoundments, dams, unscreened and screened irrigation pipes and water withdrawals that result in dewatered reaches and/or low flows that restrict migration. Natural barriers, in contrast, are characteristic of a stream's channel morphology and where present, play a vital role in the co evolution of various fish species.

B INTRODUCTION

The historic abundance and distribution of chinook, coho, steelhead and cutthroat, in the Port Orford watersheds, is poorly understood. Chinook usage of Brush Creek is sporadic while neither Hubbard nor Brush Creek support indigenous stocks of chinook. Chinook usage is likely limited to strays. Hubbard Creek contains good coho habitat, however, not enough to support an indigenous population over a long period of time. Hubbard Creek would likely need to be seeded from adjacent larger populations (e.g. Sixes or Coquille) periodically to maintain a population. Anecdotal information suggests that coho were 'frequently' observed in Brush Creek in the 1930s and 1940s. (ODFW 2001) Cutthroat are thought to utilize all portions of the basins.

<u>Life History Patterns of Anadromous Salmonids</u>

Table 9 lists the life history characteristics of anadromous salmonids in the south coast watersheds including the Port Orford watersheds. These characteristics were identified by cross referencing three sources of information: GWEB Oregon Watershed Assessment Manual; Watershed Stewardship, A Learning Guide, Oregon State University Extension Service; and Oregon South Coastal River Basin Fish Management Plan, June, 1995 (ODFW Working Draft). ODFW Fish Biologist, Todd Confer from the Gold Beach district office, then verified the information.

<u>Threatened and Endangered Species</u>

Table 10 lists the threatened and endangered species according to the National Marine Fisheries Service (NMFS) and ODFW. The Northwest Region of NMFS is responsible for marine and anadromous fishes under the Endangered Species Act. In May 1997 coho, within the Port Orford basins, were listed as Threatened. More recently, in April 2001, the status of steelhead was changed from Candidate to Not Warranted.

Table 10 Port Orford Watersheds' Threatened and Endangered Species

Species	**ESA Status** (1)	**ODFW Status** (2)	**Population Trends** (3)
Chinook	Not Warranted	Not Warranted / Not Reviewed	Not Available
Coho	Threatened	Not Listed	Not Available
Cutthroat	Not Warranted	Not Warranted / Not Reviewed	Not Available
Steelhead	Not Warranted	Not Warranted / Not Reviewed	Not Available

(1) NMFS – NW Region website //www.nwr.noaa.gov/1salmon/salmesa/specprof.htm
(2) Tim Whitesel, ODFW ESA Coordinator
(3) ODFW – Oregon South Coastal River Basin Fish Management Plan, June, 1995 (Working Draft)

Fish Distribution

Fish distribution maps were obtained in digital format from the ODFW. Due to the resolution of the scale (1:100,000) distribution of all three species was not available for small streams. All maps reflect distribution only; they do not provide any indication of the relative abundance of each species. Furthermore, all maps are in draft form. The following paragraph was adapted from the fish distribution metadata files (ODFW web site) that correspond to the maps. The following paragraph was adapted from the fish distribution metadata files (ODFW web site) that correspond to the maps.

Fish distribution maps illustrate areas of suitable habitat (spawning, rearing and migration) currently believed to be utilized by wild, natural, and/or hatchery fish populations. The term "currently" is defined as within the past five reproductive cycles. This information is based on survey data, supporting documentation and best professional judgment of ODFW staff biologists and in some cases, that of staff from other natural resource agencies within Oregon. Areas displayed may not be utilized by a species of fish on an annual basis due to natural variations in run size, water conditions, and other environmental factors. Due to the dynamic nature of this information, it may be updated at any time. This distribution information makes no statement as to the validity of absence in any particular area; no attempt has been made to verify where fish are not present. Historic genetic origin and current production origin have yet to be defined and are not found as attributes of the distribution data at this time.

Distribution of salmonids occurs throughout significant areas of the Port Orford watersheds. However, certain subwatersheds or stream reaches are more prone to provide spawning and summer/winter rearing habitat. Table 11 provides a summary of information that pertains to these important locations.

Table 11 Important Locations for Spawning and Summer/Winter Rearing

Species/Purpose	**Location**
Steelhead spawning & rearing	Not Available
Chinook spawning & rearing	Not Available
Cutthroat spawning & rearing	South Fork, Middle Fork, North Fork & Mainstem Hubbard Creek

Source: *South Coast Watershed Action Plan, 1995*

Stocking Summary

A stocking summary helps to identify potential interactions between native and stocked species and to assist in determining if hatchery fish have an influence on current population trends. Two sources were reviewed for the purpose of summarizing stocking (hatchery release) data, however no data was available. The two sources include: 1) ODFW 1995. Oregon South Coastal River Basin Fish Management Plan, (Working Draft, June 1995) and 2.) Salmon and Trout Enhancement Program. **Note:** Although not presented here, stocking data, dating from 1947 to 1985, was available from a third source known as Streamnet.

Migration Barriers

In 1995, a group of displaced fishermen were hired by the South Coast Watershed Council to conduct surveys of culverts in an effort to address fish passage concerns. The compilation of data from these surveys became known as the "Hire the Fishermen Survey". Culverts from this survey, within the Port Orford watersheds, were evaluated to determine adult and juvenile fish passage based on guidance (Robinson 1997) from the Oregon Department of Forestry and Oregon Department of Fish and Wildlife.

Initially, culverts were classified as "Adult Barrier," "Juvenile Barrier," or "Passable" categories. However, according to more recent standards (Robison, et. al., Spring 1999, Oregon Road/Stream Crossing Restoration Guide) outlet drops exceeding one foot in height are expected to restrict adults of some species. As a result, another category was created to represent "Adult Restricted". Additionally, some culvert slope measurements were estimated at 1% with a clinometer. Due to the resolution of these measurements, a degree of uncertainty exists in determining whether these slopes actually met the 0.5% slope criteria. As a result, when slope was the only criteria in doubt, these sites were classified as "Uncertain if Juvenile Barrier". Similarly, in consideration of adult passage, some culverts were estimated at 4% slope. Thus, when slope was the only criteria in doubt, these sites were classified as "Uncertain if Adult Barrier". Finally, the Outlet Drop was determined by estimating pool depth at bankfull flow. The assumption was made that bankfull flow is a better estimate of adult migration conditions than the measured summer flow pool depths.

Culvert conditions were evaluated for juvenile and adult salmonid fish passage. The listed criteria apply only to bare culverts. Few culverts surveyed were embedded or baffled. In both cases these criteria are not minimum values; they describe the conditions in which passage of most fish is blocked. Other conditions may still prevent some fish from passing through a specific culvert.

Juvenile Fish Passage Criteria

Slope	<0.5%
Outlet Drop	<6 inches, with residual pool 1.5 times deeper than the jump
Inlet Condition	Diameter > ½ bankfull channel width; no inlet drop
Length	<100 feet long

Adult Fish Passage Criteria

Slope	<4%
Outlet Drop	<4 feet, with residual pool 1.5 times deeper than the jump or 2 feet deep
Length	<200 feet long

Culverts, bridges and fords were assessed by the "Hire the Fishermen Survey". Some culverts and bridges have been more recently assessed and are included as well. Stream crossings were labeled by a "Site ID" and an estimated length of potential fish habitat. Potential fish habitat upstream of each culvert was measured, for all Hire The Fishermen culverts, to an estimated channel gradient of 16%. Stream channels greater than 16% gradient are considered "Very Steep Headwaters" as described in the Channel Habitat Component of this watershed assessment. Salmonid fish habitat in these very steep headwater channels provides only very limited rearing.

C KEY FINDINGS

Threatened and Endangered Species

- Coho have been listed as Threatened, according to the Endangered Species Act, since May 1997. No other salmonids are currently listed.

Fish Distribution

- Winter steelhead are well distributed throughout the Hubbard Creek watershed including the mainstem Hubbard as well as the North and South Forks. Winter steelhead are also well distributed throughout the Brush Creek watershed.
- Fish distribution maps for fall chinook and coho were not available for the Port Orford watersheds, perhaps because over a long period of time, neither Hubbard Creek nor Brush Creek support indigenous populations of fall chinook or coho.

Migration Barriers

- Among the culverts that were evaluated in this assessment two were assessed as adult barriers and one was assessed as a juvenile barrier. Three sites are potential juvenile barriers that may prohibit access to a significant amount of habitat. *(See Migration Barrier Map for specific locations.)* Consultation with ODFW fish biologists and site visits are recommended to verify fish passage barriers and estimated habitat above each barrier.
- Other human-caused migration barriers potentially exist. These include culverts that warrant additional surveys to determine if they meet criteria for both adult and juvenile passage. *(See Migration Barrier Map for uncertain barriers.)*

REFERENCES

GWEB 1999. Oregon Watershed Assessment Manual. Governor's Watershed Enhancement Board, July 1999

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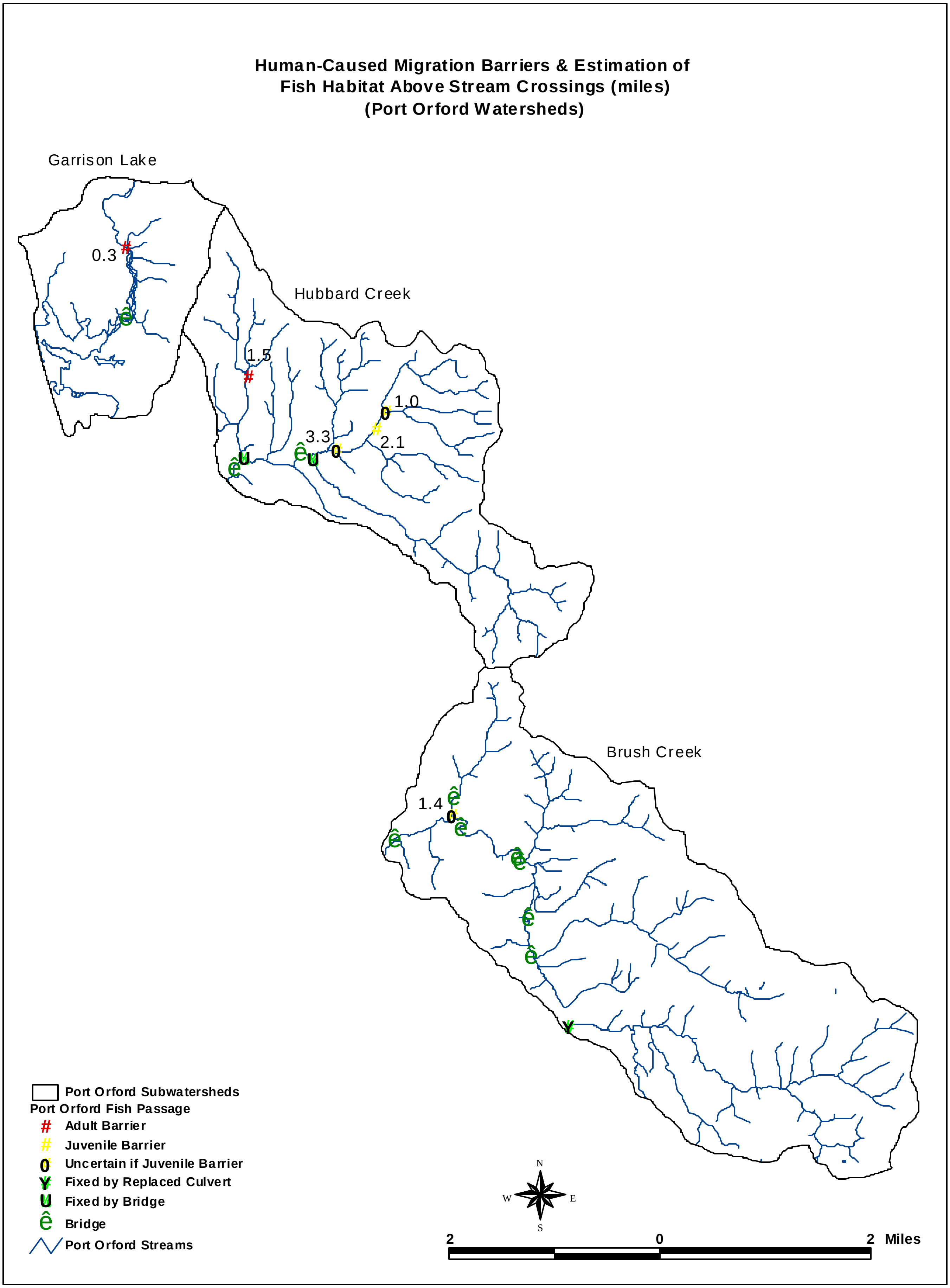
ODFW 2001. Personal communication with Todd Confer, Fish Biologist, Oregon Department of Fish and Wildlife – Gold Beach, Oregon.

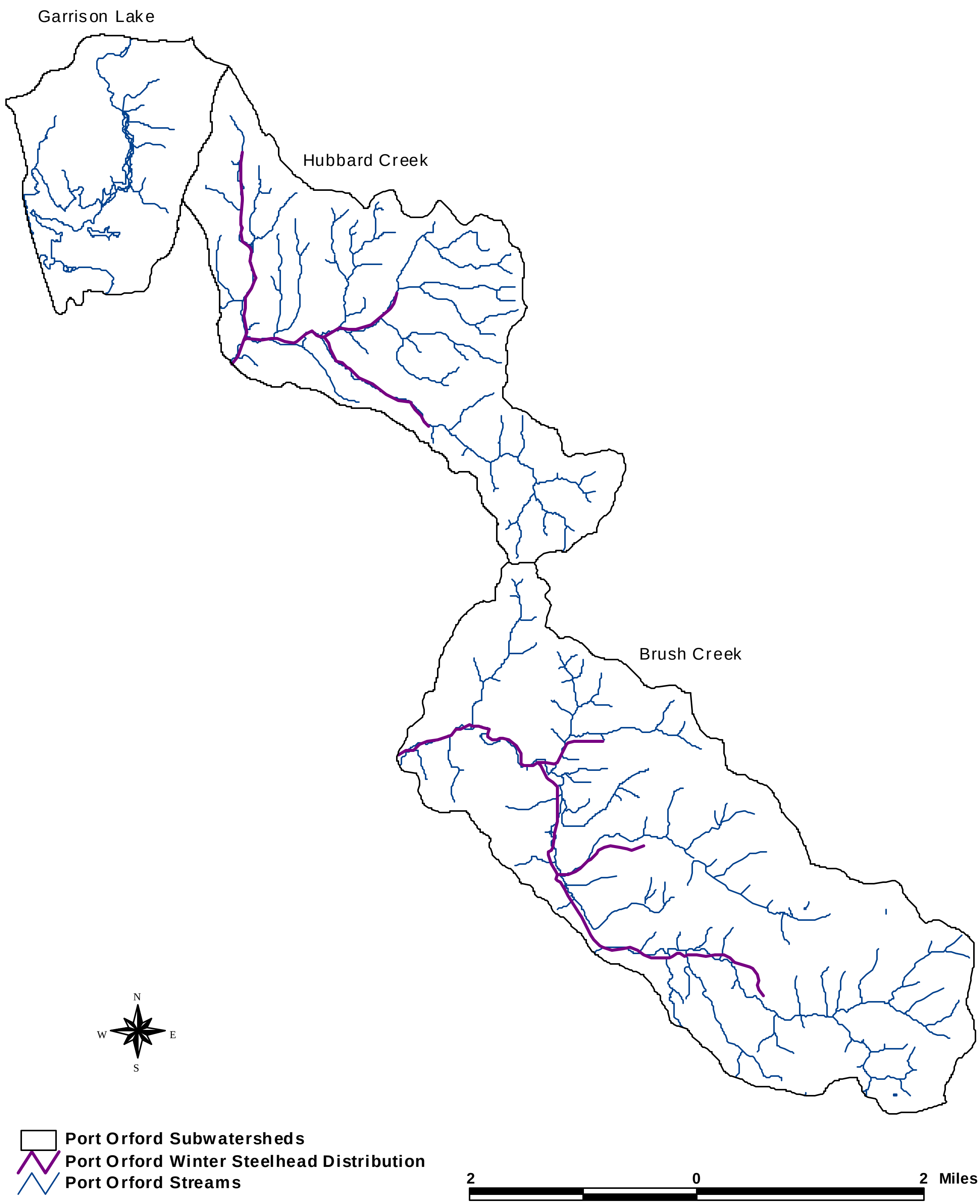
OSU 1998. Watershed Stewardship - A Learning Guide, Oregon State University Extension Service, July 1998

Robinson 1997. Oregon Road/Stream Crossing Restoration Guide

Stauff 2001. Personal communication with Russ Stauff, District Fish Biologist, Oregon Department of Fish and Wildlife – Gold Beach, Oregon


Human-Caused Migration Barriers & Estimation of
Fish Habitat Above Stream Crossings (miles)
(Port Orford Watersheds)
Garrison Lake
0.3
Hubbard Creek
1.5
1.0
3.3
2.1
Brush Creek
1.4
Port Orford Subwatersheds
Port Orford Fish Passage
Adult Barrier
Juvenile Barrier
Uncertain if Juvenile Barrier
Fixed by Replaced Culvert
Fixed by Bridge
Bridge
Port Orford Streams
N
W
E
S
2
0
2 Miles

Port Orford Winter Steelhead Distribution



VII WATER QUALITY ASSESSMENT

A BACKGROUND (GWEB 1999 and OSU 1998)

A combination of natural watershed processes and the effect of human activities determine water quality at a particular site on a stream or river. All water contains some dissolved chemical elements, particulate matter, and organic matter. The amounts of these substances vary with different watershed conditions. Water quality is described in terms of the beneficial uses of water and the level of quality needed to support those uses. Measures of water quality – the criteria or indicators – provide the connection between the beneficial uses of water and the natural and human sources of watershed inputs.

Beneficial Uses of Water

The streams and rivers in the diverse landscapes of Oregon support different uses of water. To focus the water quality assessment, it is necessary to identify the beneficial uses of water that are important in a watershed as well as those that are specifically identified in the Oregon water quality standards. Beneficial uses determine which water quality criteria apply. For example, assessment for drinking water primarily focuses on the presence of pathogens that can cause disease or chemicals that can contribute to long-term health effects such as cancer risk. Assessment for water that supports fish populations focuses on elements of the stream system such as temperature, dissolved oxygen, metals, nutrients, and chemical contaminants.

Criteria and Indicators

Water quality criteria provide a warning system when activities in a watershed are limiting beneficial uses. Water quality criteria are specifically established in the State Water Quality Standards by major river basin. Water quality indicators are used when the state standards do not specify numerical criteria. Water quality concerns can be grouped into several major categories for analysis: temperature, dissolved oxygen, pH, nutrients, bacteria, turbidity and toxics. Water quality status can also be evaluated indirectly by examining the health of the aquatic community using aquatic invertebrates and fish populations.

Stream Temperature

Cool water temperatures are necessary features of streams that support salmonid fish and the associated aquatic community. Suitable temperature ranges have been evaluated for all life history stages of salmonids – adult migration, spawning, egg incubation, embryo development, juvenile rearing, and juvenile migration. Growth and reproduction are adversely affected when water temperature is outside of the range to which these organisms were adapted.

The biological rationale for temperature criteria is based on laboratory and field studies. Laboratory studies evaluate egg development rate and juvenile survival under constant temperatures. Field studies evaluate the effect of water temperature on adult and juvenile migration behavior and adult spawning behavior. Oregon water quality standards are established to protect fish populations based on sublethal effects on fish, such as susceptibility to disease, inability to spawn, reduced survival rate of eggs, reduced growth and survival rate of juveniles, increased competition for limited habitat and food, and reduced ability to compete with other species. A general numerical standard of 64° Fahrenheit (7-day moving average of maximum temperatures) was established in Oregon on the basis of preventing these sublethal effects. Several documents (Boyd and Sturdevant 1997, Oregon Department of Environmental Quality 1995) have been published by state agencies to help understand the technical basis for the standard, and what managers and land owners can do to meet the standard.

The evaluation criteria for stream temperature is a daily maximum 64° F standard that is applied to the average of the maximum temperatures for the warmest 7 consecutive days (known as the "7-day max"). The daily maximum temperature is determined from readings at hourly or half-hour intervals for each day during the monitoring period, usually mid-June through mid-September. The difference between the coolest and warmest temperature during the warmest 7 consecutive days is known as ΔT. High ΔT values result from solar exposure, and may be used to indicate reaches where additional shade can limit the sun's ability to warm the stream. Quite strictly, shade does not lower temperature it simply blocks the sun from warming the stream.

Dissolved Oxygen

High dissolved oxygen is a basic physiological requirement of cold-water fishes such as native salmon and trout. Critical dissolved oxygen levels for various life stages have been evaluated in laboratory and field studies. The early larval stages of fish are wholly dependent on the transfer of oxygen within the redd, the salmonid gravel nest. When oxygen is below saturation, salmonid embryos are smaller than usual and hatching is either delayed or is premature. Salmonid juveniles survive in dissolved oxygen less than saturation, but growth, food conversion efficiency, and swimming performance are adversely affected. Water quality criteria are established to provide for the natural fluctuations below saturation while assuring sufficient dissolved oxygen to protect aquatic life. The concentration of dissolved oxygen is a function of many factors: water temperature, surface and intragravel water interchange, water velocity, substrate permeability, and the oxygen demand of organic material. The content of oxygen in water is directly related to water temperature and barometric pressure, and therefore, temperature and pressure (estimated through elevation) must be measured at the same time.

The Oregon Water Quality Standards contain a number of dissolved oxygen criteria. More restrictive criteria are specified for dissolved oxygen during the period that salmonid fish are spawning (11 mg/l). Also, the standards specify a dissolved oxygen concentration (8 mg/l) in the gravel used by spawning fish. For the purposes of this assessment, the evaluation criteria is set at a minimum of 8 mg/l in the water column for cold water fish.

pH

The pH is a measure of the hydrogen ion concentration of water. pH is measured in a logarithmic scale, with pH below 7 indicating acidic conditions and pH above 7 indicating alkaline conditions. PH of water is important in determining the chemical form and availability of nutrients and toxic chemicals. Measurement of pH is especially important in mining areas because there is potential for both generation of heavy metals and a decrease in pH. Metal ions shift to a more toxic form at lower pH value. The pH of waters varies naturally across Oregon due to the chemical composition of the rock type in the watershed and the amount of rainfall. Eastside basins generally will have more alkaline water than westside or coastal basins.

The Oregon Water Quality Standards specify the expected pH range for all basins in Oregon. For the purposes of this assessment, the evaluation criteria is set at 6.5 to 8.5 for all westside basins. It should be recognized that, like dissolved oxygen, pH also varies in streams naturally throughout the day due to the photosynthesis and respiration cycles of attached algae.

<u>Nutrients</u>
Nutrients refer to chemicals that stimulate growth of algae and aquatic plants in water. In fast-moving streams, algae grow attached to the substrate and are called "periphyton." Algae and aquatic plants are a necessary part of the stream ecosystem and act as the primary producers in a stream – processing the sun's energy into food for stream fish. Excess algae and aquatic plant growth, however, becomes a problem in slow moving streams and rivers, and in still waters such as ponds and lakes. The excessive growth can result in low or no dissolved oxygen and interfere with recreation, and certain algae can produce chemicals that are toxic to livestock and wildlife. Phosphorous and nitrogen are the major growth-limiting nutrients in water, and are therefore the focus of a water quality evaluation.

Total phosphorous measures primarily phosphates in the water column and phosphorous in suspended organic material. Total nitrate (commonly measured as nitrite plus nitrate) provides a measure of the majority of nitrogen present in surface waters. Evaluation criteria are based on literature values that have been identified as causing excessive plant growth.

For the purposes of this assessment, the evaluation criteria is set at 0.05 mg/l for total phosphorous and 0.30 mg/l for total nitrates.

<u>Bacteria</u>
Bacteria in the coliform group are used as indicators to test the sanitary quality of water for drinking, swimming, and shellfish culture. Bacteria in the coliform group are found in wastes associated with warm-blooded animals, including humans, domestic animals, and other mammals and birds; these bacteria are indicators of contamination of surface waters by sewage, feedlots, grazing, and urban runoff. The State of Oregon specifies the use of <u>Escherichia coli</u> (E.coli) as the bacterial indicator for water contact recreation, such as swimming, and fecal coliform bacteria as the indicator in marine and estuarine waters for shellfish growing. E.coli is a more specific test for organisms that occur in warm-blooded animals. The fecal coliform procedure tests positive for some bacteria

that occur naturally in the environment, but has generally been accepted as a good screening tool.

Fecal coliform bacteria enter streams from many sources associated with human and animal wastes in urban and agricultural watersheds. In rangelands, bacterial contamination occurs primarily from direct deposition of fecal material in streams. Good vegetative cover on the upslope areas and dense riparian vegetation impedes contaminated runoff from reaching streams. Once coliform bacteria enter streams, the majority settles to the bottom and is attached to sediment particles. The stream sediments can act as a reservoir for fecal coliform bacteria; bacteria are resuspended when bottom sediments are disturbed through increased turbulence or animal movement.

For the purposes of this assessment, the evaluation criteria is set at 406 E. coli/100ml in fresh waters and 43 fecal coliform/100ml in marine waters.

Turbidity/Suspended Sediment

Turbidity is a measure of the clarity of water. In most cases, water is cloudy due to runoff of sediment, and therefore turbidity is a useful surrogate for measuring suspended sediment. However, turbidity can also be caused by other sources of suspended material such as algae. Suspended sediment can directly affect fish by damaging their gills and reducing the feeding ability of sight-feeding fish such as salmonids. Suspended sediment is a carrier for other pollutants (nutrients, pesticides, and bacteria) and is therefore a concern for water quality in general. In addition, suspended sediment interferes with recreational uses and the aesthetic quality of water.

Turbidity varies naturally with the soil type in a landscape. The small particle sizes, silts and clays, will stay suspended for long periods and cause turbidity. Soils that break down into sand size fractions will settle to the bottom and result in comparatively low turbidity values. Turbidity in a stream will increase naturally during storm and runoff events. This high variability makes it difficult to establish a simple, meaningful criterion. For the purposes of this assessment, the evaluation criteria is set at 50 NTU. Turbidity at this level interferes with sight-feeding of salmonids and therefore provides a direct indicator of biological effect. *The unit of measure, an NTU (nephelometirc turbidity unit), is based on the original measurement device and has no direct meaning.*

Toxic Contaminants: Organic Compounds, Pesticides, and Metals

The term “contaminants” refers to chemicals that may cause toxicity in aquatic organisms. Due to the lack of data pertaining to toxic contaminants in the Port Orford watersheds no further assessment was conducted.

B INTRODUCTION

The water quality assessment is based on a process that first identifies the beneficial uses that occur within the watershed (See Table 12). Evaluation criteria that apply to these uses are then identified and finally, water quality conditions are identified by comparison of existing data with these criteria. This conceptual framework is consistent with the guidelines established by the U.S. Environmental Protection Agency (EPA) under the authority of the federal Clean Water Act and the water quality programs of the Oregon Department of Environmental Quality (ODEQ). The goal of the federal Clean Water Act, *"to protect and maintain the chemical, physical and biological integrity of the nation's waters,"* establishes the importance of assessing both water quality and the habitat required for maintaining fish and other aquatic organisms.

The requirements for in-stream water quality are based on protection of recognized uses of water. In practice, the sensitive beneficial uses drive the evaluation of water quality and are the basis for establishing best management practices.

Aquatic species, particularly salmonid fish, are often considered the most sensitive beneficial uses in a watershed. Salmonid species are adapted to cold water, high gradient habitats where temperatures are cool and dissolved oxygen is high. Salmonids have highly variable life histories but display similarity in laying eggs in gravels and have fry and juveniles that rear close to where they hatch from the egg. These early life stages are particularly sensitive to changes in water quality. Water quantity affects water quality parameters and subsequently fish, especially during summer low flow conditions. Extracting too much water from a system is just as harmful to fish as are certain water-quality parameters.

Table 12 South Coast Beneficial Uses

Beneficial Uses	Estuaries & Adjacent Marine Waters	All Streams & Tributaries
Public Domestic Water Supply (1)		X
Private Domestic Water Supply (1)		X
Industrial Water Supply	X	X
Irrigation		X
Livestock Watering		X
Anadromous Fish Passage	X	X
Salmonid Fish Rearing	X	X
Salmonid Fish Spawning	X	X
Resident Fish & Aquatic Life	X	X
Wildlife & Hunting	X	X
Fishing	X	X
Boating	X	X
Water Contact Recreation	X	X
Aesthetic Quality	X	X
Hydro Power		X
Commercial Navigation & Transportation	X	X

(1) With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards. SA\Table\WH5291.5 (ODEQ web site)

Water Quality Limited Streams 303(d) List

The ODEQ is required by the federal Clean Water Act to maintain a list of steam segments that do not meet water quality standards. This list is called the 303(d) List because of the section of the Clean Water Act that makes the requirement. The U.S. Environmental Protection Agency has approved ODEQ's 1998 list. (ODEQ web site)

According to a review of the ODEQ's 1998 303(d) there are no water quality limited streams in the Port Orford watersheds. Garrison Lake has Total Maximum Daily Load (TMDL) allocations for Aquatic Weeds/Algae, Nutrients, and pH.

Water Quality Criteria Applicable to the Sensitive Beneficial Uses

Evaluation criteria are based on an interpretation of narrative and numeric standards in the Oregon Water Quality Standards. Where numerical criteria are not provided in the state standards, evaluation indicators have been identified based on the literature. Indicators are useful for evaluating water quality conditions, but do not have any regulatory standing.

Summary of Water Quality Criteria and Evaluation Indicators

Water Quality Attribute	Evaluation Criteria	Evaluation Indicator
Temperature	Daily maximum of 64° (7 day moving average)	
Dissolved Oxygen	8.0 mg/l	
pH	6.5 to 8.5 units	
Total Phosphorous		0.05 mg/l
Total Nitrate		0.30 mg/l
E. coli	406 E. coli/100ml (no single sample can exceed the criteria)	
Fecal coliform	43 fecal coliform/ 100ml (not more than 10% of samples)	
Turbidity		50 NTU maximum

Stream Temperature

Many streams in Curry County currently exceed the state's temperature standard and have been subsequently listed as "water quality-limited" on the 303(d) list. In the Port Orford watersheds however, there are no locations that are officially recognized on this list.

Under the Clean Water Act, water quality management plans are required to lower stream temperatures to meet the standard over time, or to justify setting a new standard to be met. The collection of stream temperature data and corresponding flow data has helps landowners and agencies establish realistic, watershed-specific targets for shade and water temperature.

Since 1998, the South Coast Watershed Council has received funding from the Oregon Watershed Enhancement Board and Oregon Department of Environmental Quality to support monitoring for the Oregon Salmon Plan. Standard methods and accuracy checks were used for deploying recording thermographs (thermometers) as described in the *Stream Temperature Protocol* chapter of *Water Quality Monitoring Guide Book*. A Quality Assurance Project Plan provides direction for procedures.

Stream temperature data is collected to assist watershed council members and interested citizens assess where to focus efforts on restoring streamside vegetation in order to reduce exposure to the sun. The South Coast Watershed Council has monitored stream temperature and corresponding streamflow in the Port Orford watersheds since 1998. Stream temperature monitoring provides baseline data, long-term trend data and educational opportunities. As a result, stream reaches can be prioritized to voluntarily plant or manage vegetation in order to produce adequate shade. Monitoring also assists to measure the effectiveness of riparian restoration projects.

The following tables represent key characteristics of summarized data compiled by the South Coast Watershed Council's Monitoring Program. Table 13 illustrates the 7-Day Max Values that represent annual trends from 1998 to 1999. Table 14 illustrates the locations, number of days and associated years that exceed the state's temperature standard. All data was obtained from the Monitoring Program's Stream Temperature Report. For more details please contact the South Coast Watershed Council's Monitoring Coordinator.

Table 13 Annual Trends – 7-Day Max Values (Degrees Fahrenheit)

Location	2000	1999	1998
Hubbard mainstem below North Fork		60.4	
Hubbard North Fork below reservoir			65.2
Brush Creek at state park		60.0	60.6
Garrison Lake – Mill Creek at weir			73.8

Table 14 Days >64º F (7-day max values)

Location	2000 Days > 64º	1999 Days > 64º	1998 Days > 64º
Hubbard mainstem below North Fork		0	
Hubbard North Fork above reservoir			0
Hubbard North Fork below reservoir			18
Brush Creek at state park		0	
Garrison Lake – Mill Creek at weir			44

E KEY FINDINGS

Dissolved Oxygen, pH, Total Nitrates, Total Phosphates, Fecal Coliform, E. coli, Turbidity, & Biological Oxygen Demand

- Unlike several watersheds in Curry County, the Oregon Department of Environmental Quality does not monitor water quality in the Port Orford watersheds via the Oregon Water Quality Index. Therefore, water quality data, except for temperature, was not available to compare with the Oregon Water Quality Standards.

Temperature

- The only temperatures which exceed the 64° F temperature standard were measured below the reservoirs on Hubbard Creek and Mill Creek. All other 7-day maximum temperatures were below the standard.

REFERENCES

GWEB 1999. Oregon Watershed Assessment Manual. Governor's Watershed Enhancement Board, July 1999

OSU 1998. Watershed Stewardship - A Learning Guide, Oregon State University Extension Service, July 1998

VIII WETLANDS

A BACKGROUND (GWEB 1999 and OSU 1998)

Wetlands are often considered ecological "hot spots." They play a role disproportionate to their size in supporting endangered species and maintaining biodiversity. When considering wetland assessments and associated restoration projects it seems prudent to first understand a regulatory definition of a wetland as used by the U.S. Army Corps of Engineers and the Oregon Division of State Lands: **Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions.**

Wetlands provide a variety of important functions, including water quality improvement, flood attenuation and desynchronization, groundwater recharge and discharge, and fish and wildlife habitat. These functions are described below.

<u>Water Quality Improvement</u>

Wetlands aid in water quality improvement by trapping sediment, and contaminants that may be attached to these sediments. Dense wetland vegetation tends to slow the rate of movement of water, which allows sediments to settle out. Although deposition of sediments is beneficial to downstream resources, excessive sedimentation may have negative impacts on the wetland itself. When a wetland is subjected to ongoing sediment deposition, the bottom elevation of the wetland will change; over time, this will lead to wetland loss. This process is exacerbated by human induced factors that increase sedimentation.

Vegetation within wetlands also can assimilate certain nutrients and some toxins, thereby protecting downstream resources. The anaerobic environment of many wetland soils breaks down nitrogen compounds and keeps many compounds in a nonreactive form. The ability of a wetland to provide this function is limited: At a certain point, toxins can build up to lethal levels in the wetland community and decrease the wetlands capacity to metabolize the nutrients entering from upstream sources. In addition, plant die-back and decay can re-release nutrients or toxins back into the system, although many toxins are actually converted to less harmful forms or bound in sediments.

<u>Flood Attenuation and Desynchronization</u>

Wetlands can help alleviate downstream flooding by storing, intercepting, or delaying surface runoff. Wetlands within the floodplain of a river can hold water that has overtopped river-banks. Floodwater desynchronization occurs when wetlands higher in the watershed temporarily store water, reducing peak flows. The most effective wetlands at providing desynchronization are generally located in the middle elevations of the watershed; these wetland locations are far enough away from the receiving water to create delay, but are low enough in the watershed to collect significant amounts of water.

Groundwater Recharge and Discharge

Wetlands are intimately associated with groundwater, and some wetlands can function to recharge underlying aquifers. Wetlands are sources of groundwater discharge that may help extend streamflows into the drier summer months. In eastern Oregon, restoring wet meadows in stream headwaters has extended the seasonal duration of streamflow.

Fish and Wildlife Habitat

Wetlands provide habitat and food for a variety of aquatic and terrestrial plant and animal species. Many species rely on wetlands for all or a portion of their life cycle. In addition to directly providing habitat, wetlands can directly support fish through some of the functions, discussed previously, that protect water quality and channel stability. Estuarine wetlands provide important feeding and holding areas for out-migrating salmon smolts.

B INTRODUCTION (GWEB 1999 and OSU 1998)

Wetlands are protected by federal, state, and local regulations. In order to plan for growth and development in a watershed, it is necessary to know where these resources are located. In addition, wetlands can contribute to critical functions in the health of a watershed as mentioned above. Determining the approximate location and extent of wetlands may be essential in solving problems within a watershed.

Purpose

The purpose of the wetland characterization is to gain specific information on the location and attributes of wetlands in the watershed, including size, habitat type, surrounding land use, connectivity, and opportunities for restoration. This process will also assist in determining the relationship between wetlands and problems in the watershed that are identified through other components in this assessment. In addition, this inventory will help watershed councils determine whether it is appropriate or necessary to collect additional data on wetland function.

National Wetlands Inventory and the Cowardin Classification System

The most widely available and comprehensive wetlands information in the United States is the U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI). The NWI has located and classified wetlands as well as mapped the entire aquatic ecosystem network. NWI maps contain information on location in the watershed, water regime, vegetation class or subclass, morphology, and sheet versus channel flow. The NWI is based on the Cowardin Classification System, which was published as the *Classification for Wetland and Deepwater Habitats of the United States*. It has four objectives:

1. To describe ecological units whose natural attributes are fairly homogenous
2. To arrange these units in a system that will help people make decisions about resource management
3. To provide information for inventory and mapping
4. To create standard concepts and terminology for use in classifying aquatic ecosystems

A major weakness of the Cowardin system and the NWI is that the descriptions of mapped units often don't relate consistently to ecosystem functions. Because of the system's reliance on plant types as identifying criteria, wetlands that function very differently often are grouped into the same Cowardin class simply because they have the same vegetation.

Cowardin Classification's five major systems:

1. Marine (ocean): Consists of the open ocean overlying the continental shelf and its associated high-energy coastline. Marine habitats are exposed to the waves and currents of the open ocean and the water regimes are determined primarily by the ebb and flow of oceanic tides.
2. Estuarine (estuaries): Deepwater tidal habitats and adjacent tidal wetlands that are semi-enclosed by lands but have open, partially obstructed, or sporadic access to the open ocean, and in which open water is at least occasionally diluted by freshwater runoff from the land.
3. Riverine (rivers): Includes all wetlands and deepwater habitats contained within a channel, except: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) areas with water containing ocean-derived salts in excess of 0.5 parts per thousand.
4. Lacustrine (lakes): Includes wetlands and deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, mosses, or lichens with greater than 30% areal coverage; and (3) total area exceeds 8 hectares (20 acres).
5. Palustrine (marshes): Includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5 parts per thousand.

These systems are divided into subsystems, which reflect water flow regimes (subtidal, intertidal, etc.). The subsystems are then divided into many different classes, which reflect structural vegetative characteristics (e.g. RB Rock Bottom, UB Unconsolidated Bottom, etc.). The classification of a mapped wetland is coded by a series of letters and numbers. The first letter of the code represents the system, the subsequent number represents the subsystem and the next two letters indicate the class. All Cowardin codes have more than three letters and/or numbers. These additional characters represent more specific information about each wetland. Generally, however, the first three letters and numbers of each code are the most important for the purpose of this assessment. A summary of the Cowardin Classification Codes is provided below. These codes will be helpful in identifying restoration opportunities within the Hubbard Creek and Brush Creek watersheds.

Due to the common occurrence of Palustrine wetlands, specific descriptions of five common classes are provided as follows:

1. EM Emergent: Dominated by rooted herbaceous plants, such as cattails and grass.
2. FO Forested: Dominated by trees taller than 20 feet.
3. OW Open Water: No vegetation evident at the water surface.
4. SS Scrub-Shrub: Dominated by shrubs and saplings less than 20 feet tall.
5. UB Unconsolidated Bottom: Mud or exposed soils.

Summary of Cowardin Classification Codes

System	Subsystem	Class	
M= Marine	1 = Subtidal	RB Rock Bottom UB Unconsolidated Bottom AB Aquatic Bed	RF Reef OW Open Water/Unknown Bottom
	2 = Intertidal	AB Aquatic Bed RF Reef	RS Rocky Shore US Unconsolidated Shore
E= Estuarine	1 = Subtidal	RB Rock Bottom UB Unconsolidated Bottom AB Aquatic Bed	RF Reef OW Open Water/Unknown Bottom
	2 = Intertidal	AB Aquatic Bed RF Reef SB Streambed RS Rocky Shore	US Unconsolidated Shore EM Emergent Wetland SS Scrub/Shrub Wetland FO Forested Wetland
R= Riverine	1 = Tidal	RB Rock Bottom UB Unconsolidated Bottom AB Aquatic Bed SB Streambed	RS Rocky Shore US Unconsolidated Shore EM Emergent Wetland OW Open Water/Unknown Bottom
	2 = Lower Perennial	RB Rock Bottom UB Unconsolidated Bottom AB Aquatic Bed RS Rocky Shore	US Unconsolidated Shore EM Emergent Wetland OW Open Water/Unknown Bottom
	3= Upper Perennial	RB Rock Bottom UB Unconsolidated Bottom AB Aquatic Bed	RS Rocky Shore US Unconsolidated Shore OW Open Water/Unknown Bottom
	4 = Intermittent	SB Streambed	
L= Lacustrine	1 = Limnetic	RB Rock Bottom UB Unconsolidated Bottom	AB Aquatic Bed OW Open Water/Unknown Bottom
	2 = Littoral	RB Rock Bottom UB Unconsolidated Bottom AB Aquatic Bed RS Rocky Shore	US Unconsolidated Shore EM Emergent Wetland OW Open Water/Unknown Bottom
P= Palustrine	→	RB Rock Bottom UB Unconsolidated Bottom AB Aquatic Bed US Unconsolidated Shore ML Moss-Lichen Wetland	EM Emergent Wetland SS Scrub/Shrub Wetland FO Forested Wetland OW Open Water/Unknown Bottom

Source: Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. US Fish and Wildlife Service, FWS/OBS-79-31, Washington DC.

C METHODOLOGY

1. NWI Maps: NWI maps (scale 1:24,000) were obtained for the majority of private lands within the Hubbard Creek and Brush Creek watersheds. These maps were utilized as the base maps for identifying wetlands within the watershed. Wetlands considered in this assessment were labeled on corresponding NWI maps.
2. Wetland ID: Wetland IDs were determined by lumping or splitting individual Cowardin units. The lumping/splitting process was performed on the basis of vegetative and hydrologic similarities, land usage, buffer classification, and restoration potential of adjoining Cowardin units. A Wetland ID (1, 2, 3, etc.) was assigned to each group and labeled on the NWI map. Cowardin Classification Codes characteristic of each wetland were listed in Table 23. (Several Wetland IDs consist of more than one code.) Wetlands beginning with the letter "R" (riverine) were not considered due to the very complex NWI mapping that can occur near stream channels.
3. Color Code: Each Wetland ID was color-coded on the NWI maps to assist in locating a wetland listed on Table 15.
4. Size: The size of each wetland was estimated using a mylar template. The minimum size of a wetland assessed was approximately 1.5 acres. **Note:** A slight margin of error in size estimation was possible.
5. Connectivity: Surface-water connection between each wetland and stream was estimated. A wetland was considered connected if some part had a surface-water connection to a seasonal or perennial surface-water-body, including natural and man-made channels, lakes, or ponds. For terraces alongside major channels that are routinely flooded, the presence of a well-defined channel or depression that lacked vegetation but may potentially lead to a channel constituted a surface-water connection. Similarly, ditched pasture-land also qualified as connected.
6. Watersheds: Watersheds were identified for each wetland.
7. Buffer: Using aerial photographs, the dominant land use within 500 feet of a wetland's edge was characterized using the following codes: FO = forest or open space, AG = agriculture (pasture, crops, orchards, range land), R = rural (mix of small-scale agriculture, forest, and/or rural residential), or D = developed (residential, commercial, industrial). Where more than one land use exists, the dominant (>50% of the area) was listed.
8. Watershed Position: Using the USGS topographic maps, each watershed was divided into thirds to determine the general location of each wetland within the basin. The position of a wetland was characterized as highest, middle or lowest in position. Elevation changes were considered in determining the watershed position.
9. Degree of Alteration: A degree of alteration (Low, Moderate or High) was assigned to each wetland on the basis of past impacts. Examples of these alterations/impacts include clearing, grading, filling, ditching/draining or diking in or near a wetland.
10. Comments: Comments were primarily focused on describing the status of the existing use of the wetland (i.e. drained, converted, quality of pasture). These descriptions should be considered when determining the "likelihood" of restoration potential.

11. Other: Aerial photographs (1997 BLM) were used to assist in determining each wetland's connectivity to stream channel, adjacent land use, and ultimately for the determination of restoration potential and comments portions of the assessment.

D RESULTS

Table 15 Port Orford Wetland Attributes

E KEY FINDINGS

- An estimated 21.5 acres of wetlands, located outside the Local Wetland Inventory area, were assessed in the Port Orford watersheds. This acreage was divided into four *Wetland ID's*; each of which is comprised of one or more NWI delineated wetlands.
- The degree to which the assessed wetlands have been altered is as follows: high; 0%, moderate, 65%; and low, 35%.
- Of the four wetlands assessed, one has some riparian restoration potential and the other three should be protected in their present state.
- All of the wetlands have a surface water connection to another body of water.
- All of the wetlands were buffered by rural surroundings.
- The two "moderately" altered wetlands occur in the Hubbard Creek watershed while the two "low" altered wetlands occur in Brush Creek watershed.
- All wetlands considered in this assessment were located in the lowest watershed position. *See Methodology for explanation of watershed position.*

F DISCUSSION

The GWEB Oregon Watershed Assessment Manual defines the "Restoration Potential" of a wetland based on its degree of alteration. This implies that a wetland considered to have a low degree of alteration, such as a properly functioning wetland, should be rated as low restoration potential. In contrast, a wetland considered to have a high degree of alteration, such as one currently managed for pasture, should be rated as high restoration potential. Although this method is a true characterization of a typical wetland it can be quite misleading because it overlooks certain socioeconomic factors. Often, the most altered wetlands are those that currently serve as prime agricultural lands and, in many cases, may realistically offer only low restoration opportunities. Therefore, the term "Restoration Potential" has been exchanged for a more accurate term – "Degree of Alteration".

The actual restoration of a wetland should be based on many considerations including opportunities to protect properly functioning wetlands and enhance marginal wetlands as well as the landowner's willingness to convert a pasture back to a wetland. Ensuring adequate protection for a properly functioning wetland will typically prove more cost effective than restoration of a non-functional wetland. However, in some cases, the physical and biological benefits associated with restoring a wetland may merit significant costs.

G OTHER

Local Wetland Inventory

The following paragraphs were adapted from the Port Orford Local Wetland Inventory, prepared for the City of Port Orford by Beak Consultants Incorporated.

Local Wetland Inventories (LWIs) in the State of Oregon provide important information for local governments and land owners planning future urban growth and development. Wetland inventories within Urban Growth Boundaries (UGBs) and areas of high development pressure are also necessary to complete state planning requirements. The Oregon Division of State Lands (DSL), under a grant from the U.S. Environmental Protection Agency, conducted wetland inventories and assessments in six Oregon communities in 1995. Beak Consultants Inc. was contracted to perform the LWI and assessment for the City of Port Orford.

Beak performed an LWI within the Port Orford UGB to identify the boundaries of wetlands greater than 0.5 acres. Approximately 191 acres, divided into forty-five distinct wetlands were identified within this area. Field data were collected at 81 sample locations between July 5 and 12, 1995 and April 12 and 13, 1999. The 1999 visit was made to collect additional information for performing the Oregon Freshwater Wetland Assessment Methodology (OFWAM) (Roth et al. 1996), refining the previous LWI, and assessing riparian areas.

For more information pertaining to the Port Orford Local Wetland Inventory contact the City of Port Orford.

REFERENCES

GWEB 1999. Oregon Watershed Assessment Manual. Governor's Watershed Enhancement Board, July 1999

OSU 1998. Watershed Stewardship - A Learning Guide, Oregon State University Extension Service, July 1998

Roth, E.M., R.D. Oleson, P.L. Snow, and R.R. Sumner. 1996. Oregon Freshwater Wetland Assessment Methodology. Ed. By S.G.McCannell. Oregon Division of State Lands. Salem, OR.

IX HYDROLOGY

A BACKGROUND (GWEB 1999)

Hydrologic Cycle

The hydrologic cycle describes the circulation of water around the earth, from ocean to atmosphere to the earth's surface and back to the ocean again. Oceans, covering 70% of the earth's surface, play a large role in the movement of water through this cycle. Solar energy evaporates water from the ocean, wind carries the water over the land surface, and water is precipitated by gravity back to the earth. Rain is the most common form of precipitation, but snow, hail, dew, fog, drip, and frost all can bring water into a watershed. Precipitation that reaches the earth can move through three different pathways. Water can:

- Be intercepted by vegetation and evaporated or transpired back to the atmosphere
- Move down-slope on the surface or through soil to a stream system, eventually returning to the ocean
- Be stored in snowpack, groundwater, ponds, or wetlands for a variable period of time

Land Use Impacts on Hydrology

Land use practices can modify the amount of water available for runoff, the routing of water to the streams, the lag time (delay between rainfall and peak streamflow), the flow velocity, or the travel distance to the stream. Land use practices that affect the rate of infiltration and / or the ability of the soil surface to store water are typically most influential in affecting the watershed's hydrology. Using this as an indicator for comparison among the land uses, forest harvesting produces the smallest change in the infiltration rate, thereby producing the smallest impacts to the hydrologic regime of a basin. Forest harvest practices have evolved such that land compaction can be minimized; however, roads and grazing in these watersheds decrease the infiltration rate. In contrast to forest harvest, agricultural practices, rangeland utilization for grazing purposes, and urban development can all involve compaction of the soils and / or paved surfaces, resulting in substantial alteration of the infiltration rate. Agricultural practices and urban development directly involve altering the shape of the drainage system by ditching, channelizing, or using piped stormwater networks which decrease the infiltration and the travel time of subsurface flow to reach the channel. This effect can be much worse in high-flow conditions. While forest harvest practices are not always practiced at sustainable rates, they are temporary conversions of vegetation, and the hydrologic effects diminish as vegetative regrowth occurs. Conversion of lands to agriculture or urbanization produces generally longer-lasting effects. Road construction, associated with all land uses, alters the rate of infiltration on the road surface and replaces subsurface flow pathways with surface pathways resulting in quicker travel time to the channel network.

B INTRODUCTION

The Hydrologic Condition Assessment is a "screening" process designed to identify land use activities that have the potential to impact the hydrology of the Port Orford watersheds. Alterations to the natural hydrologic cycle potentially cause increased peak flows and/or reduced low flows resulting in changes to water quality and aquatic ecosystems. The degree to which hydrologic processes are affected by land use depends on the location, extent, and type of land use activities. When potential impacts are recognized, best management practices can be followed to minimize some of the potential hydrologic impacts; mitigation will be necessary to address other impacts.

The GWEB Oregon Watershed Assessment Manual provides a set of methods to prioritize those subwatersheds most likely to need restoration from a hydrologic perspective. Because hydrology is such a complex subject, the screening process only deals with the most significant hydrologic process affected by land use (i.e., runoff). The assessment does not attempt to address every hydrologic process potentially affected; the goal is to gain an understanding of the major potential impacts.

General Watershed Characteristics

A Geographic Information System (GIS) analysis was conducted to provide general watershed characteristics pertaining to the Hydrologic Condition Assessment of the Port Orford watersheds. The GIS shapefile used in this portion of the assessment is titled "Precipitation, Average Annual", available from the Southwest Oregon Province GIS Data CD Minimum elevations, maximum elevations and maximum elevation locations were determined using USGS 7.5 Minute Quads.

Table 16 General Watershed Characteristics

Watershed	Watershed Area (square miles)	Mean Annual Precipitation (inches)	Minimum Elevation (feet)	Maximum Elevation (feet)	Maximum Elevation (Location)
Brush Creek	11.0	123	0	3,040	Rocky Peak
Garrison Lake	3.14	80	<20	400	No Name
Hubbard Creek	6.7	91	0	1,520	China Mtn.
Totals	**20.8**				

Land Use Summary

A GIS analysis was conducted to determine land use using two shapefiles titled "Port Orford Watersheds", available from the South Coast Watershed Council, and "Vegetation", available from the Southwest Oregon Province GIS Data CD. This data was used to characterize land use by lumping several vegetation types into three categories: (1) Forestry and (2) Agriculture/Range and Rural Residential and (3) Urban.

Note:

Urban areas were confined to the Garrison Lake subwatershed. Although some agricultural, range and rural residential areas are likely situated within this watershed it was beyond the scope of this assessment to determine the total area for each specific use.

Table 17 Watershed Land Use Summary

Watershed	Forestry		Agriculture/Range & Rural Residential		Urban		Water		Total
	Acres	%	Acres	%	Acres	%	Acres	%	Acres
Brush Creek	7,033	99.8	12	0.2			3		7,048
Garrison Lake	783	38.9			1,098	54.6	131	6.5	2,012
Hubbard Creek	3,919	91.6	359	8.4					4,278
Total Acres & Percents	11,735	87.9	371	2.8	1,098	8.2	134	1.0	13,338

<u>Individual Screening Procedures</u>
Four separate screening procedures were developed to evaluate land use impacts on hydrology in the Port Orford watersheds:

C FORESTRY
D AGRICULTURE/RANGELANDS
E FOREST AND RURAL ROADS
F URBAN

C1 FORESTRY IMPACTS ON HYDROLOGY

The potential effects of forest practices on hydrology include changes in peak flows, water yield, and low flows. There are two primary mechanisms by which forest practices in the Pacific Northwest watersheds impact hydrologic processes: (1) the removal and disturbance of vegetation, and (2) the road network and related harvesting systems.

Removal of vegetation reduces interception and evapotranspiration, both of which allow additional water to reach the soil surface during rainstorms. Additionally, open areas accumulate more snowpack which can potentially produce an increase in water yield.

Forestry-related effects on peak flows may be a function not only of harvest and vegetative cover issues, but also of the type of hydrologic process that occurs in a basin. Increased peak flows, associated with rain on snow events present the greatest likelihood of problems caused by timber harvest. While rain on snow conditions can occur at almost any elevation, given a specific combination of climatic variables, the probability of rain-on-snow enhancement of peak flows differs with elevation and, to a lesser degree, aspect. The highest probability of encountering rain-on-snow conditions occurs at mid-elevations where transient snowpacks develop but not at great depths. The lowest probability occurs in the lowlands, where snowpack rarely occurs and, at the higher elevations, where winter temperatures are too cold to melt snow. The elevation of the lower boundary of the rain-on-snow zone will vary geographically and often by ecoregion.

C2 METHODOLOGY

1. The screen for potential forestry impacts on hydrology was focused on timber harvest. A GIS analysis was conducted to determine total area of transient snow elevation zones by subwatershed. The GIS shapefile used in this portion of the assessment is titled "Transient Snow Elevation Zones", available from the Southwest Oregon Province GIS Data CD.

2. Peak flow generating processes were identified for each subwatershed and characterized as rain or rain-on-snow. Peak flow generating processes within elevation zones of 0' to 2,500' are characterized as rain. In the relatively high elevations snow accumulations are considered transient; snow levels may fluctuate daily, weekly or monthly throughout the winter season. The peak flow generating process in these higher elevations (>2,500') is characterized primarily as rain on snow. However, only occasional storms result in peak flows generated by rain-on-snow conditions (Weinhold USFS).

C3 RESULTS

Table 18 Transient Snow Elevation Zones & Peak Flow Generating Processes

Watershed	Area (acres)	Rain Zone 0'-2500' (acres)	Rain Zone % Area	Rain on Snow Zone 2500'-3000' (acres)	Rain on Snow Zone % Area	Rain on Snow Zone 3000'-3500' (acres)	Rain on Snow Zone % Area
Brush Creek	7,048	6,906	97.9	145	2.1	1	0.0
Garrison Lake	2,012	2,012	100.0	0	0.0	0	0.0
Hubbard Creek	4,278	4,278	100.0	0	0.0	0	0.0
Total Acres	13,338	13,194	98.9	145	1.1	1	0.0

C4 KEY FINDINGS

- Brush Creek and Hubbard Creek have over 90% of their areas in forestry use. Garrison Lake has 39% in forest use; 55% in urban use; and 6% of the area is water (Garrison Lake).

- Results indicate that approximately 99% of the Port Orford watersheds are located within the lowest elevation zone of 0' to 2,500'. Peak flow generating processes in this elevation zone are rain dominant. Elevation zones of the remaining 1% of the watersheds are located within rain on snow zones between 2,500' and 3,500'. These areas are located in the Brush Creek watershed.

- The GWEB Oregon Watershed Assessment Manual suggests characterizing watersheds with more than 75% in the rain category as low potential risk of peak flow enhancement. Since all watersheds fall within the rain category a <u>low</u> potential risk of peak flow enhancement was assigned throughout the entire basin.

- Further analysis of forestry and surface runoff effects should be conducted on those subwatersheds where >50% of the hydrologic soil groups are in classes C and D.

C5 DISCUSSION (Stewart 2001)

Peak flows and low flows are the hydrologic processes most significantly impacted by land use activities. By removing more than 30% of a forested landscape the amount and timing of runoff can be altered. This concept is more evident in small local drainages, where some important spawning and rearing of salmonids occur, than at the mouth of a main river.

In addition to land use impacts that cause increased flows from timber harvest, the reduced infiltration capacity of the soil is also a concern. Impervious surfaces and roads are good indicators of urbanization and subsequent impacts to the hydrology of a watershed. However, this is only part of the problem. One needs to determine the percent of land surface compacted during forest harvest. Most literature cites 12% of land in a compacted state to be capable of increasing surface runoff. Many of the south coast watersheds were logged with ground based equipment or cable systems known for poor suspension of logs (Hi-Lead). These harvest systems could have compacted 20-40% of the land surface to a point where infiltration would be impaired and runoff increased.

Compounding the area of harvest and impacts to infiltration from the harvest method, the natural state of the soil in some portions of the watershed is very poor. Hydrologic Soil Group (HSG) ratings C and D have minimum infiltration rates of 1-4 and 0-1 mm/hr. respectively. Converting 0.1 inches of rain/hr. to mm/hr. equals 2.54 mm/hr. One-quarter (0.25) inch of rain/hr. exceeds the infiltration capacity of HSG-C by about 50% and HSG-D by over 600%. Given that these soil groups also correspond with areas of high precipitation the runoff effects are naturally high. Harvest removal and compaction further increase this effect.

Further analysis is warranted to look at the level of timber harvest within the watershed. Simply stating that forested areas within rain-dominated areas have a low risk of increasing peak flows is simply untrue. Past practices may still be impacting the routing of water and causing channel modifications or increased sediment routing/turbidity conditions. This would be detrimental to fish habitat and/or fish populations. One suggestion is to obtain and interpret historical photos of the watershed. When viewed on a large scale, specific areas of impact may stand out and provide some indication of historical levels of compaction and timber harvest.

D1 AGRICULTURAL & RANGELAND IMPACTS ON HYDROLOGY

Agricultural practices have most often been implemented along valley bottoms, floodplains, and other adjacent low-gradient lands. An often long-lasting change in the vegetative cover occurs from the conversion of the landscape from forested woodlands, prairie grasslands, or other natural environs, to agricultural use. Clearing for pasture or crop production has also entailed land-leveling or topographic changes of the landscape. Leveling and field drainage has resulted in the elimination of many wetlands and depressions that previously moderated flood peaks by providing temporary storage.

Without wetlands and depressions, surface and subsurface runoff move more quickly to the channel network.

Common channel modifications such as ditches, constructed to drain land, and channel straightening were created to maximize agricultural land use. These practices result in increased velocities of surface and subsurface flows that correspondingly decrease infiltration opportunities. Decreased infiltration produces increased runoff and subsequent decreased baseflows during the low-flow season.

The impact of agriculture on hydrology is dependent on specific practices such as the type of cover and management treatments, as well as the characteristics of the soil being farmed. Practices that change infiltration rates are most likely to change the hydrologic regime. The infiltration rates of undisturbed soils vary widely. Agriculture has a greater effect on runoff in areas where soils have a high infiltration rate compared to areas where soils are relatively impermeable in their natural state (USDA 1986).

The Natural Resources Conservation Service (NRCS) has characterized and mapped the soils throughout the state. As part of the mapping process, soils are classified into one of four hydrologic soil groups primarily as a function of their minimum infiltration rate on wetted bare soil. As part of the NRCS methods (USDA 1986), runoff curve numbers are assigned to areas for each of the combination of three parameters: (1) soil group, (2) cover type, and (3) treatment or farming practice.

NRCS hydrologic soil group classification (USDA 1986)

Low Runoff Potential	**Hydrologic Soil Group**	**Soil Characteristics**	**Minimum Infiltration Rate (mm/hr)**
	A	High infiltration rates even when thoroughly wetted. Deep, well-drained sands or gravels with a high rate of water transmission. Sand, loamy sand, or sandy loam.	8 – 12
	B	Moderate infiltration rates when thoroughly wetted. Moderately deep to deep, moderately well-drained to well-drained, moderately fine to moderately coarse textures. Silt loam or loam.	4 – 8
	C	Slow infiltration rate when thoroughly wetted. Usually has a layer that impedes downward movement of water or has moderately fine to fine textured soils. Sand clay loam.	1 – 4
High Runoff Potential	D	Very low infiltration rate when thoroughly wetted. Chiefly clay soils with a high swelling potential; soils with a high permanent water table; soils with a clay layer near the surface; shallow soils over near-impervious materials. Clay loam, silty clay loam, sandy clay, silty clay, or clay.	0 – 1

Runoff curve numbers are used as part of a simplified procedure for estimating runoff in small agricultural and urban watersheds (USDA 1986). Curve numbers are assigned based on factors such as soils, plant cover, and impervious area. Rainfall is converted to runoff using Curve numbers.

Certain soil conditions can make farming difficult, so amending the soil structure by adding organic matter becomes a way in which farmers can maximize the use of their land. This practice can actually change the hydrologic soil group from, say, a C to a B. In this example, it is possible to reduce the runoff rather than increase it. To detect these changes at this screening level of assessments will be difficult. Voluntary actions and implementation of best management practices to improve soil texture and water holding capacity can be a benefit to the farmer as well as to the hydrology of the watershed.

Grazing animals impact rangelands in two ways: (1) removal of protective plant material, and (2) compaction of the soil surface. Both of these actions affect the infiltration rate (Branson et al. 1981). Cattle grazing on sparsely forested lands can have similar impacts and should be considered under this heading. In general, moderate or light grazing reduces the infiltration capacity to 75% of the ungrazed condition and heavy grazing reduces the infiltration by 50% (Gifford and Hawkins1979). Soil compaction, which decreases the infiltration rate, correspondingly increases the overland flow or surface runoff.

Impacts associated with the use of range lands can be assessed in a similar manner as agricultural lands. There is no statistical distinction between the impact of light and moderate grazing intensities on infiltration rates. Therefore, they may be combined for purposes of assessment. (Gifford and Hawkins 1979).

D2 METHODOLOGY

<u>Table 19</u>

1. Using a GIS shapefile titled "Soils" (SWOP CD), hydrologic soil groups were identified in agricultural and rangeland areas in each subwatershed. **Note:** Information pertaining to hydrologic soil groups in the Garrison Lake watershed was not included due to the prior determination that the primary land use was considered urban.

2. Using two GIS shapefiles titled "Port Orford Watersheds", available from the South Coast Watershed Council, and "Soils", available from the Southwest Oregon Province GIS Data CD, hydrologic soil groups (HSGs) were identified in agricultural and rangeland areas for each watershed. **Caution:** Due to the limitations of the available GIS data, no distinction was made between agricultural, rangeland and rural residential areas.

D3 RESULTS

Table 19 Agricultural Land Use and Rangeland Use Summary

Watershed	Total Area (acres)	*Area in Ag or Range Use (acres)	(%)	Hydrologic Soil Groups in Agricultural Lands or Grazed Lands: A (acres)	A (%)	B (acres)	B (%)	C (acres)	C (%)	D (acres)	D (%)
Brush Creek	7,048	12	0.2					6	50.0	6	50
Hubbard Creek	4,278	359	8.4	1	0.3	15	4.2	323	90.0	20	5.6
Total Acres & Percents	11,326	371	3.3	1	0.3	15	4.0	329	88.7	27	7.3

D4 KEY FINDINGS

- Due to the estimated small percentage of agriculture/range use within all watersheds no peak flow impact ratings were determined. Results indicate that 96% of the watersheds are within the Hydrologic Soil Group's C & D; these soils have very low infiltration rates. Further analysis of surface runoff effects correlated to amount of land covered with older (20-30+ years) forests is warranted. *(See Forestry Impacts on Hydrology.)*

- All areas in agriculture or range use can be considered in compacted state and elevating percent of runoff. However, more information is needed to determine an accurate estimate of agriculture or range use, especially within the Garrison Lake watershed.

E1 FOREST AND RURAL ROAD IMPACTS ON HYDROLOGY

Road networks associated with forestry can alter the rate of infiltration on the road surface and potentially change the shape of the natural drainage. The surface of most forest roads is compacted soil that prevents infiltration of precipitation. Forest road networks primarily increase streamflow by replacing subsurface with surface runoff pathways (e.g., roadside ditches) (Bowling and Lettenmaier 1997). Roads can also intercept and divert overland flow and shallow subsurface flow, potentially rerouting the runoff from one small sub-basin to an entirely different subbasin (Harr et al. 1975 and 1979). Roads can potentially impact peak flows during rainfall events, rain-on-snow events, or spring snowmelt; therefore, the determination of percent of basin occupied by roads provides useful information regardless of the way in which peak flows are generated.

Rural roads associated with either agriculture or rangelands can also affect streamflow and will be characterized in a similar manner as forest roads. Roadside ditches are more structured and maintained along rural roads and can significantly extend the stream network density, because their presence is additional to the natural channel. However, if natural channels are altered through straightening or channelizing, the stream network length may decrease. Channelizing streams results in increased velocities and potentially increases erosion rates of the banks and bed.

Roads along stream channels restrict lateral movement and can cause a disconnection between the stream or river and its floodplain. Restricting lateral movement can result in down-cutting of the channel and decreased accessibility of flood waters to over-bank storage, resulting in decreased flood peak attenuation.

E2 INTRODUCTION

The focus of the road assessment is to determine the quantity of roads within the watershed but does not account for the condition of the roads. A more refined scale to separate out well-built roads that do not accelerate the delivery of water or sediment to the channel from roads that are poorly constructed is beyond the scope of this section. For example, extension of the surface-water drainage network by roadside ditches is often a major influence of increased flows. Roads with proper culvert placement and frequency may alleviate some of these impacts.

The assessment of forest and rural road impacts on hydrology in the Port Orford watersheds is designed to determine what area of the forestry-designated portion of each subwatershed is occupied by roads, as well as by rural roads in agricultural or rangeland areas, and to rate subwatersheds for potential hydrologic impacts.

Potential Risk for Peak-Flow Enhancement

Percent of Forested Area in Roads	Potential Risk For Peak-Flow Enhancement
< 4%	Low
4% to 8%	Moderate
> 8%	High

E3 METHODOLOGY

Tables 20 & 21 (See Appendix)

1. Total watershed area (square miles) and total area of forestry and rural use (acres & square miles) of each subwatershed was determined using GIS analysis. *(See Land Use Summary for details.)* Results were entered in columns 2 through 4 of Tables 20 and 21.
2. Total linear distance of forest roads and rural roads were determined using GIS analysis. Results were entered in columns 5 of Tables 20 and 21.
3. Area of each subwatershed occupied by roads was determined by multiplying column 5 by the width of the road (in miles). The average width for forest roads was assumed at 25 feet (0.0047 miles). The average width for rural roads was assumed at 35 feet (0.0066 miles). Results were entered in column 6 of Tables 20 and 21.
4. The percent of area occupied by forest and rural roads in each subwatershed was computed. Results were entered in column 7 of Tables 20 and 21.
5. A relative potential for forest and rural road impacts was assigned to each subwatershed. Results were entered into column 8 of Tables 20 and 21.

E4 RESULTS

Table 20 Forest Road Area Summary

Table 21 Rural Road Area Summary

E5 KEY FINDINGS

- A low risk to increasing peak flows from forest roads is evident in all watersheds.

- A moderate risk to increasing peak flows from rural roads was determined to exist in Garrison Lake and Hubbard Creek watersheds. A low risk exists in Brush Creek.

- The relative potential for impact largely depends on the extent of roads identified in the analysis. In this assessment a significant amount of roads were not identified because, at the time, they were not available in GIS format. If this analysis were to be repeated using an updated and more complete road coverage the relative potential of impact on hydrology from roads would only increase. *(This updated road coverage is available as of June 2001.)*

F1 URBAN IMPACTS ON HYDROLOGY

The urban assessment relies on results from several studies in which the percent of imperviousness in a watershed was related to stream quality. Research has identified that the altered hydrologic regime of a watershed under urban conditions is the leading cause of physical habitat changes (May et al.1997). Schueler (1994) reviewed key findings from 18 urban stream studies relating urbanization to stream quality and concluded that stream degradation occurs at relatively low levels (10%) total impervious area.

Imperviousness is the most common measure of watershed development; however, it can be a time consuming exercise and costly to calculate. As such, a more economical method was selected in this assessment and was based on a relationship between watershed urbanization and subwatershed road density. This relationship was used to represent the percent imperviousness. In urban areas, when road densities equal or exceed 5.5 miles/square miles, percent total impervious area probably exceeds 10%. Road densities of 4.2 miles/square mile were associated with a percent total impervious area in a subwatershed of approximately 5%.

Estimating the area in the Garrison Lake subwatershed that is impervious was the basis for determining potential hydrologic impacts from urbanization.

F2 METHODOLOGY

1. Total area (square miles) and total area of urban use (acres & square miles) of each subwatershed was determined using GIS analysis. *(See Land Use Summary for details.)* Results were entered in columns 2 through 4 of Table 22.

2. Total linear distance of urban roads was determined using GIS analysis. Results were entered in column 5 of Table 22.

3. Road density was calculated by dividing the total linear distance of urban roads by the urban area (square miles). Results were entered in column 6 of Table 22.

4. A relative potential for peak-flow enhancement (column 7) was assigned to the Garrison Lake subwatershed.

Table 22 Urban Road Density Summary

1 Watershed	2 Area (square mi)	3 Area Urban (acres)	4 Area Urban (square mi)	5 Total Linear Distance of Urban Roads (miles)	6 Road Density Col. 5/4 (mi/square mi)	7 Relative Potential for Peak Flow Enhancement
Garrison Lake	3.1	1,098	1.7	15.7	9.2	High

F3 KEY FINDINGS

- The Garrison Lake watershed was assigned a high risk to increasing peak flow. Further investigation is warranted. However, some scrutiny should be applied with this assessment. It is uncertain to what degree the assessment's protocol applies to coastal lakes.

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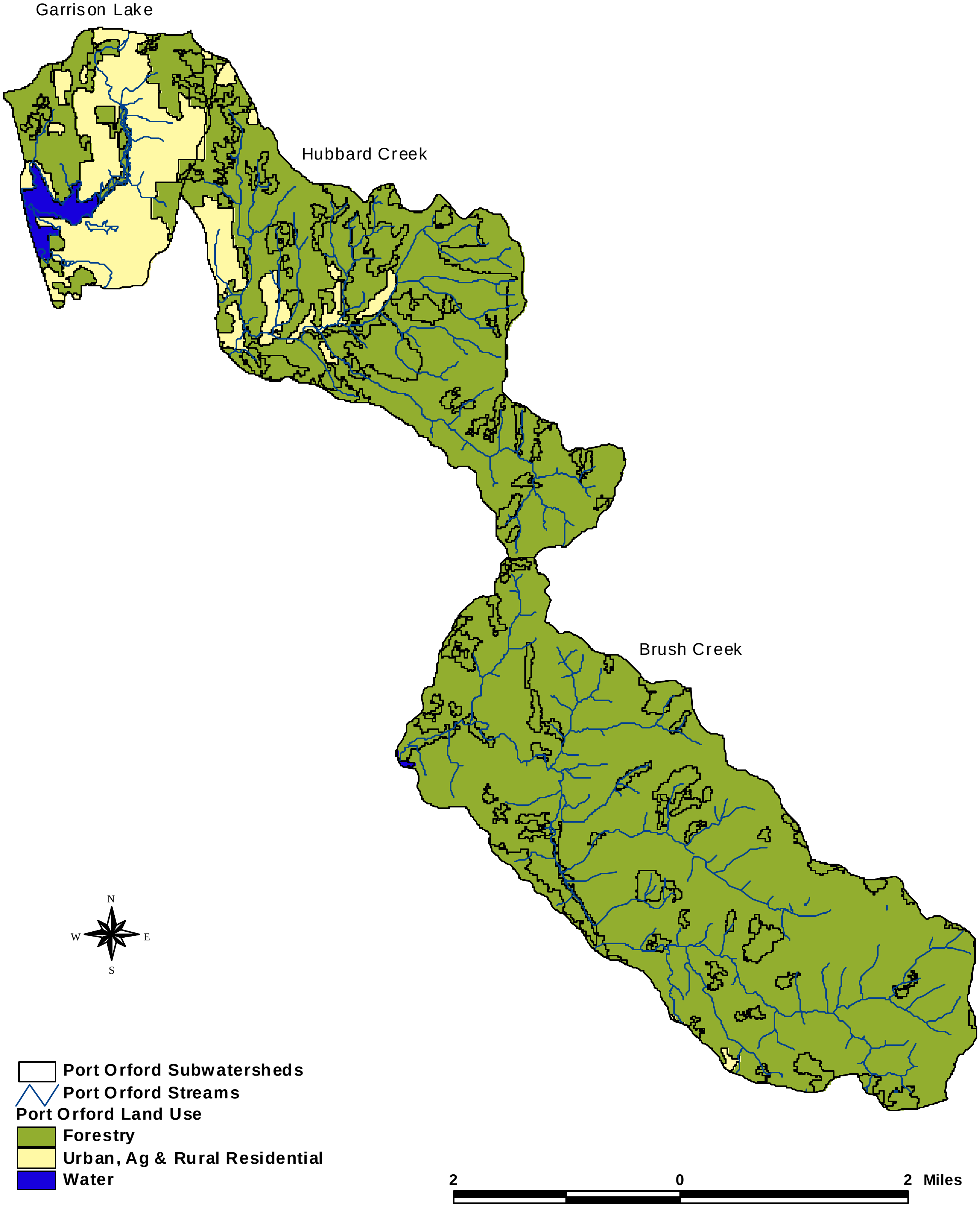
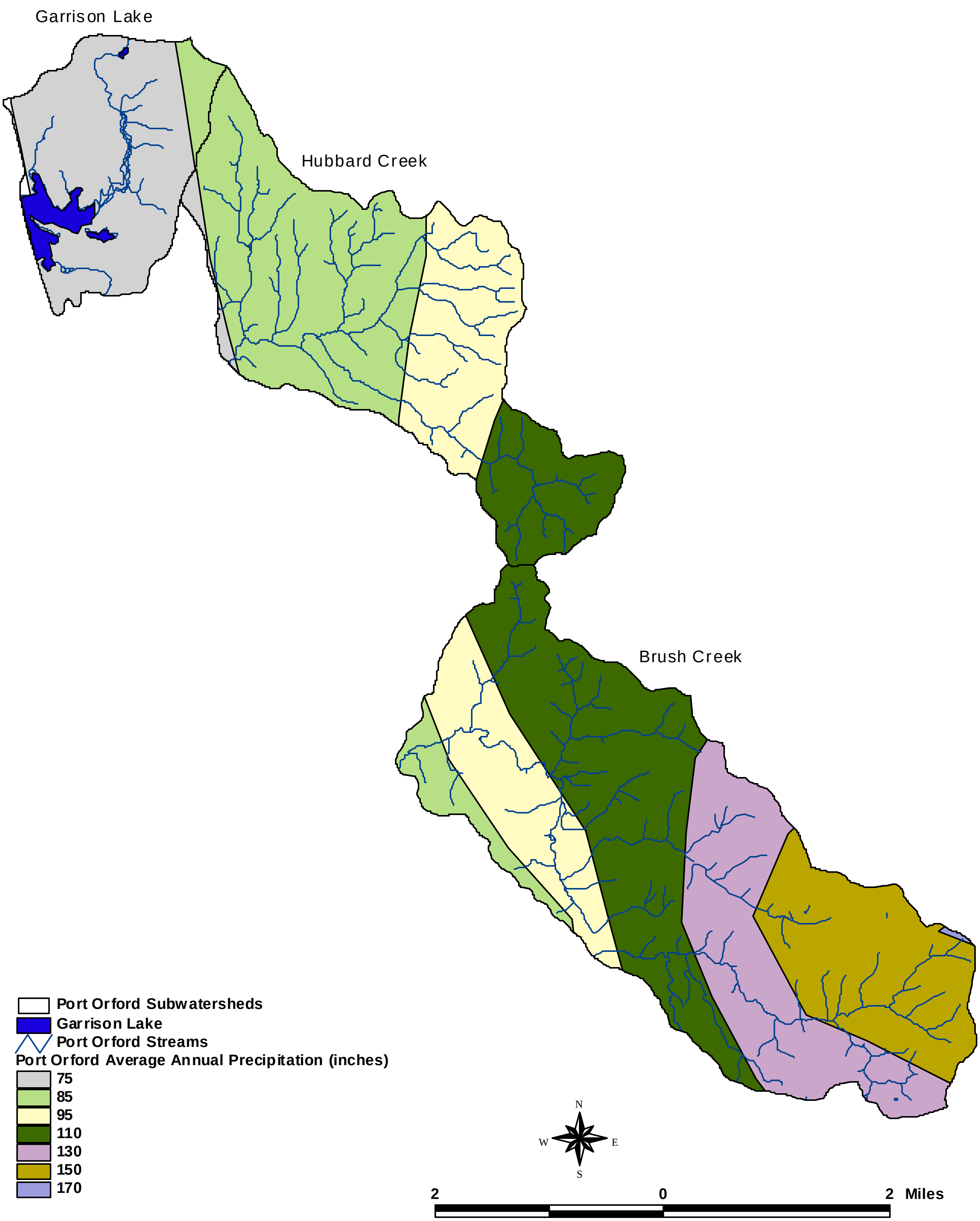
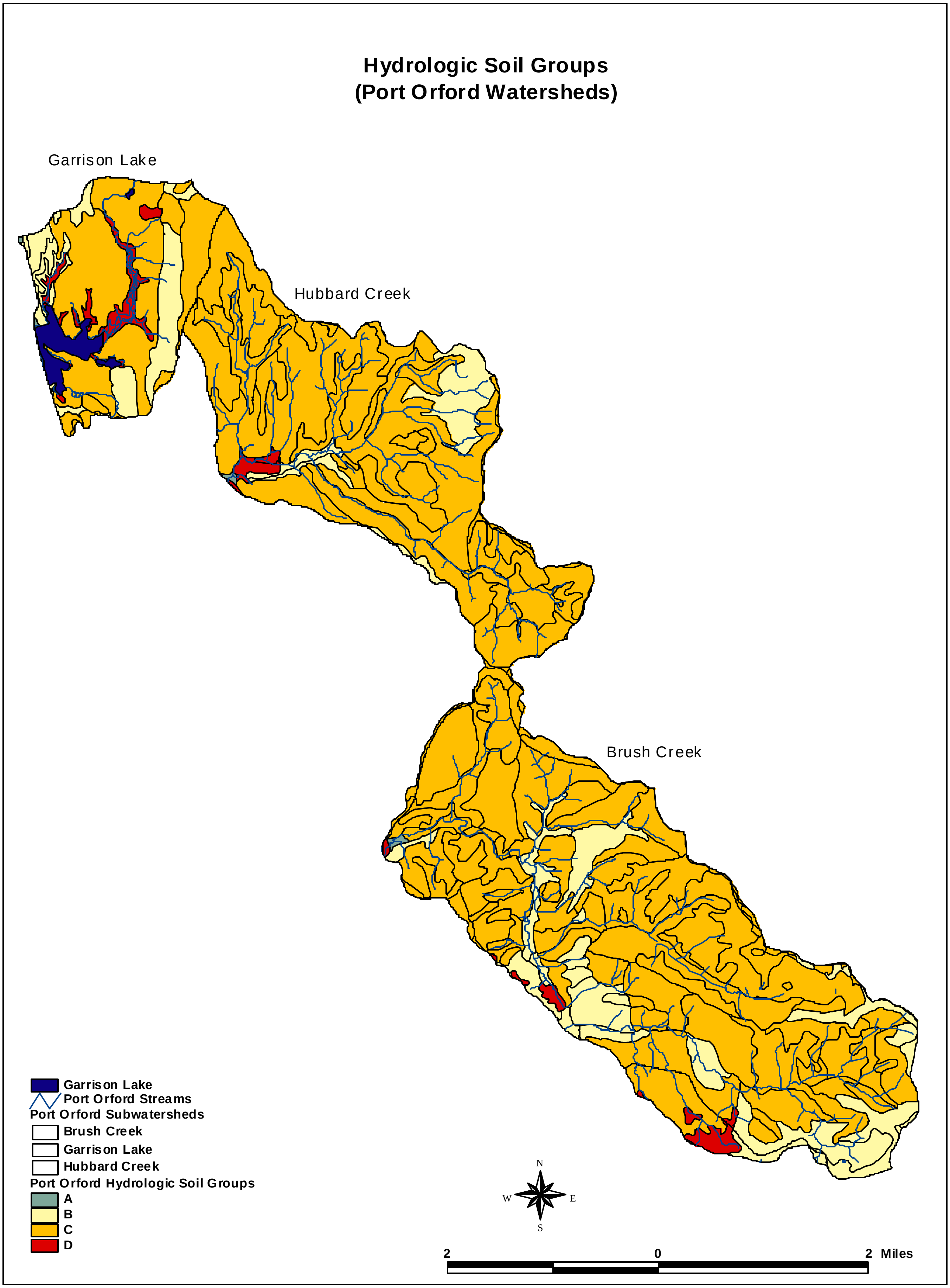
Land Use
(Port Orford Watersheds)



Average Annual Precipitation
(Port Orford Watersheds)





Hydrologic Soil Groups
(Port Orford Watersheds)
Garrison Lake
Hubbard Creek
Brush Creek
Garrison Lake
Port Orford Streams
Port Orford Subwatersheds
Brush Creek
Garrison Lake
Hubbard Creek
Port Orford Hydrologic Soil Groups
A
B
C
D
N
W
E
S
2
0
2 Miles

X WATER USE

A BACKGROUND (GWEB 1999)

Water Law and Water Use

Any person or entity withdrawing water from a stream or river must have a water right from the Oregon Water Resources Department (OWRD). These water rights are in various levels of use and certification or adjudication. For example, there are certificates, applications for certificates, water rights on record and not being used, and rights not using their entire full entitlement. Each water right has an instantaneous flow amount (the maximum rate at which water can be withdrawn at any point in time), an annual volume restriction (water duty), and a designated beneficial use, including agriculture, domestic, urban, industrial, commercial, fish and wildlife, power, recreation, etc. Water law in the State of Oregon is based on the Prior Appropriation Doctrine or "first in time, first in right," subject to the physical availability of water and the ability to put it to beneficial use without waste. The most senior appropriator (the right with earliest date) has a right to divert water prior to any junior right (a later date). The most senior right is the last one to be shut off from diverting water during low stream flows.

In general, agriculture places the greatest demand on our water resources compared to other uses. Water is required for irrigation of crop lands (e.g., cranberry production), pasture and stock watering. In most cases, the period of high demand for irrigation coincides with the period of low streamflow; crop water requirements tend to peak in August, when streamflows are usually the lowest. Water withdrawals are applied to the crop lands for irrigation, and part of that water is used by the crop (evapotranspiration), a portion percolates to deep ground water, and a portion may be returned to another watershed. The total portion not returned to the river is called consumptive use. The portion of the diversion that returns to the stream system through surface and subsurface avenues at points downstream is called return flow.

Urban water supply can provide for residential, commercial, and some industrial uses. Water is diverted, treated, and then distributed throughout a municipality. Subsequently, the wastewater is delivered to a sewage treatment facility where it is treated to a "primary" or "secondary" level and discharged to a stream or bay at a distinct location. In residential settings, for example, water is not actually consumed but returned to the stream network from wastewater facilities. An exception to this is lawn watering which may infiltrate to groundwater. Lawn-irrigation return flow occurs through subsurface avenues.

National forests, national parks, US Bureau of Land Management lands, Indian reservations, etc., are federal reservations. These entities maintain federal reserved rights for the purposes for which the reservations were established. Their priority date is the date the reservation was created. In many cases, reservations were established in the mid to latter part of the 19th century. Many of the federal reservation rights have been tried in the courts of law, and, more often than not, case law has set precedent of adjudicating (to settle judicially) federally reserved water rights. (Winters Doctrine).

Water Rights

There are three primary types of surface water rights: (1) out-of-stream rights, (2) storage rights, and (3) in-stream rights. Out-of-stream rights are also called "direct flow" or "run of the river" diversions. These rights entail withdrawing water directly from the channel with subsequent application for a specific beneficial use such as irrigation, domestic or urban water supply, industrial use, etc. Storage rights can be for on-stream or off-stream reservoirs. On stream reservoirs capture water as it flows into the reservoir. Water is stored until it is needed for the specified beneficial use, at which time it is released either into the channel and withdrawn downstream or released into the river to the storage site, and subsequent release and conveyance to the point of use. In-stream rights are those that require a designated quantity of water to remain in the stream or river for a specified beneficial use, most often for aquatic resources, wildlife, or aesthetics.

Water withdrawals reduce streamflows, potentially resulting in a negative impact on the biologic resources, particularly during the low-flow season. In recent years, in-stream water rights have become more common as a means of protecting the biologic resources. In-stream water rights did not exist in Oregon prior to 1955. Minimum flows were established by administrative rule in 1955, but they did not carry the full weight of a water right. Between 1955 and 1980, the Oregon Department of Fish and Wildlife conducted basin investigations from which minimum flows were recommended and adopted by rule. In 1987, the legislature changed the administrative rulemaking into an application process for a water right. OWRD holds the water right, but ODFW, Department of Environmental Quality, and State Parks can apply for an in-stream right. Minimum flows were changed into in-stream rights, and the date minimum flows were adopted became the priority date. The in-stream rights can have the value up to but not exceeding the median flow. In-stream rights tend to be junior to the majority of the out-of-stream water rights; this reduces their ability to maintain effective streamflows in the channel. If federal reserved rights for in-stream flows have been adjudicated, they would usually have the most senior right in the basin, because federal reservations were established before the implementation of the Prior Appropriation Doctrine.

Water users with large demands generally have storage rights, because reservoirs provide a more certain supply during low-streamflow conditions. The ability to capture streamflow during the high flows and use it during low flows can be a significant benefit to water users. In some instances, reservoirs are constructed as flood control facilities to provide attenuation of the peak flows and reduce downstream flooding and damage.

Groundwater rights are those attached to the withdrawal of water from a well. With some exceptions, all water users extracting groundwater as the source of supply must have a water right for the legal use of water. There are exempt uses that do not require a right. The most significant of these is rural residential water users; these users are limited to 15,000 gallons per day for noncommercial use and irrigation of less than 0.5 acres.

Groundwater has the potential to influence surface water by what is called hydraulic continuity. Depending on the location of the well and the geology in the area, water withdrawn can have a corresponding effect on the streamflow. In other words, it is possible for the extraction of groundwater to dry up a nearby stream during low flows. Consequently, the State of Oregon manages surface and groundwater rights conjunctively, which means there are times at which groundwater withdrawals will be shut down due to low flows in the channel.

Storage

Man-made storage facilities such as water supply reservoirs, flood control reservoirs, or multipurpose reservoirs impact the peak flows downstream of the impoundment. Each reservoir has its unique operating scheme, and therefore requires more detailed hydrologic investigations, often including release schedules, reservoir routing, etc.

Water Availability

The OWRD has developed a computer model, Water Availability Report System (WARS), which calculates water availability for any of their designated water availability basins (WABs) in the state. Water availability, as defined by the OWRD, refers to the natural streamflow minus the consumptive use from existing rights. It is the amount of water that is physically and legally available for future appropriation. If water is available, additional in-stream or out-of-stream rights may be issued. This value is dynamic and is often updated to account for issuance of new water rights.

The WARs program produces both the 80% exceedance and the 50% exceedance flows, along with the associated water availability under each condition. The 50% exceedance flow is the same as the median flow value. The median flow value means half the time the natural flows are above this value and half the time flows are below this value. The 50% exceedance flows were those used as an upper limit in developing in-stream rights for aquatic species and other in-stream beneficial uses. Water rights for out-of-stream use are issued only when water is available at the 80% exceedance level. (*This assessment considered only water availability at the 50% exceedance flows.)*

Salmonid Fish Considerations

Potential channel dewatering (zero flow in the channel) can present problems for spawning and fish passage. Typically, the spawning period that coincides with the lowest flow begins on approximately September 1 and extends through October. Rearing habitat in the summer also requires flow levels to be maintained. While these are the critical times of the year, flow levels throughout the year need to be maintained to cover all life stages of all species present in a watershed.

Streamflow Restoration Priority Areas

Oregon's Departments of Fish and Wildlife and Water Resources collaborated to develop the Streamflow Restoration Priority Areas (SRPA). This effort was an outcome of the Oregon Plan (1997), which is the broader framework for the Coastal Salmon Restoration Initiative (CSRI). The CSRI mission is to restore coastal salmon populations and fisheries to sustainable levels. Three major factors were identified in CSRI as exacerbating the loss of fish populations: (1) fish resources, (2) fish habitat, and (3) loss of streamflow. The loss of streamflow is the focus of the SRPA analysis.

The identification of priority areas was based on a combination of biological factors and water use. ODFW identified priority areas to enhance fish populations. A rank was assigned to three categories under fisheries: (1) fish resources; (2) habitat integrity; and (3) risk factors such as listing under the Endangered Species Act, in-stream flow protection, or natural low-flow problems. OWRD identified areas in which an opportunity existed to enhance in-channel flows, situations under which water could by saved through conservation, efficiency of use, etc. The criteria for water resources was assigned to two categories: (1) consumptive use by percentage of the median (50% exceedance) streamflow, and (2) number of months an in-stream water right is not met. A priority was established based on the combination of the two resulting factors: "need" (fisheries) and "optimism" (water resources). Determination of the South Coast Flow-Restoration Priorities requires that the "need" rank 3 or 4 and the "optimism" rank 2, 3, or 4. In the need and optimism column, 1 is the lowest rank and 4 is the highest.

Basin	Flow Restoration		
	Need	**Optimism**	**Priority**
South Coast	1 or 2	1	No
	3 or 4	2,3 or 4	Yes

B INTRODUCTION

Water use is generally defined by beneficial use categories such as municipal, industrial, irrigated agriculture, etc. The Water Use Assessment summarizes the water rights in the Port Orford watersheds and intends to provide an understanding of what beneficial uses these water withdrawals are serving. The assessment of water use is primarily focused on low-flow issues. While low-flow issues can be extremely important, they are difficult to characterize at the screening level. Water use activities can impact low flows, yet the low flows can be enhanced through adopting water conservation measures to keep more water in the stream system.

The basis for the water use assessment is the output from the Water Availability Reports System (WARS) and other data provided by the OWRD. Their system has accounted for consumptive use and presents the best available information at this time.

C METHODOLOGY

Out-of-Stream Rights

- Water rights information was obtained from the OWRD Water Rights Information System (WRIS) files. Although not presented in this document, information relevant to the assessment of water use was summarized, sorted and listed by date.

Storage Rights

- Storage rights (measured in Acre Feet) were identified for each of the Port Orford watersheds.

Table 23 In-Stream Rights

- In-stream Rights were obtained by request from the OWRD.

Table 24 Streamflows

- Streamflows measured by the Oregon Department of Water Resources in August 2000.

Table 25 Water Availability Summary (See Appendix)

- Water Availability Reports were obtained from the OWRD web site.
- Net water available, at the 50% exceedance level, for each month and for each Water Availability Basin (WAB) within each watershed was listed.
- For each month and each WAB the "net water available" less than or equal to zero was highlighted to indicate that water is not available at the 50% exceedance level.

Streamflow-Restoration Priority Areas

- Priority WABs, designated as streamflow restoration priority areas, were identified for each applicable season.

D RESULTS

Out-of-Stream Rights

- Out of stream rights for Brush Creek total approximately 0.25 CFS.
- Out of stream rights for Garrison Lake total approximately 3.6 CFS.
- Out of stream rights for Hubbard Creek total approximately 1.7 CFS.

Storage Rights

- Storage rights for Brush Creek total 2.6 AF
- Storage rights for Garrison Lake total 23.5 AF
- Storage rights for Hubbard Creek total 18.3 AF

Table 23 In-Stream Water Rights

Location	Reach (From/To)	Certificate #	CFS			Priority Date
			July	August	September	
Hubbard Creek	Unnamed Tributary River Mile 1/RM 0	73135	7.97	5.23	3.5	11/4/92
Brush Creek	Bear Trap Cr. / River Mile 0	72889	14.1	9.22	6.85	1/29/93

Table 24 Streamflows

Location	2000 Date	Flow (cfs)
*Hubbard Creek above North Fork	August 1	5.2
*North Fork Hubbard Creek near mouth	August 1	0.4

**All flows from Oregon Department of Water Resources are provisional data pending final review.*

E KEY FINDINGS

Out of Stream and Storage Rights

- The primary use for water rights in Garrison Lake is cranberry use.
- The largest user on Hubbard Creek is municipal (1.25 CFS).
- Water rights on Brush Creek are very minimal (0.25 CFS).

In-Stream Rights

- Both Hubbard and Brush Creeks have in-stream rights that vary from month to month during the summer. These in-stream rights are relatively recent (1992 & 1993) compared to most larger basins in Curry County. The implication pertaining to when the in-stream right was adopted is significant because many users will likely have "senior" water rights. Unlike "junior rights" senior water rights are not regulated if actual flows fall below the flows associated with the in-stream rights.

Water Availability Summary

- The net water available at the 50% exceedance level, from May to October, is less than or equal to zero for both Hubbard Creek and Brush Creek basins. No data/information was found pertaining to Garrison Lake.

Streamflow Restoration Priority Areas

- According to the ODFW/OWRD Streamflow Restoration Priority Areas there are no priority Water Availability Basins in the Port Orford watersheds.

REFERENCES

GWEB 1999. Oregon Watershed Assessment Manual. Governor's Watershed Enhancement Board, July 1999

XI WATERSHED SYNTHESIS

The watersheds near Port Orford include Brush Creek, Hubbard Creek, and Garrison Lake. All are small, independent, and flow into the Pacific Ocean. Hubbard Creek is contained within the Southern Oregon Coastal Mountains (48%), Coastal Lowlands (37%), and Coastal Uplands (14%). Brush Creek is Southern Oregon Coastal Mountains (57%) and Coastal Uplands (43%). Garrison Lake is contained entirely within the Coastal Lowlands ecoregion. Approximately 69 percent of the Port Orford watersheds are privately owned.

Garrison Lake has had a historic pattern of cycling between lake and lagoon. The watersheds have been mined for gold, timber harvested and partly consumed by wildfires. Brush Creek has been moved from its original channel with highway development through the canyon areas.

Sediments in portions of the Hubbard and Brush Creek are unstable, with high sediment production in a Brush Creek tributary. The municipal water supply is in the north Fork of Hubbard Creek, and water quality has been affected by a landslide and by natural tannins. Sediment is linked to phosphate inputs into Garrison Lake. Water temperatures in Hubbard Creek are above the 64 degree standard. Total Maximum Daily Load allowances have been established for aquatic weeds/algae, nutrients, and pH for Garrison Lake. Phosphate levels have declined since the sewage treatment outfall was relocated out of Garrison Lake.

Risk to peak flow enhancement (PFE) due to forest roads and timber harvest is low. Urban roads in the Garrison Lake watershed have a high risk of PFE and rural roads moderate, though how that relates to lake levels in unknown. Rural roads in Hubbard Creek also pose moderate risk to PFE.

Of the 27 miles of stream channel assessed in these watersheds, little less than ten miles are reported as high response reach types. Three miles are in low gradient, confined channels. Fish use is limited to steelhead and cutthroat, with no chinook or coho, and is likely not changed in history. A bypass in Brush Creek was constructed to shunt a 5-year flow away from developed areas. Passage concerns exist on North Fork Hubbard Creek and the mainstem for juveniles.

We have no data on shade or large wood in Hubbard, Brush or Garrison Lake. North Fork Hubbard has opportunities for vegetation improvements, and increases are needed in Upper Hubbard. Gorse populations are a concern.

Water use is minimal, with greatest interest in protecting and treating municipal water supplies. Wetlands assessed (not including wetlands report for Port Orford), report two wetlands in Hubbard and two in Brush. All have some potential for improvement through vegetation or connection to another water body.

Limiting factors to fish production appear to be: road densities and flood peak flow, sediment sources, wetland connectivity, and channel alterations.

APPENDIX

Table 15 Hubbard Creek and Brush Creek Wetland Attributes

Wetland ID	7.5 Minute Quad	Watershed	Size (ac.)	Connected	Cowardin Code	Cowardin Code	Cowardin Code	Buffer	Degree of Alteration	Color Code
1	Port Orford	Hubbard Cr	7	Y	PFOA	PEMA	PABFb	R	MODERATE	R
	Protect - numerous roads - check connectivity thru roads									
2	Port Orford	Hubbard Cr	7	Y	PFOA			R	MODERATE	B
	Protect/Enhance - numerous roads; improve riparian									
3	Port Orford	Brush Cr	5	Y	M2USP	E2USN	EIUBL	R	LOW	G
	Protect - functional estuary									
4	Port Orford	Brush Cr	2.5	Y	PFOA			R	LOW	B
	Protect - moderately functioning									

Table 25 Monthly Net Water Available by Water Availability Basin (cfs) (of 50% Exceedence)

Watershed ID#	Water Availability Basin	Stream	Tributary to	Location	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
72974	24000000	Hubbard Cr	Pacific Ocean	Mouth	24.00	30.00	21.00	-1.30	-1.30	-1.40	-1.50	-1.40	-1.30	-1.30	-1.30	28.00
73210	25000000	Brush Cr	Pacific Ocean	Mouth	46.00	57.00	45.00	1.10	-0.03	-0.04	-0.05	-0.04	-0.03	-0.02	1.60	57.00

Shaded Area = Water not available at 50% exceedance level.

Table 20 Forest Road Area Summary

1 Subwatershed	2 Area (square mi)	3 Forested Area (acres)	4 Forested Area (square mi)	5 Total Linear Distance of Forest Roads (miles)	6 Roaded Area Col. 5 x *Std. Width (square miles)	7 Percent Area in Roads Col. 6/4*100	8 Relative Potential for Impact
Brush Creek	11.02	7,033	10.99	36.58	0.17	1.56	Low
Garrison Lake	3.14	783	1.22	2.01	0.01	0.77	Low
Hubbard Creek	6.68	3,919	6.12	18.40	0.09	1.41	Low
Totals	20.84	11,735	18.34	56.99	0.27	1.46	

**Standard Width for Forest Roads = 25 feet (.0047 miles)*

Table 21 Rural Road Area Summary

1 Subwatershed	2 Area (square mi)	3 Rural Area (Ag + Range) (acres)	4 Rural Area (Ag + Range) (square mi)	5 Total Linear Distance of Forest Roads (miles)	6 Roaded Area Col. 5 x *Std. Width (square miles)	7 Percent Area in Roads Col. 6/4*100	8 Relative Potential for Impact
Brush Creek	11.02	12	0.02	0.03	0.00	1.04	Low
Garrison Lake	3.14	1,098	1.72	15.71	0.10	6.04	Moderate
Hubbard Creek	6.68	359	0.56	5.30	0.03	6.24	Moderate
Totals	20.84	1,469	2.30	21.04	0.14	6.05	

**Standard Width for Rural Roads = 25 feet (.0066 miles)*