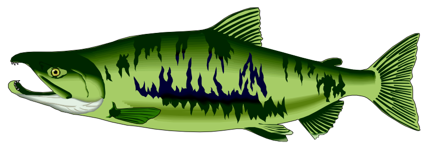
HUNTER CREEK

WATERSHED ASSESSMENT



Prepared for

The Hunter Creek Watershed Council

Prepared by

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June 2001

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ABSTRACT

The *Hunter Creek Watershed Assessment* was prepared for the Hunter Creek Watershed Council whose members are dedicated to sustaining the health of their watershed. This document contains detailed information about the Hunter Creek 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 *Hunter Creek 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 *Hunter Creek Watershed Assessment* contains technical information about past and present conditions in the watershed. This document updates and expands on information presented in the *South Coast Watershed Action Plan (1995)*. This assessment is a resource to promote better understanding of Hunter Creek and its drainage area. 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 watershed. Particular emphasis was placed on private lands within the basin. The *Hunter Creek 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 historical conditions, ecoregions, channel habitat types, salmonid fish and their habitat, water quality, sediment sources, riparian and wetland conditions, hydrology and water use. Among the components addressed in the Oregon Watershed Assessment Manual that were not included in this assessment was an assessment of channel modifications.

The purpose of this assessment was to compile, summarize and synthesize existing data and information pertaining to Hunter Creek's watershed conditions. Near completion of this document an interdisciplinary team, comprised of twelve technical specialists, reviewed the individual components of this assessment. The interdisciplinary team later met to discuss key findings, issues and/or concerns related to each of the assessment components. This information was then synthesized to provide a foundation for the prioritization of projects outlined in the *Hunter Creek 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 Hunter Creek watershed drains approximately 28,405 acres or 44.4 square miles of land. Hunter Creek is situated entirely within Curry County and is among the smaller watersheds on the southern Oregon coast. Flowing in a westerly direction Hunter Creek crosses Highway 101 and drains into the Pacific Ocean just south of the community of Gold Beach. Elevations in the watershed range from sea level to approximately 3,558 feet on Sugarloaf Mountain. Major tributaries include the North Fork and Big South Fork. The upper portion of the basin is characterized by steeply sloped forested areas with narrow valleys and tributary streams that have moderately steep to very steep gradient. Grazing, rural residential development and other agricultural uses are dominant in the lower portion of the basin. Over 60% of the watershed is in private ownership.

B SUBWATERSHEDS

The Hunter Creek watershed was divided into five “subwatersheds” for the purpose of this assessment. These subwatersheds generally follow hydrologic boundaries. However, some units include a series of small watersheds that do not drain into a common stream or include segments that are parts of a larger watershed. The delineation of subwatersheds provides a convenient way to refer to areas within the larger watershed.

Delineation of subwatershed boundaries was based on several factors, including preexisting boundaries established by federal agencies and major changes in topography, land use and stream size. Subwatersheds were named after the major tributary within the subwatershed so that references to each subwatershed would be consistent throughout all components of the assessment. In cases where no major tributary exists subwatersheds were named according to their relative location within the watershed (e.g. Lower Hunter Mainstem subwatershed).

The Upper Hunter Mainstem, as referred to in this document, includes the Hunter Creek mainstem and small tributaries from the North Fork confluence to the headwaters. The Middle Hunter Mainstem includes the Hunter Creek mainstem and small tributaries from Section 21 to the North Fork confluence. Finally, the Lower Hunter Mainstem includes the Hunter Creek mainstem and small tributaries from the mouth to Section 21.

Table 1 Hunter Creek Subwatersheds

Subwatershed	Subwatershed Area (square miles)	Subwatershed Area (acres)
Big South Fork	6.1	3,882
Lower Hunter Mainstem	6.8	4,356
Middle Hunter Mainstem	12.1	7,748
North Fork Hunter	6.0	3,818
Upper Hunter Mainstem	13.4	8,601
Totals	44.4	28,405

C LAND OWNERSHIP AND USE

Land Ownership

Approximately 62% of the land in the Hunter Creek watershed is in private ownership. Private lands are divided into industrial and non-industrial lands. Industrial private lands account for approximately 50% of the basin whereas non-industrial private lands comprise about 11.5% of the total area. Industrial private lands are divided among a small number of landowners that own relatively large tracts of land. In contrast, non-industrial private lands are divided among a large number of individuals that own relatively small parcels. Some of the larger industrial private lands in the basin are believed to be owned and/or managed by South Coast Lumber Co., Crook Estate and Menasha Corporation. Public ownership in the watershed is estimated at about 38.5%. Public lands, managed by the United States Forest Service (USFS), account for approximately 26% of the watershed area whereas the Bureau of Land Management (BLM) manages roughly 12.5% of the basin. State lands comprise <0.5% of the basin. Table 2 provides a list of land ownership by subwatershed.

Table 2 Land Ownership by Subwatershed (acres)

Subwatershed	BLM	Private Non-Industrial	Private Industrial	USFS	State	Total Acres
Big South Fork	210		3,128	546		3,884
Lower Hunter Mainstem	78	2,017	2,252		11	4,358
Middle Hunter Mainstem	708	1,083	5,955			7,746
North Fork Hunter	1,223	4	2,066	525		3,818
Upper Hunter Mainstem	1,319	157	822	6,303		8,601
Total Acres	3,538	3,261	14,223	7,374	11	28,407

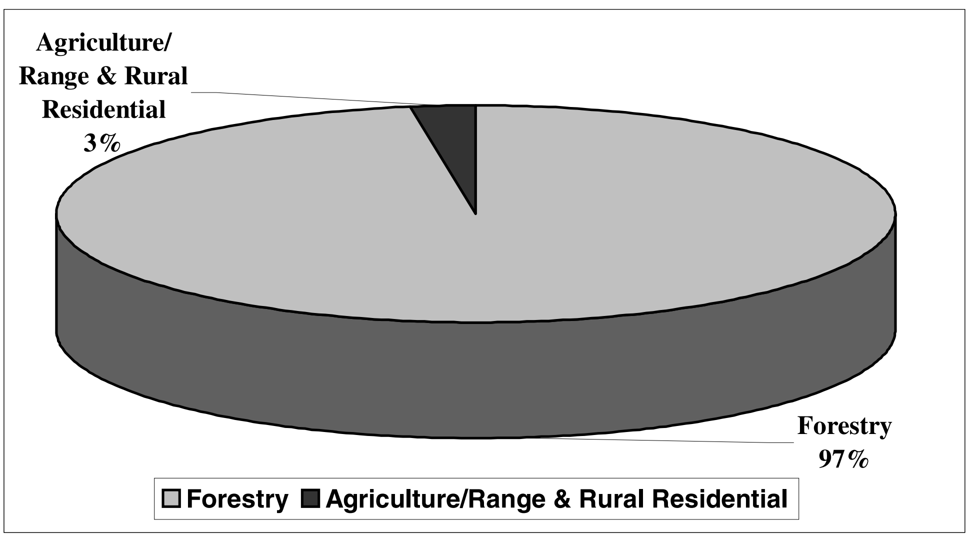
Land Use

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

(1) Forestry, the most dominant land use in the watershed, accounts for 97% of the watershed area and includes private industrial and private non-industrial lands in forestry use as well as those lands managed by the USFS and BLM. Although forestry use is common throughout the entire basin it is most prevalent in the middle and upper portions of the watershed.

(2) Urban, agriculture/range and rural residential areas account for 3% of the watershed. These lands are located primarily in the Lower Hunter Mainstem subwatershed. Much of the residential housing in the lower watershed is within the urban growth boundary of Gold Beach and is thus considered urban. Residential areas outside of the Gold Beach urban growth boundary are considered rural residential areas. Finally, agricultural or range lands include those areas throughout the Lower Mainstem and Middle Mainstem subwatersheds that are managed for livestock grazing. Major types of livestock include sheep and cattle.

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 Hunter Creek Watershed Council's perspective on those practices that may potentially impact salmonid fish habitat and water quality. The watershed council identified critical issues during a council meeting held in Gold Beach on September 14, 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 Hunter Creek watershed issues are summarized in two tables: Table 3 Hunter Creek Regulatory Issues and Table 4 Hunter Creek Watershed Council Issues.

Table 3 Hunter Creek Regulatory Issues

Aquatic Resource Issues (Based on federal and state law)	**Endangered Species Act** coho – threatened chinook – not warranted steelhead – not warranted cutthroat – not warranted
	Clean Water Act – 303 (d) List Mouth to river mile 16.5

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

Table 4 Hunter Creek Watershed Council Issues

Land Use	Practice	Issue
Forestry	I Timber harvest from old (and current) practices	1) Increased sedimentation of fines and gravels: A Increased bedload movement B Increased channel width / Reduced channel depth C Increased temperatures
		2) Does timber harvest affect water quantity?
	comments: *1) South Coast Lumber, the largest private landowner, has done a good job replanting and "cleaning-up" over the last ten years.* *2) Most of the drainage is in public ownership (USFS) where there is virtually no more timber harvest.* *3) There were mixed opinions about timber harvest effects on water quantity*	
	II Removal of large wood from streams	1) Lack of large wood in streams
Rangeland	I Grazing in riparian zones	1) Loss and/or damage of riparian vegetation 2) Increased streambank erosion 3) Reduced shade
	comments: there are few cattle in the whole system; most of the impacts are concentrated in one reach	
Commercial Development	I Turtle Rock RV Park, Freeman Marine Fabrication and County Road Department	1) Placement of fill within the flood plain 2) Potential water pollution
Residential Development	I Septic Systems	1) Potential contamination of creek from overflow of septic tanks 2) Quantity and quality of septic systems
	comments: The south side residents of Hunter Creek, to Mateer Bridge, are served by the Gold Beach city sewer system. The north side residents are served by individual septic systems.	
Mining	I Mining of gravel bars by the County Road Dept.	1) Potential impacts to spawning beds - disturbance and/or removal 2) Possible source of pollutants into water - antifreeze, oil and/or other
	II Chromium or nickel mine at Red Flat	1) Possible source of pollutants
Irrigation	I Residential and Rangeland Use	1) Water rights - are users permitted?
	comments: Residential = withdrawals for lawns and domestic use. Rangeland = withdrawals for livestock, primarily cattle.	

Land Use	Practice	Issue
	I Unauthorized driving in the creek during summer	1) Possible source of pollutants

Land Use	Practice	Issue
Recreation		2) Possible disturbance of salmon redds
	II Sport fishery	1) Over fishing and poaching

Road Network	I Extensive road network and old "cat roads"	1) Increased culvert failures 2) Increased sedimentation 3) Increased run-off 4) Increased landslides

III HISTORICAL CONDITIONS

A INTRODUCTION

This chapter summarizes available information on historic and current land use effects on the natural watershed. While the Hunter Creek watershed has 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). Watershed steward and council member, Bob Van Leer, prepared this chapter.

B HISTORICAL NARRATIVE

The Hunter Creek watershed remained virtually undisturbed from the time of European settlement on the Oregon coast in the mid-nineteenth century until after World War II.

<u>Natives Here First</u>

The Yashutes band of TuTutNi Indians made use of the basin, probably for hunting, fishing and gathering. Evidence of native sites is found in several places in the basin and there may have been a settlement in the tidewater area.

<u>Whites Reach Pacific</u>

After white Euro American settlement in the mid-19th century, on the extreme lower reaches of the stream near the ocean a few people settled and ranched and, after the mid-1920s, serviced the limited traffic on Highway 101, which crossed it and all coastal streams. Inland were a handful of homesteads that raised livestock and one small farm raised produce, milk and butter and eggs for the few hundred people who lived in Gold Beach. The opening of Highway 101 put this farm out of business.

The interior of the basin was empty of habitation until the 1930s when scattered mining activity was under way in the Red Flats-Signal Buttes section. The Siskiyou National Forest occupies a fourth of the basin in the headwaters area and the U. S. Bureau of Land Management administers another 13% of scattered federal lands west of the National Forest. During the Depression and World War II Curry County acquired thousands of acres in the basin for non-payment of taxes. Timber companies owned much of the rest.

Until after the war there was no road up the valley. Access for the handful of residents was by trail and driving up the creek bed in low water. In 1946 the Menasha Corp. completed a road up to what is now known as the High Bridge. The Little South Fork Road was surveyed in 1944 by S. O. Newhouse for Kerber Loging Company and the eight-mile long road was built in stages after World War II to connect the Menasha road with the CCC (Civilian Conservation Corps) road built up Pistol River and on the divide between Hunter Creek and Pistol River to the Pyramid Rock, Wildhorse and Snow Camp Lookouts.

The Trees Begin To Fall

From the late 1940s to the 1980s timber harvest and milling was the dominant activity in the Hunter Creek basin. Curry County had sold its property in the basin to Agnew Timber Products. The Foster-Clyde Lumber Mill was built on one of the homesteads in the lower basin that was formerly an alfalfa field. This property is now occupied by the Oregon State Police, Oregon Highway Department and Freeman Marine. In the late 1940s and early 1950s extensive logging was done in the basin with much of the timber going through the new mill.

Evans Products Company bought the Foster-Clyde mill in 1955. At about the same time the Siskiyou National Forest put up the first major timber sale in the basin, 33 million board feet. The aim was to build a road to open up the basin for further timber sales and tie the new road together with the existing CCC roads.

Evans Products bought the timber sale and Brownie Coldiron Logging Company, then of Powers, got the contract to log the sale. Coldiron, who still lives in Gold Beach, said he logged the furthest east unit of the sale, which was actually over the divide in the Lawson Creek drainage, to get a supply of logs for Evans for the first winter and hauled over the existing narrow roads. After that the logging company built the new road up from the High Bridge to open up the country. The work was done in 1955-57. Coldiron said in 2000 the volume of wood in the cut areas exceeds that originally cut.

The private land had been substantially logged out by 1960. Reforestation was limited on private ownerships. By the 1990s South Coast Lumber, Brookings, had acquired much of the cutover land and has been logging what reproduction was there and doing a professional job of reforesting the land.

The National Forest had two periods of substantial logging sales in the basin, 1955-1964 and 1980-1989. Logged areas were promptly reforested. With the advent of protection for the spotted owl, selling of timber in the National Forest portion of the basin was substantially restricted. The Forest Service at the present time is obliterating some roads and closing others. Little further development of the Forest Service ownership of the basin is expected. In the heyday of logging, Hunter Creek was a major industrial area. Starting at the mouth, Campbell-McLean built a veneer mill that handled cull as well as sound logs, making a new market for culls. The mill was located on the property now occupied by Turtle Rock RV Park. Sunset Mills built a stud sawmill on the same site.

Further upstream Gold Beach Lumber and Manufacturing had a sawmill on the site now occupied by the Curry county road shop. Next upstream was the Evans Products site which was composed of both a veneer and sawmill. Just upstream from it was Tamco which utilized scrap veneer from Evans to make box shooking, and at the Leith Ranch still further up Darrell Anderson built a sawmill. None of the mills remains.

Miners Try, and Try and Try

Mining in the basin has always been something that might happen, but has not happened yet. Betty Hedderly Smith, Florence, OR, who lived intermittently on Red Flats from

1946-1954, said Red Flats was the main prospecting area but some was done across the basin on Signal Buttes on the Rogue River-Hunter Creek divide. Prospecting on the flats started in the 1930s and was for gold first and then other minerals. She said there was enough mercury to coat the inside of some of the road culverts and it could literally be spooned out. But the most extensive prospecting was for nickel. Much of Red Flats contains nickel laterite ore. Pacific Nickel Co. under Rose Nunenmacher did extensive prospecting in the 1950s, mostly by trenching, utilizing the heavy equipment of Coldiron Logging then available in the area. She said the federal Bureau of Mines did exploratory drilling about 1973, but no production ever developed. She said there were hundreds of claims and some company owners kept assessment work up to keep the claims alive, but after the death of President Dennis Winn in the early 1970s other stockholders tried to hang on but the cost of the assessment work became too great. Deanna Greco, U. S. Bureau of Land Management, Coos Bay District, says she does not know of any active mining claims on Hunter Creek today. Some assessment work has been done recently on the Pistol River side of Red Flats.

Salmon in the Creek

Hunter Creek supports runs of chinook salmon and steelhead. Edsel Colvin, Gold Beach, whose father owned the dairy ranch, said his family had moved to town but used the ranch for a weekend vacation spot. He said the steelhead fishing was really good, but they did not utilize the salmon. His father thought the quality was not good and bright Rogue River fish were available for 25 cents each. He thought at one time there was some commercial netting. G. C. LeClair, who bought the ranch from the Colvins, said in the early 1940s there were at times so many dead spawned out fish in front of his house he pitchforked them into the creek to float away because they smelled so bad.

With the advent of the heavy logging, and increased sports fishing pressure following road building, the number of fish in the basin dropped dramatically. The creek was closed for all fishing except steelhead in 1988 and the Oregon Department of Fish and Wildlife began a rebuilding and restocking plan for the creek. With the near end of logging in the basin and extensive reforestation, the creek began healing up. Local volunteer groups did rehabilitation projects in the basin. The efforts are successful enough that Hunter Creek was reopened for limited salmon fishing in 1999. About 8-10 miles upstream from the mouth there are natural barriers to fish passage with limited potential spawning areas above the barriers. The central reaches of the creek and its major tributaries flow through the serpentine area which provides little water cover and allows the creek to heat up to over 70 degrees, not ideal anadromous fish habitat.

End of War Brought People

Population in the basin was extremely limited from the time of white settlement until after World War II. Colvin estimated in the 1930s that from the Lafferty Place, one of the furthest upstream homesteads, to the mouth, there were no more than 20-25 people living in the basin. With the advent of roads, and the building up of the population from logging and milling, Hunter Creek became a desirable rural residential area. The area built up to the extent that first a water district was formed and then in 1995 the Hunter Creek area was annexed to the City of Gold Beach. The annexed area contained a population estimated at 414. The lower couple of miles of the creek is now in the Gold Beach city limits, and is served with city water and sewer.

What Happens Next?

Looking into the future of Hunter Creek, the lower reaches, especially within the city limits, will probably be used increasingly for residential housing. The old mill sites have developed into commercial and industrial uses, with Freeman Marine, now the area's largest manufacturing concern, occupying part of the former Evans Products site. The area available for commercial development is limited. Above the city limits, residential development is severely limited by zoning and land use laws.

The central area of the basin, mostly owned by private timber companies, can expect to see continued logging on a sustained yield basis which will limit the logging done in any one year. With the continued reforestation following logging, the effect of logging activity on the creek will be limited. The federal agencies have dramatically reduced timber sales and only occasional logging activity can be expected on federal lands. After a half-century of heavy exploitation the Hunter Creek basin appears headed for a period of sustainable management of private land and preservation of federal land.

REFERENCES

HRWA 1999. Hood River Watershed Assessment. December, 1999

Hunter Creek Watershed Analysis
Prepared for Siskiyou National Forest, Aug., 1998

Interview with: Betty Hedderly Smith, Florence, Or, retired prospector, January, 2000

Interview with: Brownie Coldiron, retired logger, Gold Beach, January, 2000

Interview with Edsel Colvin, early Hunter Creek resident, Gold Beach, January, 2000

Interview with H. J. Newhouse, Wedderburn, surveyor, February, 2000

Information from Norma Rath, City of Gold Beach, February, 2000

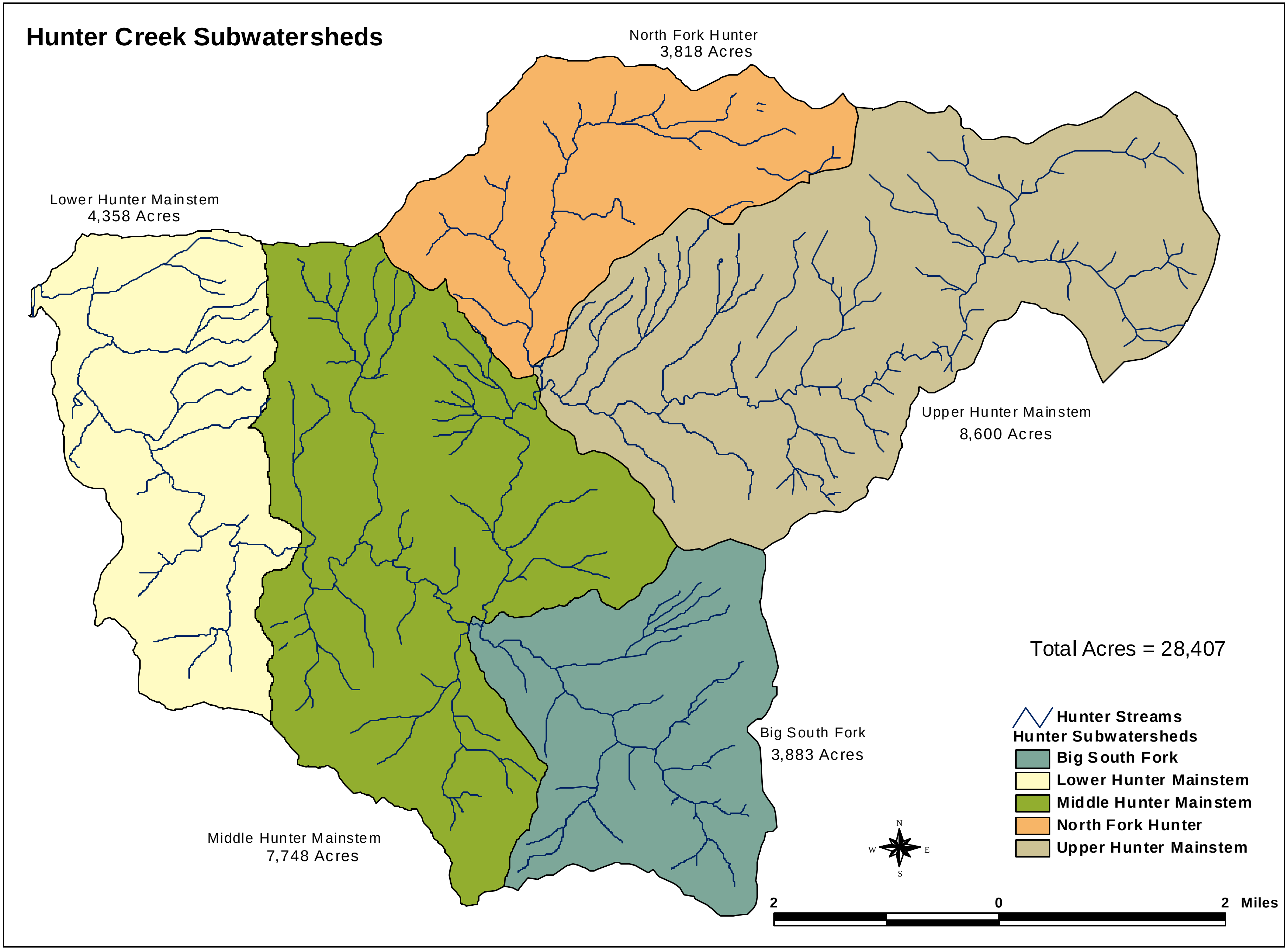
Conversation with Dennis Anderson, logger, Gold Beach, February, 2000.

Comments from F. W. Burgess, retired Gold Beach District Ranger,
February, 2000

Comments from Bill Blackwell, Gold Beach Ranger District, February, 2000

Comments from Milt Walker, Curry County native, February, 2000

Personal knowledge from living on Hunter Creek since 1962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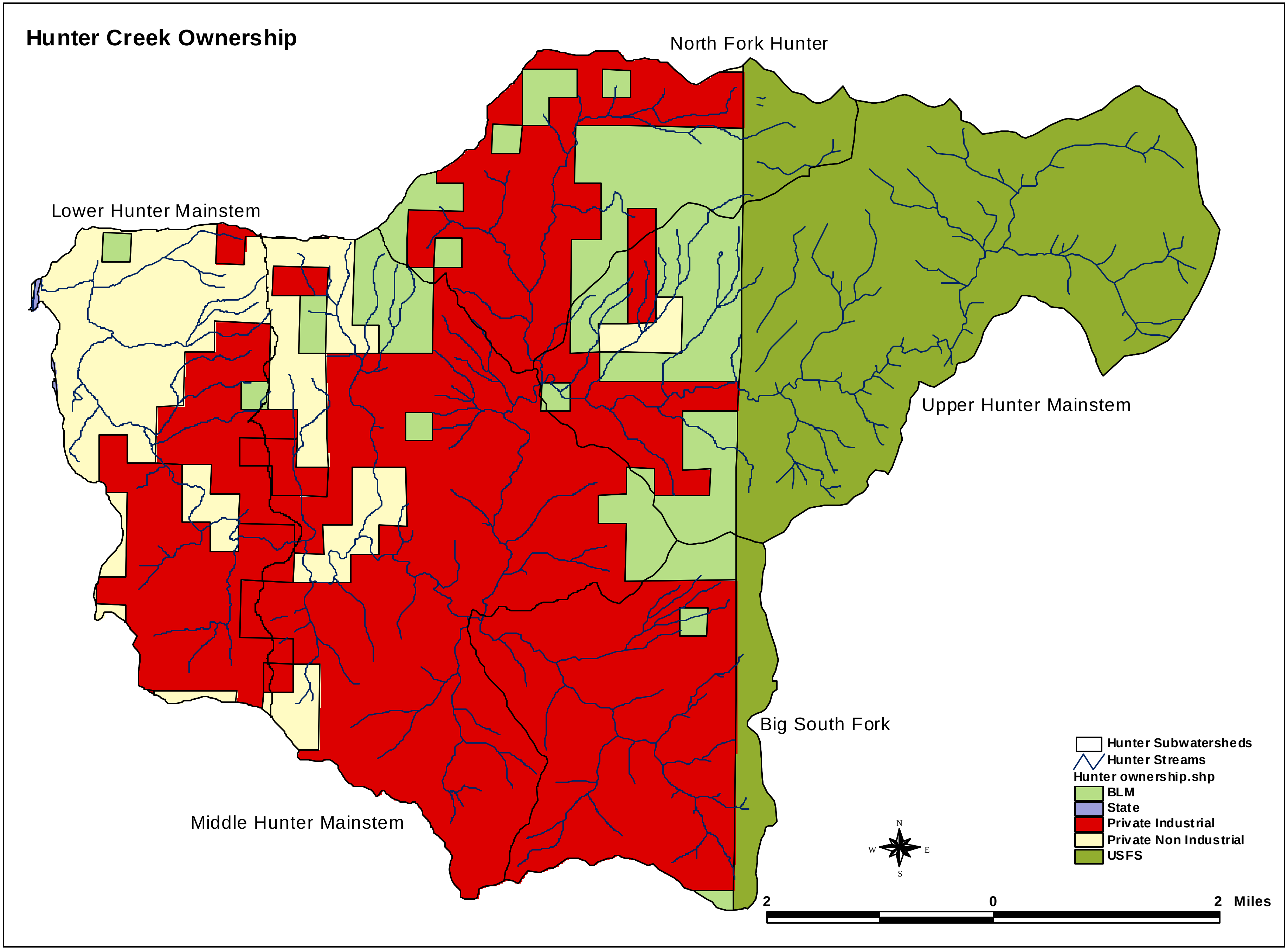
Hunter Creek Ownership
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Lower Hunter Mainstem
Upper Hunter Mainstem
Big South Fork
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IV ECOREGIONS

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 Hunter Creek watershed is situated within two Level-III Ecoregions that are subdivided into three Level-IV Ecoregions. The Level-III Ecoregions include the **Coast Range** and the **Klamath Mountains**. Brief descriptions of these two broad ecoregions are provided in the following paragraphs. 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. A portion of the Hunter Creek watershed is situated within two of these Level IV Ecoregions. They include the **Coastal Uplands** and the **Southern Oregon Coastal Mountains**. 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.

Klamath Mountains

The Klamath Mountains ecoregion is physically and biologically diverse. Highly dissected, folded mountains, foothills, terraces, and floodplains occur and are underlain by igneous, sedimentary, and some metamorphic rock. The mild, subhumid climate of the Klamath Mountains is characterized by a lengthy summer drought. It supports a vegetal mix of northern California and Pacific Northwest conifers. Within the Klamath Mountains exist several Level IV Ecoregions. A portion of the Hunter Creek watershed is situated within one of these Level IV Ecoregions. It is titled the **Coastal Siskiyous**. The Coastal Siskiyous reflect the steep southwest mountains located within 60 miles of the coast.

Table 5 Level IV Ecoregions by Subwatershed

	Coastal Uplands		Southern Oregon Coastal Mountains		Coastal Siskiyous		Total Acres	Total Square Miles
Subwatershed	**(acres)**	**%**	**(acres)**	**%**	**(acres)**	**%**		
Big South Fork		0	1,905	49	1,977	51	3,882	6.1
Lower Hunter Mainstem	3,436	79	920	21		0	4,356	6.8
Middle Hunter Mainstem	1	0	6,994	90	753	10	7,748	12.1
North Fork Hunter		0	1,207	32	2,611	68	3,818	6.0
Upper Hunter Mainstem		0	1,439	17	7,162	83	8,601	13.4
Totals	3,437	12	12,465	44	12,503	44	28,405	44.4

C LEVEL IV ECOREGION DESCRIPTIONS

(1) Coastal Uplands (12% of Hunter Creek Watershed)

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

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.

(Wiggins, 2001)

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 recreation. Rangelands include livestock grazing (sheep, cattle, goats and llamas). Other land uses include rural residential development, light industrial, utility infrastructure (power/communication lines and underground cables), tourism, recreation (hunting, boating, fishing, camping, hiking, etc.), forestry, Christmas trees, 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 (44% of Hunter Creek watershed)

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 Siskiyous (44% of Hunter Creek Watershed)

Overview
The Coastal Siskiyous ecoregion has a wetter and milder maritime climate than elsewhere in the Klamath Mountains. Productive forests composed of tanoak, Douglas-fir, and some Port Orford cedar cover the dissected, mountainous landscape. These steep mountains are located within 60 miles of the coast. Elevations in this ecoregion range from 1,000 to 4,800 feet.

Physiography & Topography
Mountains are highly dissected. High gradient perennial and intermittent streams along with a few small alpine glacial lakes are characteristic of this ecoregion. Waterfalls are common. Stream density within watersheds is high; valleys are narrow.

Geology and Soil
Geology is underlain by conglomerates, sandstone, or siltstone. Soils range from deep, very gravelly 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)
70-130	100-190	38/50	50/76

Runoff

Spring	Partially uniform; rainstorms create periods of higher runoff
Summer	Uniform; runoff gradually declines, higher runoff during thunderstorms
Fall	Mostly uniform; runoff gradually increases; higher runoff during late fall rains
Winter	Not uniform; high runoff during rain storms and snow melt

Erosion and Peak Flows
Natural erosion rate is high due to steep terrain, high winter precipitation, high uplift rates, and weak rock. Peak flows (50-year recurrence interval, cfs per square mile) are 400 to 600.

Stream Channel Characteristics

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

Natural Disturbances
Both lightning-caused and human-caused fires were common in this region in the past. Streamside areas sometimes escaped the fires. Past fires varied in severity, depending on specific site conditions. Fire suppression has reduced the frequency of wildfires.

Upland and Riparian Vegetation

Conifers	Douglas-fir, western hemlock, Port Orford cedar, knobcone pine, Jeffrey pine, and western white pine
Hardwoods	red alder, big leaf maple, myrtle, madrone, tanoak, Oregon white oak, golden chinquapin, and canyon live oak
Shrubs	ceonothus spp., elderberry, manzanita, hazelnut, and vine maple
Understory	ferns, salmonberry, thimbleberry, skunk cabbage, rushes, sedges, grasses, herbaceous (flowers etc.), and poison oak
Noxious	scotch broom, gorse, blackberry, tansy, and thistles spp.

(Wiggins, 2001)

Current riparian conifer regeneration is common except where tanoak becomes established. Potential riparian vegetation will vary according to channel confinement. Confined and moderately confined channels may include a narrow band of hardwoods with mainly Douglas-fir, tanoak, Port Orford cedar, and Jeffrey pine beyond. Unconfined channels differ primarily in their width of hardwoods, which may be considered moderately wide rather then narrow.

Land Use
Forestry, ranching, rural residential development, recreation, rock quarries, greenery, mushrooms and some mining are the predominant land uses (Wiggins, 2001). Much of this area is managed by the Siskiyou National Forest so commercial forestry activities have been greatly curtailed in recent years.

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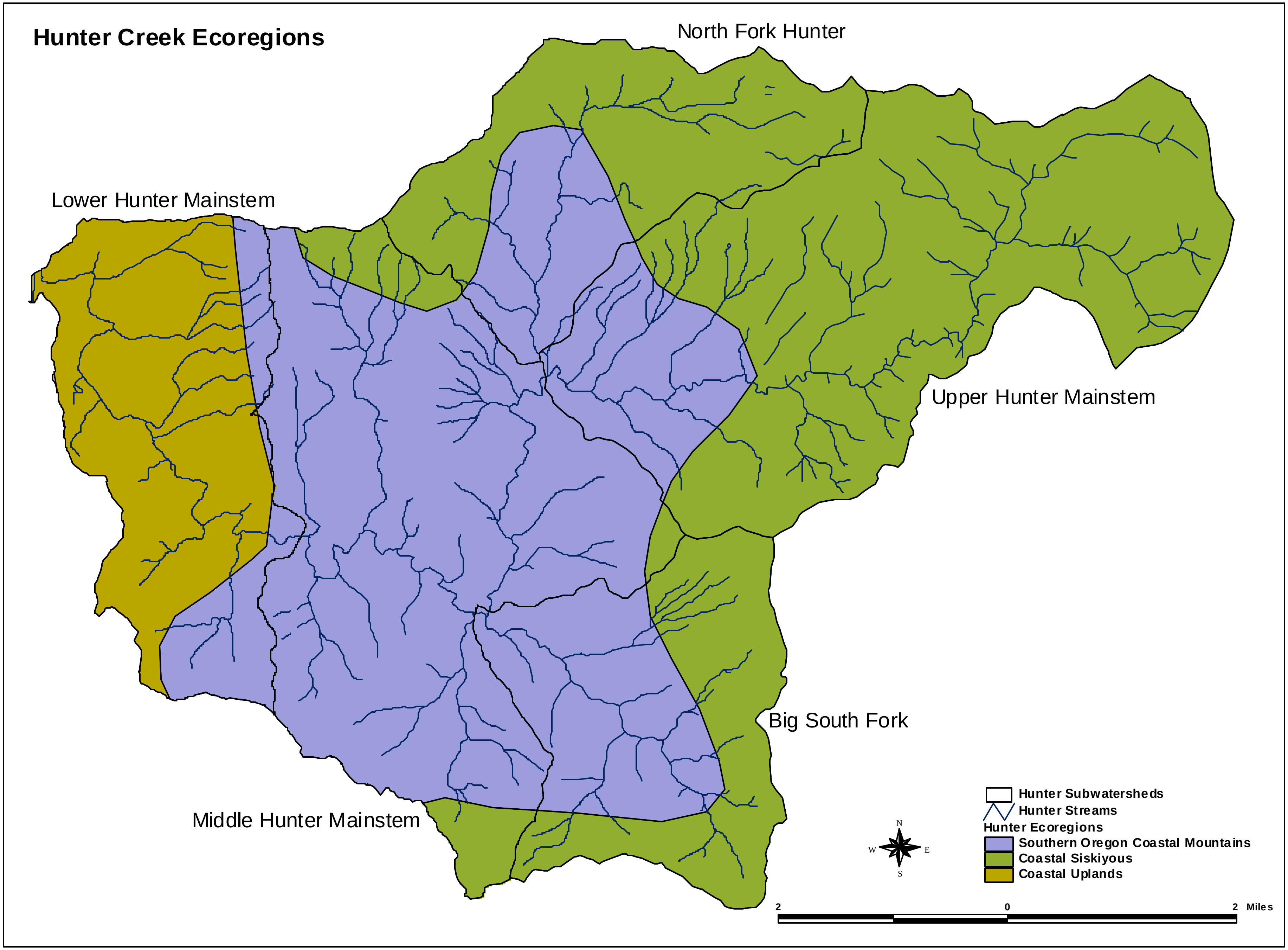
Hunter Creek Ecoregions
North Fork Hunter
Lower Hunter Mainstem
Upper Hunter Mainstem
Big South Fork
Middle Hunter Mainstem
Hunter Subwatersheds
Hunter Streams
Hunter Ecoregions
Southern Oregon Coastal Mountains
Coastal Siskiyous
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V CHANNEL HABITAT 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

Hunter Creek and its tributaries represent a diversity of Channel Habitat Types. Table 6 Channel Habitat Type Attributes provides a comparison of the 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 74 miles of streams within the Hunter Creek basin. A description of each Channel Habitat Type is presented in Section E of this component.

1. Small Estuarine Channel (ES)
2. Low Gradient Confined Channel (LC)

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 Hunter Creek

3. Steep Narrow Valley Channel (SV)
4. Moderately Steep Narrow Valley Channel (MV)
5. Moderate Gradient Confined Channel (MC)
6. Very Steep Headwater Channel (VH)
7. Low Gradient Moderately Confined Channel (LM)
8. Moderate Gradient Moderately Confined Channel (MM)
9. Moderate Gradient Headwater Channel (MH)

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 lower Hunter Creek watershed. 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 OWEB Assessment Manual.
4. CHT classifications were verified with stream survey data, available in digital format from the Southwest Oregon Province GIS CD Data Set. The name of the shapefile used for this purpose is “Stream Surveys”.
5. CHTs were measured on USGS maps using a map wheel.
6. A labeling system was developed for purposes of subwatershed characterization.

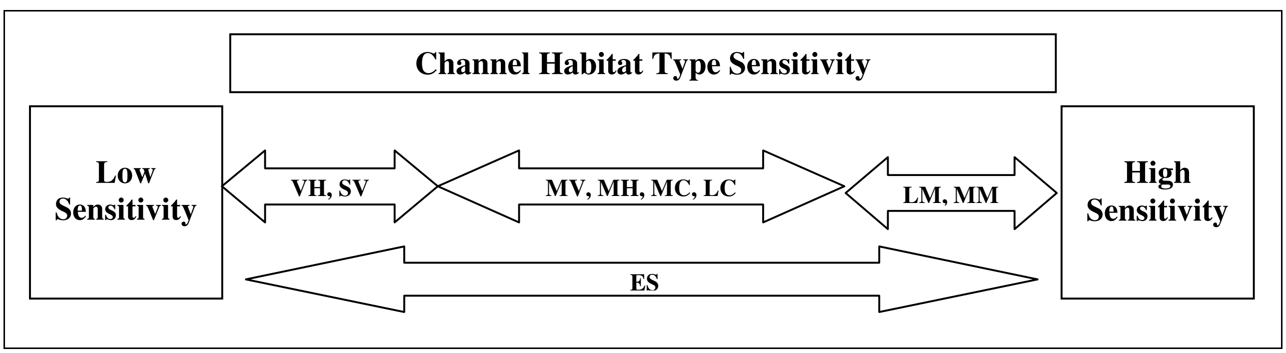
D CHANNEL SENSITIVITY / RESPONSIVENESS (GWEB 1999)

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



E DESCRIPTION OF CHANNEL HABITAT TYPES (GWEB 1999)

(1) Small Estuarine Channels (ES) (1% of Hunter Creek's Channels)

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 Confined Channels (LC) (4% of Hunter Creek's Channels)

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.

(3) Low Gradient Moderately Confined Channel (LM) (9% of Hunter Creek's Channels)

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.

(4) Moderate Gradient Confined Channel (MC) (10% of Hunter Creek's Channels)

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.

(5) Moderate Gradient Moderate Confined Channel (MM) (2% of Hunter Cr. Channels)

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.

(6) Moderate Gradient Headwater Channel (MH) (1% of Hunter Creek's Channels)

These channels are similar to LC channels, but occur exclusively in headwater regions. They may be sites of headwater beaver ponds. They are potentially above the anadromous fish zone. These gentle to moderate headwater streams generally have low streamflow volumes and, therefore, low stream power. The confined channels provide limited sediment storage in low-gradient reaches. Channels have a small upslope drainage area with sediment sources limited to upland surface erosion.

Channel Sensitivity / Responsiveness

The low stream power 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 usually localized and of a moderate magnitude.

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

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

Riparian Enhancement Opportunities
These channels are moderately responsive. 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.

(7) Moderately Steep Narrow Valley Channel (MV) (18% of Hunter Creek's Channels)

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 = 44% & VH = 11% of Hunter Creek's Channels)

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 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. 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)

Subwatershed	ES	LM	LC	MM	MC	MH	MV	SV	VH	Totals
Lower Mainstem	0.8	4.2	0.2	0.4	0.0	0.8	0.9	7.2	3.4	17.8
Middle Mainstem	0.0	2.3	1.5	0.0	2.1	0.0	2.5	8.7	0.4	17.4
Big South Fork	0.0	0.0	0.0	0.0	0.6	0.0	3.6	4.2	4.0	12.3
North Fork	0.0	0.0	0.0	0.0	1.3	0.4	1.3	3.0	0.4	6.4
Upper Mainstem	0.0	0.0	1.5	0.9	3.4	0.0	4.9	9.5	0.0	20.3
Totals	0.8	6.4	3.2	1.3	7.4	1.1	13.3	32.6	8.1	74.2

Figure 2 Channel Habitat Types by Subwatershed (miles)

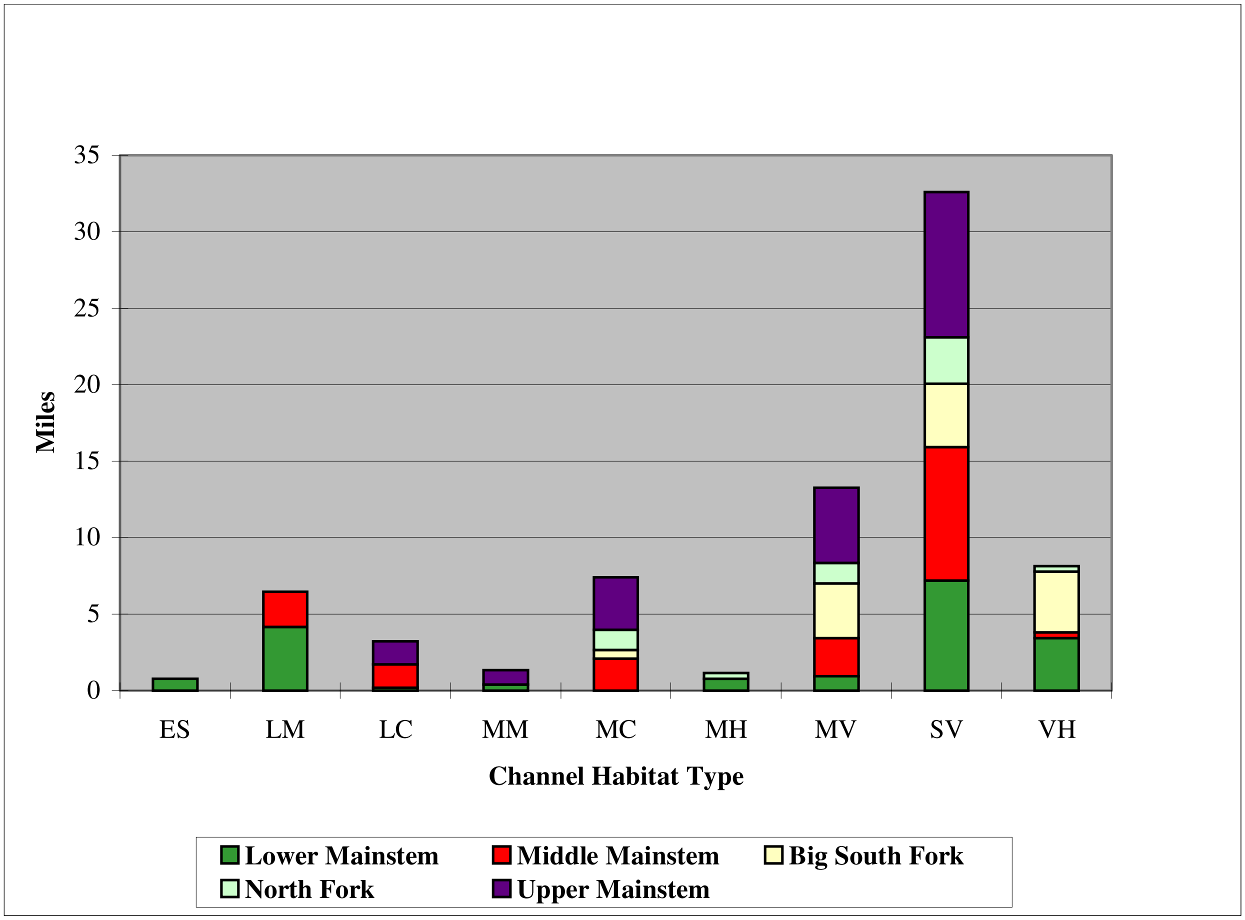


Table 8 Hunter Creek Channel Habitat Type Summary

CHT	Channel Description	Percent of Miles	Response to Disturbance	Riparian Treatment Opportunities
ES	Small estuarine	1	Moderate	Limit structures
LM	Low gradient moderately confined	9	High	Good candidates
LC	Low gradient confined	4	Low Mod	Manage livestock access
MM	Moderate gradient moderately confined	2	High	Good candidates
MC	Moderate gradient confined	10	Mod	Manage livestock access
MH	Moderate gradient headwater	1	Mod	Manage livestock access
MV	Moderately steep narrow valley	18	Mod	Manage livestock access
SV	Steep narrow valley	44	Low	Few opportunities
VH	Very steep headwater	11	Low	Few opportunities

G KEY FINDINGS

- Of the 74 stream miles evaluated in this assessment, 55 percent are classified as steep (SV) to very steep (VH) narrow valleys. These are typically the small headwater streams in all of the Hunter 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, MH, and MV) comprise 29 percent of the channels, and low gradient confined channels (LC) are 4 percent, for a total of 33 percent. These are typically located in small to medium size streams of all subwatersheds, with the largest amounts in the middle and upper mainstem 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 2 percent and low gradient streams that are moderately confined (LM) characterize 9 percent of the channels. The greatest amount of these is the LM in the lower and middle mainstem, with small amounts of MM in the lower and upper mainstem. These 11 percent of the channel miles 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.

- One percent of the channel length inventoried was classified as small estuarine channel (ES), the first 0.8 mile of the Hunter Creek mainstem. 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

Salmonid Life Cycles (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.

Chinook salmon

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

Chinook, coho, steelhead and cutthroat are all native to the Hunter Creek watershed. The historic abundance and distribution of these salmonids, within the watershed, is poorly understood (ODFW 1995). Historical numbers of coho are thought to have been relatively small in most south coast basins, including Hunter Creek. Coho populations in Hunter Creek were probably smaller than chinook populations due to the relatively steep topography that leads to steep, confined and high-energy systems (ODFW 2001). Abundance of coho has probably been reduced due to modification of low gradient streams (ODFW 2001).

Although information describing historic distribution of chinook within these basins is scant, it is likely that contemporary distributions of chinook and steelhead are not considerably reduced from the period when white settlers in the area began altering pristine habitats. (ODFW 1995) While considerable information exists regarding the contemporary distribution of spawning and rearing of chinook, coho and steelhead, little is known about contemporary cutthroat distributions. Typically, however, cutthroat are thought to utilize all portions of the basin.

Life History Patterns of Anadromous Salmonids

Table 9 lists the life history characteristics of anadromous salmonids in south coast watersheds including Hunter Creek. 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.

Table 9 Life History Patterns of Anadromous Salmonids in South Coast Watersheds

Species	Adult Return	Spawning Location	Spawning Period	* Eggs in Gravel	Young in Stream	Freshwater Habitat	Young Migrate Downstream	Time in Estuary	Outmigration Period	Time in Ocean	Adult Weight (average)
COHO	Oct-Jan	coastal streams, shallow tributaries	late fall-early winter	Oct-May	1+yrs	tributaries, mainstem, slack water	Mar-June (2nd yr)	few days - several weeks	fall-winter	2 yrs	5-20 lb (8)
CHINOOK		mainstem large & small rivers				mainstem large & small rivers		days-months		2-5 yrs	
spring	Jan-Jul			Jul-Jan	1+yrs		Mar-Jul (2nd yr)				10-20 lb (15)
fall	Aug-Mar		Nov-Jan	Sep-Mar	3 months		Apr-July	3-4 months	Aug-Oct		10-40 lb
STEELHEAD		tributaries, streams & rivers	Feb-Apr			tributaries		less than a month		1-4 years	
winter	Nov-Jun		Dec-May	Jan-Jul	1-3 yrs		Mar-Jun (2nd-5th yr)		1-3 yrs after hatch		5-28 lb (8)
summer (Col. R.)	Jun-Oct			Feb-Jun	1-3 yrs		Mar-Jun (3rd-5th yr)				5-30 lb (8)
Coastal Sea Run CUTTHROAT	Jul-Dec	small tributaries of coastal streams	Feb-May?	Dec-Jul	1-3 yrs (2 avg.)	tributaries	Mar-Jun (2nd-4th yr)	less than a month **	1-3 yrs after hatch	0.5-1 yrs	0.5-4 lb (1)

* The eggs of most salmonids take 3-5 months to hatch at the preferred water temperature of 50-55 F; steelhead eggs can hatch in 2 months.

** Fluvial and immature sea run cutthroat may reside in estuary through the summer

Threatened and Endangered Species

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 (ESA). In May of 1997, coho within the Hunter Creek basin were listed as Threatened. More recently, in April 2001, the status of steelhead was changed from Candidate to Not Warranted.

Table 10 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	Small but stable

(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 Hunter Creek watershed. 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	Lower mainstem to road mile 10.75 and lower portions of tributaries
Chinook spawning & rearing	Lower mainstem to road mile 8.25 and Little South Fork

(USFS 1998 and ODFW 2001)

Spawning Surveys – Peak Counts

Peak counts from spawning surveys provide one measure of fish populations and long term trends in streams and rivers. Spawning surveys on selected rivers range from ½ mile to 2 miles of stream. A trained biologist walks the stream during the peak spawning season (December to January), counting live and dead salmon. Surveys are conducted every 7-10 days. Adverse conditions such as turbidity indefinitely affect the observer's ability to see fish. The numbers listed in Table 12 reflect the peak counts for each spawning season, from 1995 to 2000. Numbers include both live and dead adult fish; jacks are not included.

Table 12 Chinook Peak Counts from 1995-2000 (ODFW #20176, #20178, & 20179)

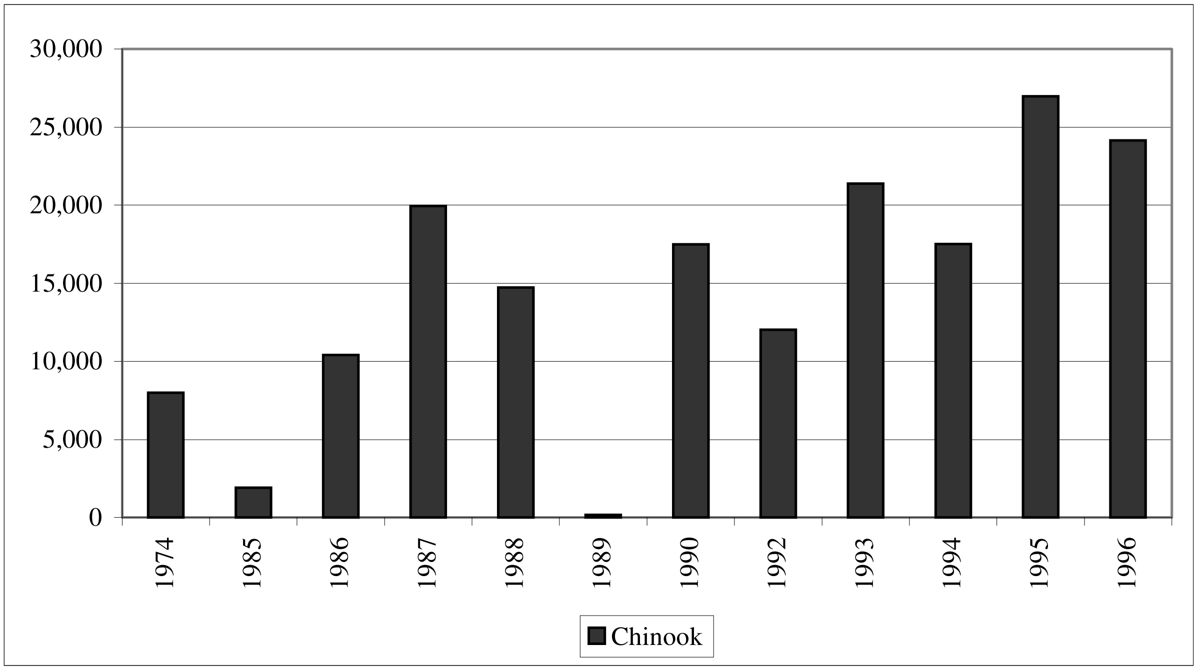
Survey	1995	1996	1997	1998	1999	2000	Historic High
Hunter	173	93	141	101	114	NA	NA

NA = Not Available

Stocking Summary

Figure 3 illustrates the total releases of hatchery fish for each species and each year on record with the local ODFW district office in Gold Beach. Stocking (hatchery release) data was compiled from two sources: ODFW's draft basin plan and the local Salmon and Trout Enhancement Program. The stocking summary is provided to help identify potential interactions between native and stocked species and to assist in determining if hatchery fish have an influence on current population trends. **Note:** Although not present here, stocking data, dating back to 1948, was also available from a third source known as Streamnet.

Figure 3 Hatchery Releases in Hunter Creek (1974 – 1996)



<u>Migration Barriers</u>

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 Hunter Creek watershed, 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 applies 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 are 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.

<u>Stream Surveys</u>

The ODFW has developed a standard stream habitat survey methodology (Moore et al. 1997) that they and other agencies and some industrial landowners have used to collect extensive amounts of fish habitat data. An assessment of existing stream habitat survey data was conducted in the Hunter Creek basin to help determine how habitat conditions vary throughout the watershed and/or to identify specific portions of the watershed where problems may exist. Existing stream survey summary data was compiled in GIS format from the Southwest Oregon Province GIS Data CD (shapefile titled "Stream Survey Data"). Sampled conditions were compared to "benchmark" conditions established by the ODFW. Conditions were rated as Undesirable (U), Desirable (D), or in-between range (B). The overall condition rating was assigned using the following criteria:

- **Desirable (D):** All parameters rated desirable or in-between
- **Between (B):** Parameter ratings were mixed
- **Undesirable (U):** Most of the parameters rated undesirable
- **ND:** No data

ODFW HABITAT BENCHMARKS
(GWEB 1999)

The ODFW habitat benchmark values are designed to provide an initial context for evaluating measures of habitat quality. While the natural regime of a stream depends on climate, geology, vegetation, and disturbance history, it is useful to know whether a value of a habitat feature in a reach of stream is high or low. For example, knowing whether a reach has a lot of large woody debris (LWD) or fine sediments is useful for understanding the condition of aquatic habitat and its influence on the life history of fishes. The determination of whether the "value" of a habitat feature is "good" or "bad" depends on the natural regime of the stream and the fish species of interest. The habitat benchmark values for desirable and undesirable conditions are derived from a variety of sources. Values for specific parameters were derived for appropriate stream gradient, and regional and geologic groupings of reach data (see Moore et al. 1997). This assessment is designed to look at combinations of features rather than to single out individual values. This approach should help identify patterns within these features that can then be interpreted in a broader watershed context.

The benchmark values of habitat features are listed as desirable or undesirable, but emphasis should be applied to view the values on a sliding scale, and that watershed context be considered. For example, eight pieces of LWD per 100 meters may be very low for a stream in the Cascade Mountains, but extremely high for a stream in the high desert of southeast Oregon. The stream must be viewed within its natural environment. Similarly, a reach in the Cascade Mountains may have eight pieces of LWD per 100 meters, but neighboring reaches may have 25 pieces of LWD per 100 meters. Variability within a watershed may reflect normal disturbance and hydrologic cycles in addition to management history. The assessment of habitat conditions should look to other components of the watershed assessment to find if there are historic or current activities influencing these measures. This provides the basis for linking the findings from the broader assessments of upslope and upstream activities and impacts to actual in-channel conditions.

Tables 13, 14, and 15 (See Appendix) include summaries of available stream survey data, individual benchmark ratings and overall habitat ratings based on various habitat attributes. Specifically, the tables include a Riparian Habitat Condition Summary (Table 13), Pool Habitat Condition Summary (Table 14), and Riffle and Woody Debris Habitat Condition Summary (Table 15).

Caution: Stream survey data is like a single photograph of a dynamic system. Stream channel conditions may change drastically between years, especially if there has been a high flow (flood) event. Also, some surveyed reaches have been inconsistently sampled, and the summary data do not necessarily reflect actual conditions.

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 basin and extend into all subwatersheds.
- Coho and chinook appear to have very similar distribution patterns. Both species are found in the Lower Hunter Mainstem, Middle Hunter Mainstem, and Big South Fork subwatersheds. Neither coho nor chinook migrate into the Upper Hunter Mainstem or North Fork subwatersheds.

Stocking Summary

- Chinook releases represent a short-term rehabilitation project conducted between 1987 and 1996. Due to the rebound in chinook numbers the program was discontinued. (ODFW 2001)
- Over time, there has been a general reduction in chinook releases as well as a modification of hatchery programs in order to reduce risk to naturally produced fish. Large-scale releases of hatchery fish and transfers between basins have discontinued. Stocks of fish from other watersheds that were released in south coast basins were not particularly well adapted and do not appear to have survived well. Limited genetic analysis indicates that non-indigenous stocks have not persisted in south coast basins since releases were discontinued. (ODFW 2001)

Migration Barriers

- Relatively few adult fish passage barriers are thought to exist throughout the watershed. One "adult restricted" barrier is present on Little South Fork with 0.5 miles of habitat estimated above the site. One juvenile barrier is identified in the Lower Hunter Mainstem subwatershed with an estimated 0.6 miles of habitat above the site.

Riparian Habitat Condition Summary

- No riparian conifer information available.
- Shade values are high.
- Big South Fork #1 and #2 show high percentages of secondary channel area
- Bank erosion is generally low, with N. FK Hunter and Hunter Creek #3 showing the highest values

Pool Habitat Condition Summary

- Pool area and frequency generally moderate, with desirable rating in Hunter #1 & #2 for area and Big S FK #2 for frequency.
- Pool depths mixed with in-between and undesirable ratings. Cross check with sediment and hydrology modules, especially Big South Fork Hunter.
- Complex pool information not available for any of the surveyed reaches.
- Overall pool rating in-between for all reaches.

- Reaches with high percentage of pool area, low channel widths per pool and low wood values, may indicate a dominance of long, simple, lower quality pools

<u>Riffle and Woody Debris Habitat Condition Summary</u>

- Width to depth ratios generally undesirable, with only Big S FK #2 showing a desirable rating.
- Percent of gravel area has a moderate rating for all reaches except desirable ratings in Big S FK #3 and Hunter #1.
- Percent fine sediments in gravels and overall riffle rating generally moderate, with Hunter Creek #1 and #2 showing undesirable values.
- Large wood is generally lacking in all reaches, with a desirable rating found only in N. Fk Hunter Creek #1.
- No information is available for key pieces of large wood in the surveyed reaches

REFERENCES

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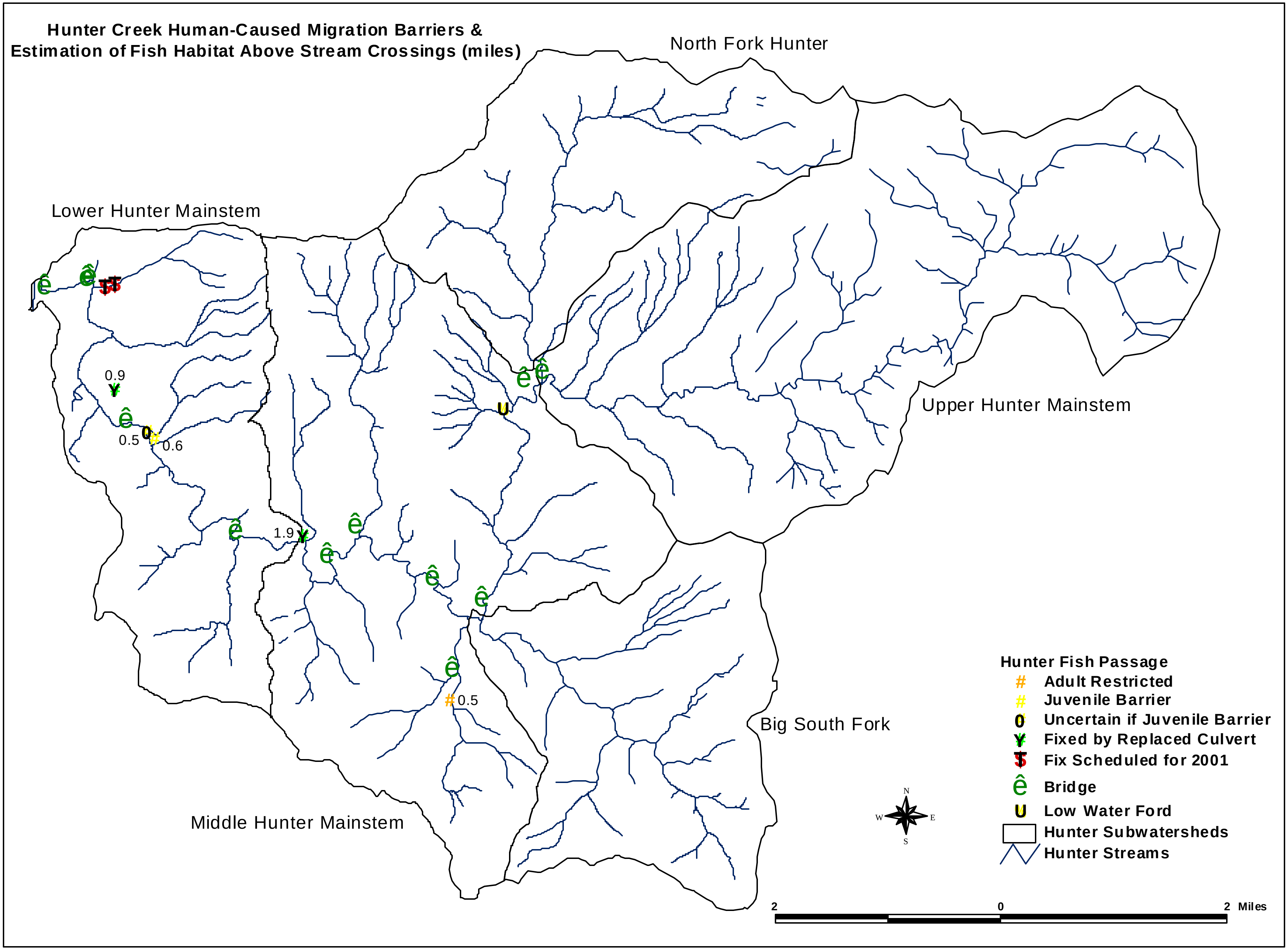
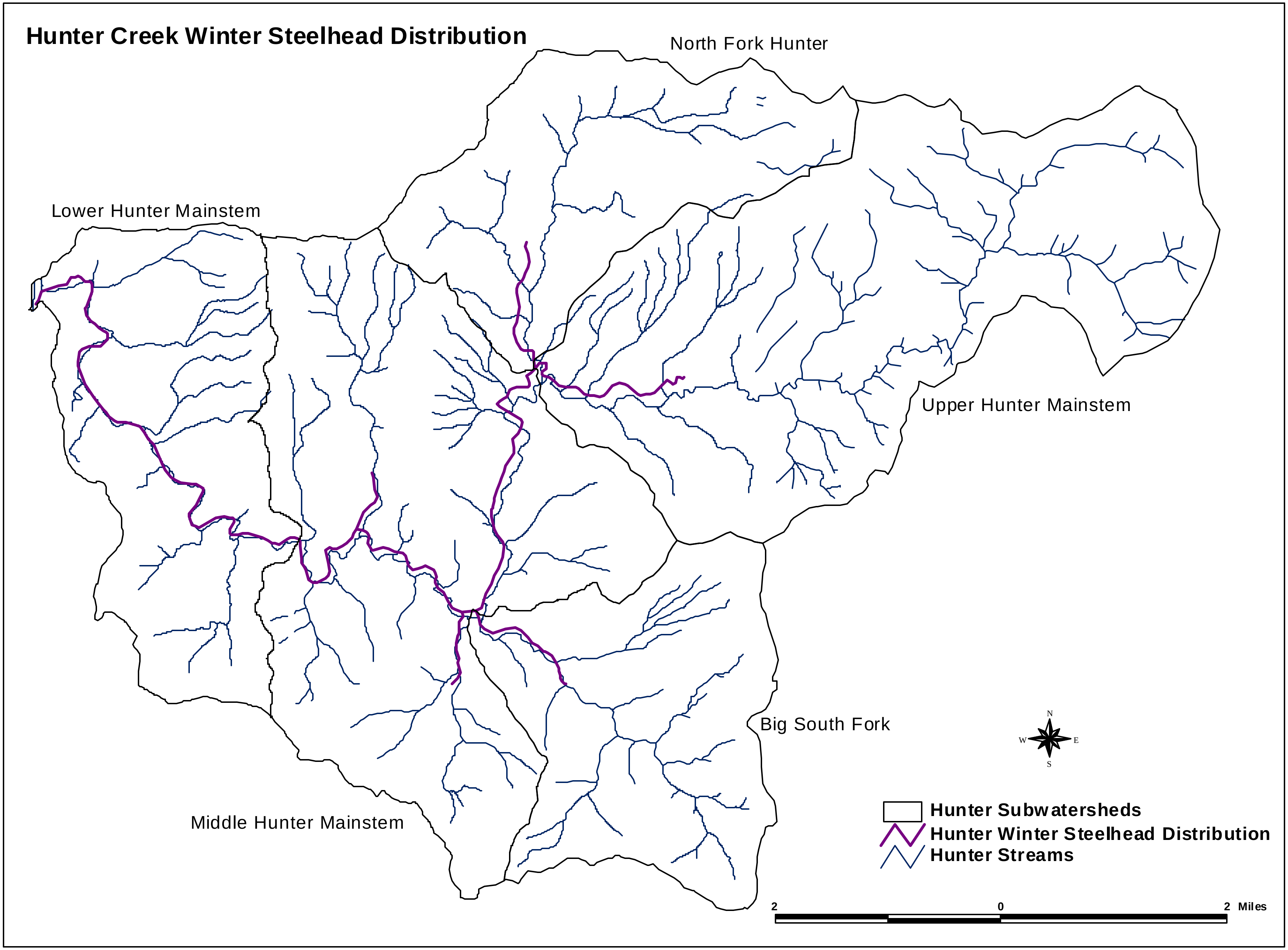
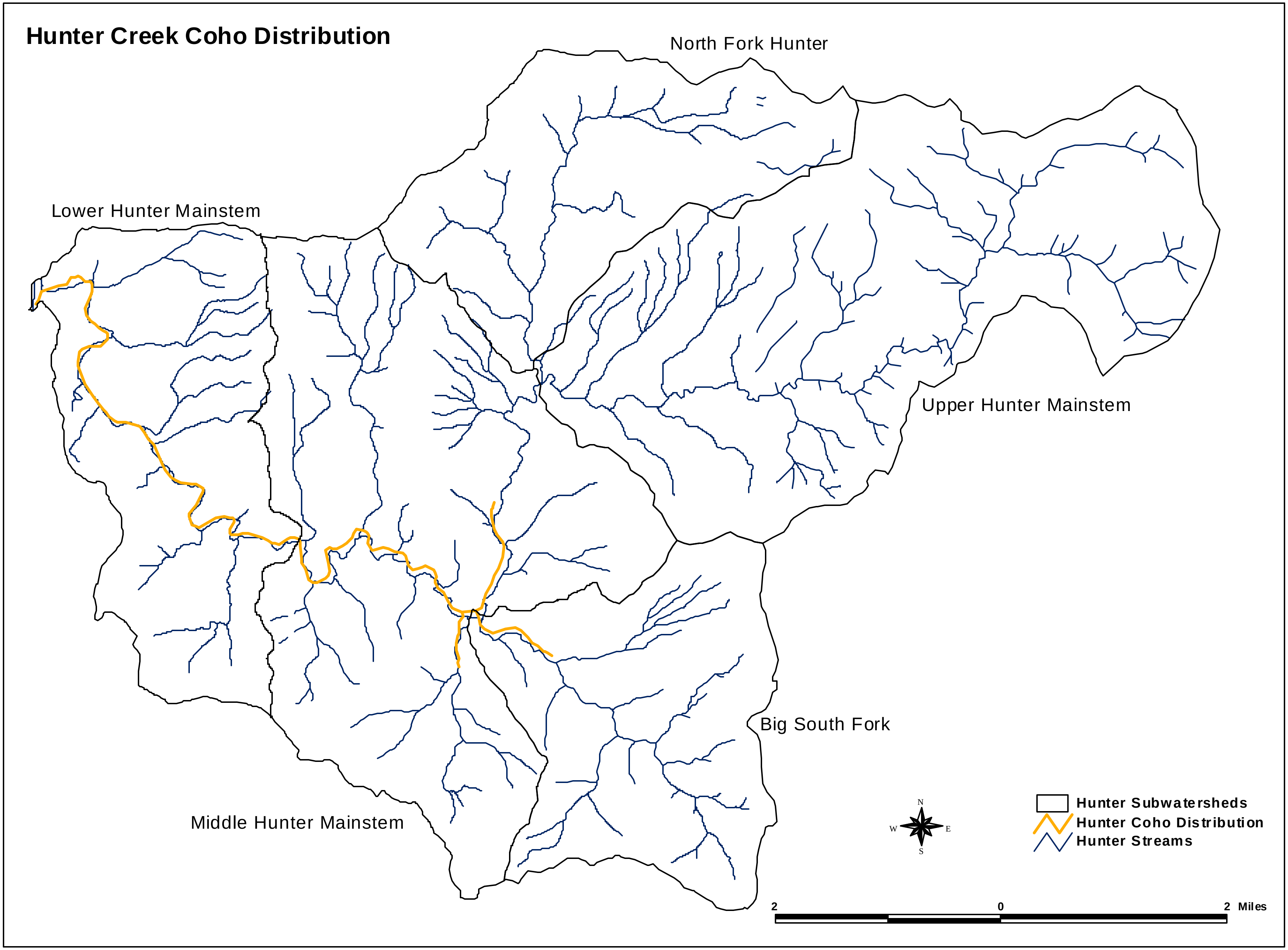
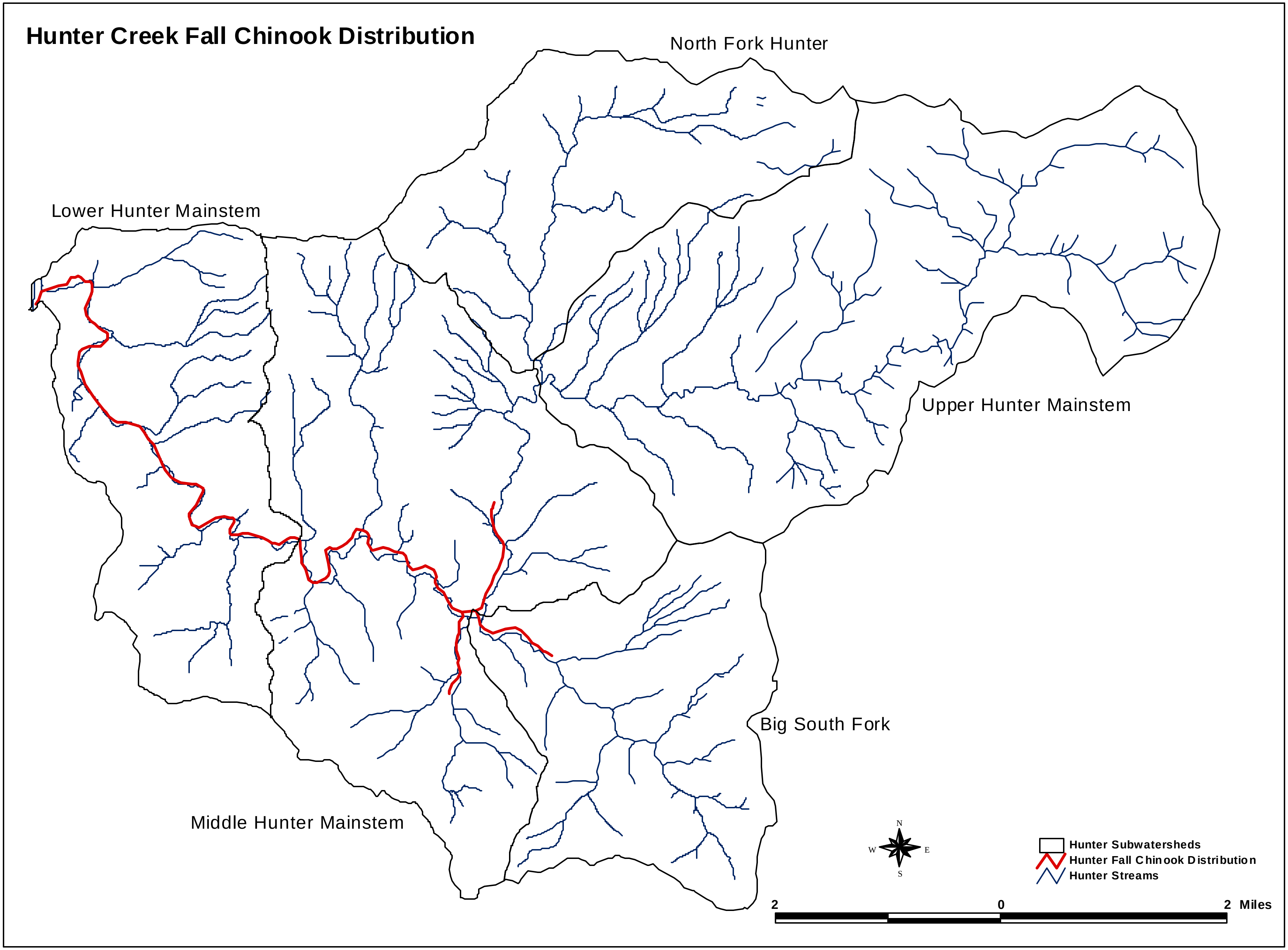


Hunter Creek Human-Caused Migration Barriers &
Estimation of Fish Habitat Above Stream Crossings (miles)
North Fork Hunter
Lower Hunter Mainstem
Upper Hunter Mainstem
Big South Fork
Middle Hunter Mainstem
0.9
0.5
0.6
1.9
0.5
Hunter Fish Passage
Adult Restricted
Juvenile Barrier
Uncertain if Juvenile Barrier
Fixed by Replaced Culvert
Fix Scheduled for 2001
Bridge
Low Water Ford
Hunter Subwatersheds
Hunter Streams
N
W
E
S
2
0
2 Miles



Hunter Creek Winter Steelhead Distribution
North Fork Hunter
Lower Hunter Mainstem
Upper Hunter Mainstem
Big South Fork
Middle Hunter Mainstem
N
W
E
S
Hunter Subwatersheds
Hunter Winter Steelhead Distribution
Hunter Streams
2
0
2 Miles


Hunter Creek Coho Distribution
North Fork Hunter
Lower Hunter Mainstem
Upper Hunter Mainstem
Big South Fork
Middle Hunter Mainstem
N
W
E
S
Hunter Subwatersheds
Hunter Coho Distribution
Hunter Streams
2
0
2 Miles


Hunter Creek Fall Chinook Distribution
North Fork Hunter
Lower Hunter Mainstem
Upper Hunter Mainstem
Big South Fork
Middle Hunter Mainstem
N
W
E
S
Hunter Subwatersheds
Hunter Fall Chinook Distribution
Hunter Streams
2
0
2 Miles

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.

Nutrients

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.

Bacteria

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 Escherichia coli (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 Hunter Creek watershed 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 16). 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 16 illustrates the Beneficial Uses that pertain to the south coast watersheds including Hunter Creek. This list was obtained from the ODEQ's web site.

Table 16 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

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)

Table 17 illustrates the Water Quality Limited Streams that pertain to the Hunter Creek watershed. The 7-day maximum temperatures listed below reflect the highest on record as of 2000.

Table 17 Water Quality Limited Streams

Tributary / Reach	Boundary	Parameter	Listing Status	Highest As of 2000	
				7-day max	Hrs >64 F
Hunter Creek	Mouth to RM 16.5	Temperature	303(d) List	75 in 1998	1,097 @ Mateer Bridge
	Mouth to RM 16.5	Sedimentation	Need data		

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 Hunter Creek watershed there are no locations that are officially recognized on this list. However, stream temperature measurements suggest that certain areas of the watershed do not meet the state's temperature standard.

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 helped landowners and agencies establish realistic, watershed-specific targets for shade and water temperature.

Since 1995, 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 Hunter Creek basin since 1995. 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, Siskiyou National Forest, BLM and the Oregon Department of Fish and Wildlife. Table 18 illustrates the 7 Day Max Values that represent annual trends from 1995 to 2000. Table 19 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. In most cases on public lands, resource personnel from the agencies listed above measured the 7-day max values. For more details please contact the South Coast Watershed Council's Monitoring Coordinator.

Table 18 Annual Trends – 7-Day Max Values (Degrees Fahrenheit)

Location	2000	1999	1998	1997	1996	1995
Hunter at NF Boundary	73.6	72.9	75.2	74.2	74.5	74.4
North Fork	68.0	65.6	68.0	68.6	65.3	65.6
Big South Fork			62.6	62.9		63.2
Hunter at High Bridge	70.9	69.6	71.5		70.4	71.2
Hunter at Mateer Bridge	70.9	*69.2	72.9		70.1	

* 7-day maximum post August 13th only, due to equipment loss

Table 19 Days >64º F (7-day max values)

Location	2000 Days > 64º	1999 Days > 64º	1998 Days > 64º	1997 Days > 64º
Hunter mainstem at NF boundary		60		
North Fork at mouth	48	33		
Hunter mainstem at High Bridge	56	72		
Hunter mainstem at Mateer Bridge	56	34		
Hunter mainstem at Highway 101 Bridge		73		

E KEY FINDINGS

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

- The Oregon Department of Environmental Quality does not monitor water quality in the Hunter Creek watershed via the Oregon Water Quality Index. As such, water quality data, except for temperature, was not available to compare with the Oregon Water Quality Standards.

Temperature

- Mainstem Hunter Creek consistently exceeds 64°F temperature standard in summer, with the highest recorded 7-day maximum temperature of 75.2°F.
- Large ΔT on mainstem Hunter Creek at Mateer Bridge.
- Mainstem heating may be due to lack of shade producing vegetation on serpentine bedrock within the national forest.
- Big South Fork of Hunter Creek is consistently the coolest tributary of Hunter Creek and is consistently below the 64°F standard.
- Warmest – Hunter Creek at the national forest boundary.

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 SEDIMENT SOURCES

A BACKGROUND (GWEB 1999)

Erosion that occurs near streams and on surrounding slopes is a natural part of any watershed. Fish and other aquatic organisms in a region are adapted to deal with a range of sediment amounts that enter streams. The amount of erosion in a watershed and the sediment load in the streams vary considerably during the year, with most sediment moving during the few days that have the highest flows. The most significant land-forming events occur during precipitation or snowmelt events that happen only once every decade or more.

Sediment is delivered and transported to stream channels by a variety of processes. Landslide types vary from rapid, shallow debris slides and flows on steep terrain to slow-moving episodic earthflows covering hundreds of acres. Erosion processes include overland flow, concentrating into rills and gullies as well as streambank erosion.

Effects of sediment on stream channels and aquatic habitat are related to the volume, texture, and rate of delivery (see diagram below), as well as the characteristics of receiving stream channels. Fine particles (sand, organics, and silt) deposited on the streambed may blanket spawning gravels and reduce survival of fish eggs incubating in the gravel. Fine sediment may cover the exposed rock surfaces preferred by aquatic insects, reducing the food supply to fish. Suspended sediments cause turbidity (clouding of water), which prevents fish from feeding. Large deposits of coarse sediments can overwhelm the channel capacity, resulting in pool-filling, burial of spawning gravels, and, in some cases, complete burial of the channel, resulting in subsurface streamflows.

Channel Response to Bedload Supply (Lisle USFS)

Bedload Supply →		
← →	Armoring	Braiding
Incision		Aggradation
	Embeddedness	Bank erosion
Bank erosion		Pool filling by unsorted bedload
	Fines in pools	Bar construction
Morphologic Response	Textural Response	Morphologic Response

The hardness of the underlying rock and its fracturing as the land is uplifted over long periods of time determine the rate of erosion. These geological processes also influence the pattern and density of streams in a watershed.

In addition to natural levels of erosion, human-induced erosion can occur from roads, landings, rock sources, and other land disturbances. Separating human-induced erosion from natural erosion can be difficult because of the highly variable nature of natural erosion patterns. Furthermore, human-caused erosion may also be highly variable in timing and spatial pattern. While it is nearly impossible to specify when a human-induced change in sediment is too much for a local population of fish and other aquatic organisms to handle, in general, the greater a stream deviates from its natural sediment levels the greater the chance that the fish and other aquatic organisms are going to be affected. Sediment in streams can have a human dimension, too. High sediment levels can increase the cost of treating drinking water, can be aesthetically displeasing, and can decrease fish angling access.

It is important to recognize that much eroding soil will deposit on a hill slope before it reaches the stream. This is good news, since there are a number of things that can be done to fix a site that is eroding before the sediment enters the streams. For example, water draining from a rutted road surface can be delivered onto a well-drained slope where the sediment will be filtered out, and the clean water can flow beneath the ground's surface to the stream.

Road-Related Erosion

The road network is potentially a significant erosion feature. Improperly placed roads can divert sediment-laden water to streams. Poor drainage of roads can lead to gullying and channeling of the road surface. Improper maintenance of inboard ditches can cause saturation of the roadbed, leading to mass wasting.

Road washouts also can occur when a road adjacent to the stream is undercut and a portion of the road drops into the stream, or at stream crossings during a high flow where there was either an undersized or plugged culvert or bridge. In steeper terrain, road washouts can create shallow landslides on unstable fill or cut-slopes failures. Appropriate sizing of culverts and bridges at stream crossings, locating roads away from streams, designing roads properly, and correctly disposing of soil during road construction on steeper slopes can prevent most road washouts.

B INTRODUCTION

The assessment of sediment within the Hunter Creek watershed was focused on the results of two analyses that serve as indicators of sediment related concerns. These indicators include an analysis of road density on steep slopes (>50%) and an analysis of road crossing density. Individually, each indicator can help direct land managers toward areas within the watershed that may warrant further investigation. Collectively, however, these indicators identify the relative risks of sediment impacts for each subwatershed throughout private lands in the basin.

The two indicators considered in this assessment (See Tables 20 & 21) focus on roads. They are designed to characterize past and future sediment delivery potential. These indicators represent processes that cause sediment delivery to stream channels, and should be interpreted with stream channel data, such as substrate and pool depth benchmarks used by ODFW. Data on cobble and dominant substrate at pool tail-outs are also available for channels of various gradients measured at several sites throughout private lands in the watershed. Although natural and harvest-related sediment sources are also present, they offer fewer opportunities for restoration and are therefore not included in this assessment.

Table 20 Roads on Slopes >50% (Indicator I)

Process: Failure of road fills, steep road surfaces and ditches concentrating runoff onto hillslopes.
Comments: Road failures result when road fill becomes saturated and/or incorporated woody debris decays. Prior to changes in the forest practice rules, roads were constructed by excavating and "sidecasting" road fill on slopes greater than 60%. Current practices call for excavating a "full bench" road and end-hauling the material to a stable landing. Although this indicator does not account for the age of the road, most roads were constructed before the change. Roads with well-maintained drainage systems may minimize the erosion, but large storms may move enough sediment to overwhelm the drainages.

Table 21 Road Crossings (Indicator II)

Process: Plugging of culverts, leading to wash-outs or diversions down the road and onto unprotected hillslopes.
Comments: Old forest practice rules required culverts to be sized for storms recurring every 25 years or less. Many of these older culverts cause water to pond during storms, and allow woody debris to rotate sideways and plug the culvert. Culverts that are substantially narrower than the stream channel are also more likely to plug. Crossings located on steeper stream channels are subject to higher stream power mobilizing sediment and wood in the channel, and on hillslopes when diverted. Debris flows are also more likely to be generated on steeper channels. **Note:** *Currently, this indicator has not been refined by considering the stream gradient or the stream junction angle that would factor in the likelihood of continued debris flow run-out. Also, not all culverts that are included in this indicator are likely to plug or fail.*

Ideally, the sediment indicators could characterize the probability of delivering an estimated volume of sediment with a known range of particle sizes. In reality, we can only infer the processes likely to deliver sediment, and identify locations where the processes are most likely to occur.

C METHODOLOGY

- Roads on Slopes >50%: USGS 7.5 Minute topographic maps and digital orthophoto quads were interpreted to generate a comprehensive watershed road map in GIS. Old roads were included on the map. Slopes >50% were generated from a slope class map (originally from 10 meter digital elevation models) prepared by the Rogue Valley Council of Governments' GIS department. The length of all roads with slopes >50% were calculated for each subwatershed.
- Road Crossings: USGS 7.5 Minute topographic maps and digital orthophoto quads were interpreted to generate a comprehensive watershed road crossing map in GIS.

Crossings were identified at sites where contours or road configuration indicated the presence of distinct channels. (Larger drainage areas are required to create channels on more gentle slopes.) Old roads were included on the map. Crossings on these old roads may already be washed out, or no longer accessible for restoration, but their effects may be reflected in stream channel conditions below.

- For each subwatershed and each indicator a rating of sediment impacts was assigned based on comparisons of all south coast subwatersheds considered in this assessment. A percentile rating of 0-100 was established to represent the relative risk of each indicator for each subwatershed relative where 0 = lowest possible risk and 100 = highest possible risk. The percentile rating was further divided in the following categories: 0-19 (low); 20-39 (moderately-low); 40-59 (moderate); 60-79 (moderately high) and 80-100 (high).

D RESULTS

Table 22 Summary of Sediment Impacts

Subwatershed	Non USFS Acres	Roads on Slopes>50%			Road Crossings		
		Total Road Miles	Density/ Sq Mi	Roads on Slopes >50% Percentile	Total # of Crossings	Density/ Sq Mi	Road Crossings Percentile
Big South Fork	3,338	1.83	0.35	28	98	18.79	100
Lower Hunter Mainstem	4,358	3.01	0.44	36	95	13.95	73
Middle Hunter Mainstem	7,746	3.17	0.26	21	162	13.38	70
North Fork Hunter	3,293	0.79	0.15	12	21	4.08	17
Upper Hunter Mainstem	2,298	0.05	0.01	1	12	3.34	13

E KEY FINDINGS

<u>Density of Roads on Slopes >50%</u>

- Subwatersheds that received a moderately low risk rating of density of roads on slopes >50% include Lower Hunter Mainstem (36%), Big South Fork (28%), and Middle Hunter Mainstem (21%).
- The North Fork and Upper Hunter Mainstem received low risk ratings of 12% and 1% respectively.

<u>Density of Road Crossings</u>

- The Big South Fork received the highest risk rating (100%) of road crossing density among all south coast subwatersheds considered in this assessment.
- The Lower Hunter Mainstem and Middle Hunter Mainstem each received moderately high risk ratings of 73% and 70% respectively.
- The North Fork and Upper Hunter Mainstem received low risk ratings of 17% and 13%.

F OTHER

Although not available at this time, an analysis of roads within 100 feet of stream channels will serve as a third indicator. Data produced by the Rogue Basin Restoration Technical Team should be available in the near future.

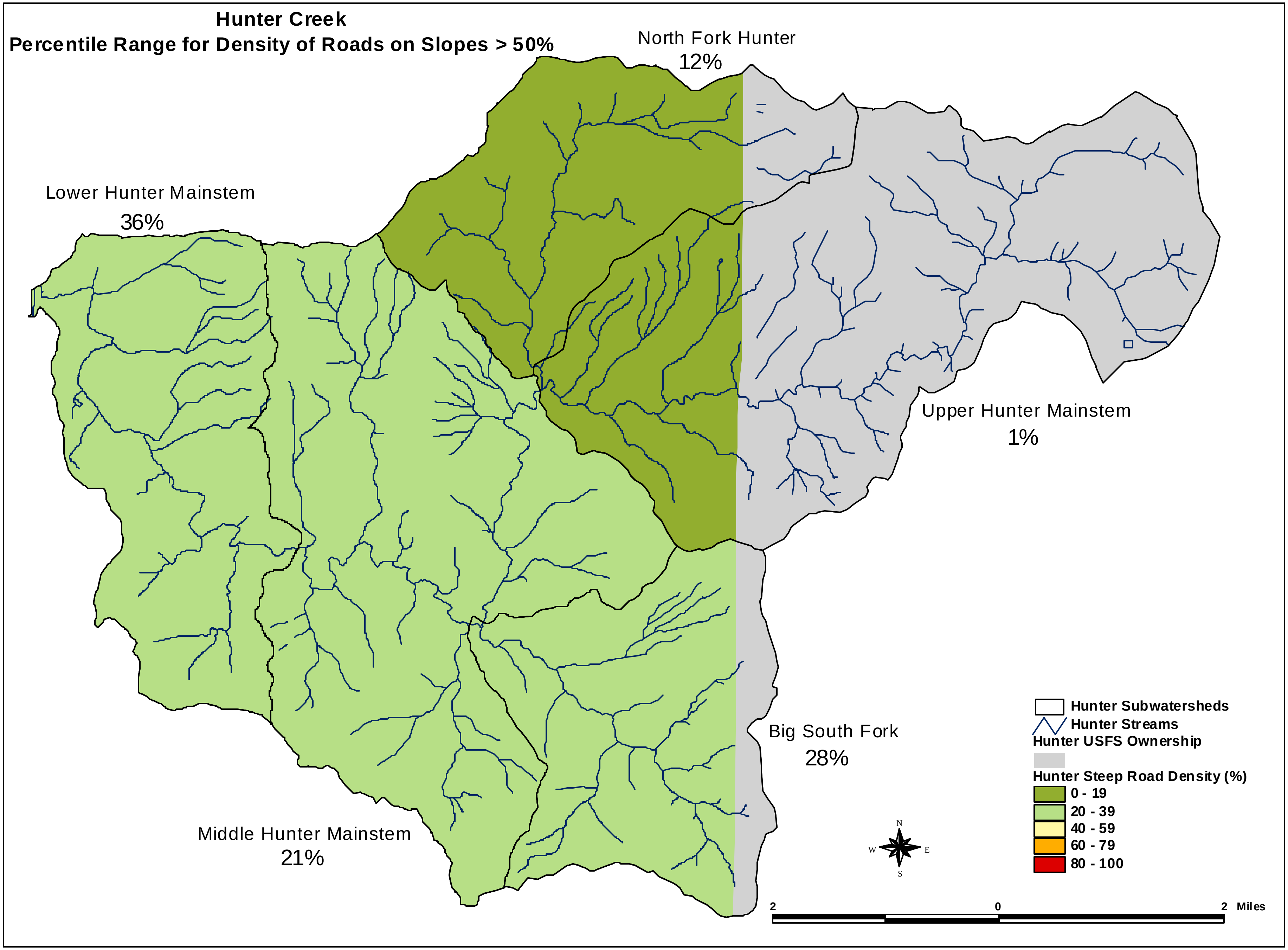
Table 23 Roads Within 100 feet of Stream Channels (Indicator III)

Process: Ditch erosion delivered directly to streams at crossings and at ditch relief culverts (less opportunity for fines to deposit on slopes), fill failures more frequent in wet toe-slope position and more likely to deliver to channels. Removal of large wood from channels.
Comments: The amount of fines generated from the road surface and ditch is related to the traffic and season (e.g. wet weather haul), frequency of disturbance including grading, and quality of the surfacing on the road. These factors however are not taken into account by this indicator.

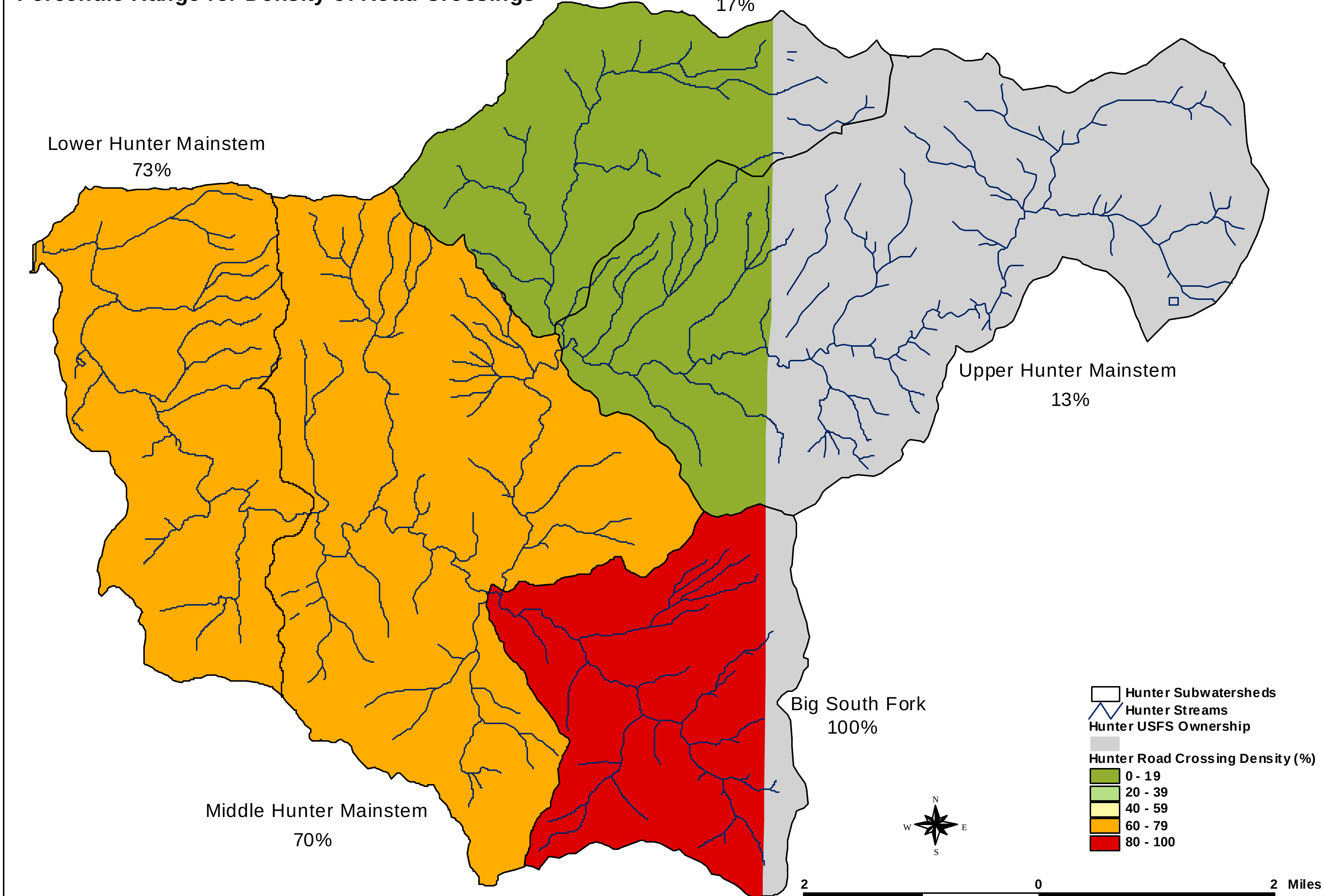
REFERENCES

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

Lisle USFS. Tom Lisle, USFS, Redwood Sciences Laboratory, Arcata, California


Hunter Creek
Percentile Range for Density of Roads on Slopes > 50%
North Fork Hunter
12%
Lower Hunter Mainstem
36%
Upper Hunter Mainstem
1%
Big South Fork
28%
Middle Hunter Mainstem
21%
Hunter Subwatersheds
Hunter Streams
Hunter USFS Ownership
Hunter Steep Road Density (%)
0 - 19
20 - 39
40 - 59
60 - 79
80 - 100
N
W
E
S
2
0
2 Miles

Hunter Creek
Percentile Range for Density of Road Crossings



IX RIPARIAN ASSESSMENT

A **BACKGROUND** (GWEB 1999)

A riparian area or zone is a term that is often difficult to define. At its simplest, it is a green area along a body of water such as a stream or river. Riparian areas generally have higher levels of soil moisture than adjacent upland areas, and usually are well-vegetated. A wide variety of hydrologic, geomorphic, and biotic processes determine the character of a riparian zone.

Riparian vegetation influences fish habitat and water quality in a number of ways. Riparian vegetation may act as a filter in some areas, keeping sediment and pollutants out of streams. The roots of riparian vegetation stabilize streambanks by reducing erosion and preventing stream channels from downcutting. Streamside vegetation provides habitat for insects, some of which fall in the water and provide a food source for fish. In addition, vegetative litter is an important source of nutrients to the stream. During high stream flows, riparian vegetation may slow and dissipate the energy of floodwaters, preventing erosion. Although all of these are important functions of riparian vegetation, they are difficult to quantify and are beyond the scope of this assessment. This assessment focuses only on the functions of riparian areas in providing a source of large wood to the stream, and in providing shade for temperature control. Riparian zones that are functioning to provide these two key inputs typically provide many other valuable functions and processes attributed to these dynamic areas.

<u>Large Wood Recruitment</u>

Riparian areas are an important source of large woody debris (LWD) that enters, or is recruited to, the stream channel. LWD, including tree boles, root wads, and large branches, is recruited to the stream by bank erosion, mortality (e.g. disease or fire), or wind throw. Also, trees from both riparian and upland areas may also be carried into the stream by landslides.

In the stream channel, LWD diverts and obstructs flow, thereby increasing channel complexity (i.e., the large wood creates pools and riffles that provide areas of different velocity and depth). This complexity provides cover from predators, creates rearing areas, and develops refuge areas for fish during high stream flows. LWD also creates storage sites for sediment in all sizes of streams. In small headwater streams, wood controls sediment movement downstream. In larger streams, accumulation of sediment behind LWD often provides spawning gravels. LWD plays an important role in stream nutrient dynamics by retaining leaf litter and needles, making these energy supplies available for consumption by aquatic insects that ultimately serve as food for fish.

<u>Riparian Shade</u>

Although other processes besides shading affect heating and cooling of water (such as groundwater inflows), shade can have the largest affect because it counteracts the most important source of stream heating during the summer – solar radiation. Riparian enhancement efforts that provide shade have a high potential to contribute to temperature moderation as well as provide direct benefits to fish and wildlife habitat.

Shade provided by riparian vegetation affects stream temperature by reducing the inputs of solar radiation to the water surface. Although the vegetation itself will radiate heat to the stream, the increase in water temperature due to radiation from this source is very small compared with heating from direct solar radiation. Radiation from vegetation is important, however, because it decreases fluctuation of water temperatures on a daily (or diurnal) basis in forested streams compared with streams that have no canopy cover. The slope and aspect of a site also affect the amount of radiation received. In some areas (e.g. deep canyons) the topography of the land can also provide significant shade.

Role of Ambient Air Temperature

In most streams, evaporation of moisture is a primary mechanism of stream cooling; the heat is used to turn water into vapor. Turbulent streams will cool faster than slow streams with smooth surface conditions, due to the higher evaporation rate. Inputs of cool groundwater are also a significant source of stream cooling in some areas.

Stream temperatures are cooler than the ambient air temperature because of the higher specific heat of the water, and the cooling processes associated with evaporation and the inflow of groundwater. The daily patterns in stream temperature follow the daily change in air temperature. Typically, the maximum daily temperature occurs in the late afternoon and the minimum occurs late at night or early morning.

In many streams in Oregon, late-summer streamflows are lowest when the net heat gain is the greatest, resulting in the warmest water temperatures of the year. This phenomenon reflects the fact that the maximum water temperature is a result of both the net heat received and the amount of water that is heated. Consequently, the maximum annual stream temperatures may be higher in low-flow or drought years even though the stream receives the same level of heating each year.

Stream Order (OSU 1998)

A basic description of stream order is essential to understand the relationship of existing, potential, and potential increase in shade on perennial stream reaches. Stream order is a useful way to classify streams because within a given climatic and geologic region, certain stream orders tend to share many features and processes. The most common stream order classification system is to call the initial channel where a small stream first appears a first-order stream, and then to increase the order with each successive downstream junction with a stream of equal or higher order. Thus, small streams have low order numbers, while large streams and rivers have high order numbers.

B INTRODUCTION

Riparian vegetation has been removed along streams throughout the Hunter Creek watershed for a variety of management practices and also naturally, through streambank erosion. Historically, many riparian zones within the Hunter Creek basin contained large conifers that were later harvested. In many cases, alder (*Alnus rubra*) dominant riparian communities have succeeded in the years following these harvests. Conifers typically grow taller and live longer than alders. The act of converting these present-day alder dominant communities back to mixed stands that include conifers (alder conversion) will undoubtedly provide increased shade for the long term.

The removal of riparian vegetation has reduced shade and subsequently increased the amount of sunlight reaching the stream. As noted previously, shade is one of the factors that controls summer stream water temperatures. In-stream flow and groundwater, as well as channel width/depth, and bedrock/substrate heating are other factors to be considered, but are not included in this assessment.

In 2001, an assessment of shade was conducted to estimate the existing and potential shade on perennial streams within the Hunter Creek watershed. Existing shade is defined as shade that is currently present as evidenced by aerial photograph interpretation and selected field measurements. Potential shade is defined as the amount of shade that can be produced over time based on the site's potential to grow trees. The results of these two analyses were compared to estimate the potential increase in shade throughout the watershed.

A summary of the riparian assessment is presented in Tables 24 to 27. The Key Findings portion of this assessment highlights significant attributes of each table. **Note:** the Riparian Assessment evaluated riparian zones and streams only on private lands within the Hunter Creek watershed.

C METHODOLOGY

- Topographic maps (USGS 7.5 minute quads) and aerial photos (1997 BLM) were compiled to divide streams into numerous reaches (segments) based on differences in riparian vegetation, orientation (aspect), size and gradient.
- Riparian vegetation was characterized into nine different classes. These classes and their attributes include the following: Mature = coniferous trees >121 feet; High (reproduction) = coniferous trees 91 – 120 feet; Low (reproduction) = coniferous trees 31 to 90 feet; Hardwood = deciduous and evergreen hardwood trees >31 feet; Brush = shrubs < 30 feet and Pioneer = bare or nearly bare ground. Other classes include Alder/High, Alder/Low, and Other.
- Field visits were conducted at several sites and included the following measurements: summer low flow width, bankfull channel width, distance from bankfull to riparian vegetation, streambank slope, various tree heights, percentage of overhanging vegetation, and shade density. The existing percentage of shade was also measured at each site in the middle of the bankfull channel with an instrument known as the Solar Pathfinder. This device allows the user to estimate the percent of solar radiation shaded by riparian vegetation for any given day of the year. **Note:** *Additional Solar Pathfinder measurements could be used to validate the SHADOW results or to modify assumptions used to date. Although there is a lack of channel data for numerous small streams (not necessarily perennial) in the watershed, these contribute the least*

flow and require the shortest vegetation to provide shade. Sensitivity analysis for the variables used in SHADOW would help focus attention on those least certain data fields.

- Existing shade was estimated using a computer spreadsheet program known as SHADOW. SHADOW considered the angle of the sun on August 1st in determining how far a tree projects a shadow across a stream during each hour of the day. For each stream reach, information was obtained from maps, photos, and field measurements to estimate a low flow channel width (wetted width) and existing tree height. SHADOW estimated shade for each stream reach based on its aspect, characterized as diagonal, north-south, or east-west.
- Average channel widths and tree heights were used to create an existing shade map overlay. Local conditions differ from assumed conditions and will determine the actual shade along any particular stream reach. Landowners can obtain more specific estimates of potential shade for any set of field conditions. SHADOW can also be used to calculate widths of riparian vegetation that are shading in the primary (11:00 AM-1:00 PM) and secondary (before 11:00 AM and after 1:00 PM) zones.
- The process for estimating potential shade was identical to that of estimating existing shade, with the added assumption that a tree can grow to a certain height over time. Based on field measurements of mature stands of mixed conifers and hardwoods in several watersheds on the south coast it was assumed that trees could grow an average of 132'.
- The percentage of existing shade was mapped (on mylar), in 20% increments, to illustrate the current condition on all perennial streams within the watershed. Similarly, the percentage of increased shade was mapped (on mylar), in 20% increments, to illustrate the potential condition on all perennial streams within the watershed. Increased shade was determined by subtracting the existing shade from the potential shade.

D RESULTS

Table 24 Miles of Streams by Perennial Stream Reach & Stream Order

	Stream Order						Total Miles of Stream
Perennial Stream Reach	1	2	3	4	5	6	(All Stream Orders)
Mainstem	1.3	9.7	14.9	7.9	2.5	11.1	47.5
North Fork	0.3	1.7	3.5	4.0	0.8	0.0	10.4
Big South Fork	0.0	1.4	4.6	3.2	2.0	0.0	11.2
Total Miles	1.6	12.8	23.1	15.1	5.4	11.1	69.1

Table 25 Average Existing Shade (%) by Perennial Stream Reach & Stream Order

	Stream Order						Total Averages for All
Perennial Stream Reach	1	2	3	4	5	6	Stream Orders
Mainstem	92	93	87	77	39	42	74
North Fork	95	92	86	72	60	-	80
Big South Fork	-	89	79	74	60	-	75

Table 26

Average Potential Shade Increase (%) by Perennial Stream Reach & Stream Order

Perennial Stream Reach	Stream Order 1	2	3	4	5	6	Total Averages for All Stream Orders
Mainstem	4	4	5	9	15	13	8
North Fork	4	6	6	11	12	-	8
Big South Fork	-	8	13	7	11	-	11

Table 27 Riparian Vegetation Classes (miles) by Perennial Stream Reach

Perennial Stream Reach	Riparian Vegetation Classes (miles)									Percentage of Mature & High
	Mature	High	Low	Hardwoods (Alder)	Brush	Pioneer	Alder/ High	Alder/ Low	Other	
Mainstem	0.0	2.7	1.1	30.3	5.4	1.3	0.9	0	0.5	6
North Fork	0.6	0.5	0.0	6.2	0.7	0.6	0.7	0	0.0	12
Big South Fork	0.0	0.0	0.0	7.3	2.0	0.2	0.0	0	0.9	0

E KEY FINDINGS

<u>Table 24</u>

- Approximately 69 miles of streams, located on private lands within the Hunter Creek watershed, were evaluated in this assessment. Of the total stream miles assessed the majority were located along the Hunter Mainstem (69% of the total). Other drainages considered in this assessment include: the North Fork and Big South Fork.
- Stream orders in the Hunter Creek watershed range from 1st to 6th. In order of greatest occurrence the percent of stream orders found throughout the basin are 3rd order (33.4%); 4th order (21.8%); 2nd order (18.5%); 6th order (16.1%); 5th order (7.8%); and 1st order (2.4%).

<u>Table 25</u>

- In general, existing shade percentages are highest in 1st and 2nd order streams and lowest in 5th and 6th order streams. The highest existing shade is 93% on 9.7 miles of 2nd order streams in the Hunter Mainstem area. The lowest existing shade is 39% on 2.5 miles of 5th order streams in the Hunter Mainstem area.

<u>Table 26</u>

- The stream reaches in the Big South Fork have the highest potential shade increase (11%) on average for all stream orders.
- The highest potential shade increase on 1st order streams is 4% on 1.3 miles of the Hunter Mainstem area.
- The highest potential shade increase on 2nd order streams is 8% on 1.4 miles of the Big South Fork.
- The highest potential shade increase on 3rd order streams is 13% on 4.6 miles of the Big South Fork.
- The highest potential shade increase on 4th order streams is 11% on 4.0 miles of the North Fork.

- The highest potential shade increase on 5th order streams is 15% on 2.5 miles of the Hunter Mainstem area.
- The highest potential shade increase on 6th order streams is 13% on 11.1 miles of the Hunter Mainstem area.
- Individual stream reaches have higher potential increases in shade than the averages for the corresponding stream order. These specific locations are illustrated on mylar overlays located in the Curry County Soil and Water Conservation District Office.

Table 27

- Mature and high vegetation classes comprise a low percentage of the riparian vegetation in private lands within this watershed.
- The only mature riparian vegetation is on 0.6 miles of the North Fork. High vegetation classes are concentrated along 2.7 miles of the Hunter Mainstem area. These areas are likely sources of large woody debris.

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

X 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 the 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 Hunter Creek watershed.

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 Hunter Creek watershed. These maps were utilized as the base maps for identifying wetlands within the watershed.
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 28. (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 28.
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. Subwatersheds: Subwatersheds 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, the 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. Field Verification: No field verifications were conducted.
11. Comments: Comments were primarily focused on Degree of Alteration. In many cases, key words were used to indicate restoration opportunities including: Protect, Restoration Potential, or Low Restoration Potential. Protect refers to a high value, functioning wetland that should be considered for protection from

potential land use impacts. Restoration Potential refers to a site where restoration or enhancement work is feasible, and Low Restoration Potential typically indicates a site that will not likely be restored (e.g. "prime pasture"). Comments also provide some information pertaining to the existing status of the site.

12. 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 28 Hunter Creek Wetland Attributes (See Appendix)

E KEY FINDINGS

- An estimated 25 acres of wetlands were assessed in the Hunter Creek watershed. This acreage was divided into 8 Wetland ID's; each of which is comprised of one or more NWI delineated wetlands.
- The degree to which these wetlands have been altered is as follows: High, 70%; Moderate, 26%; and Low, 4% *Percentages are based on total acres.*
- Of the 8 wetlands assessed, one has no restoration potential, one should be protected in its present state, and six have moderate restoration potential.
- The wetland buffers are as follows: rural, 96% and forested, 4%. *Percentages are based on total acres.*
- The wetland connectiveness to other waterbodies is as follows: connected, 84% and not connected, 16%.
- Distribution of wetlands occurs in the following subwatersheds: Lower Hunter Mainstem, 96% and Middle Hunter Mainstem, 4%. *Percentages are based on total acres.*
- All wetlands considered in this assessment were located in the lowest watershed position. *See Methodology for explanation of watershed position.*

F DISCUSSION

The OWEB 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.

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

XI 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 Hunter Creek watershed. 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.

<u>General Watershed Characteristics</u>

A Geographic Information System (GIS) analysis was conducted to provide general watershed characteristics pertaining to the Hydrologic Condition Assessment of Hunter Creek. 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 29 General Watershed Characteristics

Subwatershed Name	Subwatershed Area (square miles)	Mean Annual Precipitation (inches)	Minimum Elevation (feet)	Maximum Elevation (feet)	Maximum Elevation (Location)
Big South Fork	6.1	110	160	2,800	No Name
Lower Hunter Mainstem	6.8	92.5	0	1,768	No Name
Middle Hunter Mainstem	12.1	102.5	80	2,080	Sundown Mtn.
North Fork Hunter	6.0	120	480	3,512	"Stack" near Signal Buttes
Upper Hunter Mainstem	13.4	120	480	3,558	Sugarloaf Mtn.
Totals	**44.4**				

<u>Land Use Summary</u>

A GIS analysis was conducted to determine land use using a shapefile titled “Vegetation”, available from the Southwest Oregon Province GIS Data CD. This data was used to characterize land use by lumping several vegetation types into two categories: (1) Forestry and (2) Agriculture/Range and Rural Residential.

Table 30 Land Use by Subwatershed

Subwatershed	Forestry		Agriculture/Range & Rural Residential		Total
	Acres	%	Acres	%	Acres
Big South Fork	3,877	100.0	1	0.0	3,878
Lower Hunter Mainstem	3,784	86.8	560	12.8	4,359
Middle Hunter Mainstem	7,593	98.0	152	2.0	7,745
North Fork Hunter	3,815	100.0	0	0.0	3,815
Upper Hunter Mainstem	8,600	100.0	0	0.0	8,600
Total Acres	27,669	97.4	713	2.5	28,397

Individual Screening Procedures

Three separate screening procedures were developed to evaluate land use impacts on hydrology in the Hunter Creek watershed:

C FORESTRY
D AGRICULTURE/RANGELANDS
E FOREST AND RURAL ROADS

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 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 31 Transient Snow Elevation Zones and Peak Flow Generating Processes

Subwatershed	Area (acres)	Rain Zone		Rain on Snow Zone		Rain on Snow Zone		Rain on Snow Zone	
		0'-2500' (acres)	% Area	2500'-3000' (acres)	% Area	3000'-3500' (acres)	% Area	3500'-4000' (acres)	% Area
North Fork Hunter	3,818	3,041	79.6	425	11.1	352	9.2	0	0.0
Upper Hunter Mainstem	8,601	5,262	61.2	2,627	30.5	711	8.3	1	0.0
Lower Hunter Mainstem	4,356	4,356	100.0	0	0.0	0	0.0	0	0.0
Middle Hunter Mainstem	7,748	7,748	100.0	0	0.0	0	0.0	0	0.0
Big South Fork	3,882	3,806	98.0	76	2.0	0	0.0	0	0.0
Total Acres	28,405	24,213	85.2	3,128	11.0	1,063	3.7	1	0.0

C4 KEY FINDINGS

- Results indicate that approximately 85% of the Hunter Creek watershed is 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 15% of the watershed are located within the rain on snow zone of 2,500' to 4,000'. The GWEB Oregon Watershed Assessment Manual suggests characterizing subwatersheds with more than 75% in the rain category as low potential risk of peak flow enhancement. Four of the five subwatersheds are predominantly (>75% of area) situated at the lowest elevation zone where rain is considered the peak flow generating process. Thus, a low potential risk of peak flow enhancement was assigned for the following subwatersheds:

    1. North Fork Hunter
    2. Lower Hunter Mainstem
    3. Middle Hunter Mainstem
    4. Big South Fork

- One subwatershed, the Upper Hunter Mainstem, contains 39% of its area within higher elevation zones of 2,500' to 4,000' where peak flow generating processes are characterized as rain-on-snow. However, due to the limitations of this assessment, no further analysis was conducted. Thus, the risk of peak flow enhancement in this subwatershed is unknown.
- Big South Fork, Upper Hunter Mainstem and the North Fork subwatersheds may have peak runoff risk due to presence of HSG-C and HSG-D combined with high precipitation.
- Further investigation of peak flow increases based on percent of land in a forested condition >30 years of age needs to be conducted.

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

Table 32 (See Below)

1. Using a GIS shapefile titled "Soils" (SWOP CD), hydrologic soil groups were identified in agricultural and rangeland areas in each subwatershed.
2. Using two GIS shapefiles titled "Hunter Creek Subwatersheds", 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 subwatershed.
3. Cover types and treatment practices were identified for the primary hydrologic soil groups of each subwatershed. Cover types and treatment practices were also identified for secondary hydrologic soil groups where each HSG accounted for 20% or more of the subwatershed area. **Caution:** Due to the limitations of the available GIS data, no distinction was made between agricultural, rangeland or rural residential areas.

Table 33 (See Appendix)

4. Hydrologic condition classes of good, fair, or poor were determined for each cover type/treatment practice by referring to Table 34 (See Appendix). Hydrologic condition of "Good" was assigned to all HSGs in all subwatersheds based on the criteria of >75% ground cover and lightly or only occasionally grazed.
5. A curve number was selected based on the cover type/treatment practice and hydrologic condition in columns 3 and 4 of Table 33. The selected curve number was then entered in column 5 of Table 33.
6. Background curve numbers were determined from Table 34. The background curve numbers in all cases were based on "woods" in "good" condition. The curve number for the proper hydrologic soil group was then selected and the results were entered in column 6 of Table 33.
7. The 2-year, 24-hour precipitation (i.e., annual maximum 24-hour precipitation with a recurrence interval of 2 years or 50% probability of occurring in any given year) was estimated for each subwatershed. This information was obtained using a GIS shapefiles titled "2-Year, 24-Hour Precipitation", available from the Southwest Oregon Province GIS Data CD. Results were then entered in column 7 of Table 33.
8. Using the current curve number in column 5 and rainfall depth in column 7, runoff depths were identified from Table 35 (See Appendix) for each cover type / treatment combination. Values were interpolated to obtain runoff depths for curve numbers or rainfall amounts not shown. Results were entered in column 8 of Table 33.
9. Using the background curve number in column 6 and rainfall depth in column 7, the runoff depth from Table 35 was identified. Results were identified in column 9 of Table 33.
10. Change in runoff depth from background conditions to current conditions was calculated by subtracting the Background Runoff Depth (column 9) from Current Runoff Depth (column 8). Results were entered in column 10 of Table 33.

Table 36 (See Appendix)

11. The average change from background was calculated (sum of column 10, Table 33, divided by number of HSGs) from all the combinations of cover type / treatment and hydrologic condition. Results were entered in column 3 of Table 36. Percentages from Table 32, column 4 (A, B, C or D) were transferred to column 2 of Table 36.
12. Where more than one hydrologic soil group is dominant in a subwatershed steps 3 through 11 were repeated. Results were entered in column 5, 7, and 9 of Table 36. Percentages from Table 32, column 4 (A, B, C or D) were transferred to column 4, 6, and 8 (respectively) of Table 36.
13. Weighted averages were computed and results entered in column10 of Table 36.
14. Using the subwatershed average change from background (column 3, Table 36) or the weighted average (column 10, Table 36) the potential hydrologic risk was selected and entered into column 11 of Table 36.

Potential Risk of Agriculture and/or Rangelands

Change in Runoff From Background (inches)	Relative Potential for Peak-Flow Enhancement
0 to 0.5	Low
0.5 to 1.5	Moderate
>1.5	High

D3 RESULTS

Table 32 Agriculture and Rangeland Use Summary

	Total Area	Area in Ag or Range Use		Hydrologic Soil Groups in Agricultural Lands or Grazed Lands							
				A		B		C		D	
Subwatershed	(acres)	(acres)	(%)	(acres)	(%)	(acres)	(%)	(acres)	(%)	(acres)	(%)
Big South Fork	3,878	1	0.0	0		0		0		1	100.0
Lower Hunter Mainstem	4,359	560	12.8	5	0.9	289	51.6	74	13.2	192	34.3
Middle Hunter Mainstem	7,745	152	2.0	0		66	43.4	5	3.3	82	53.9
North Fork Hunter	3,815		0.0	0		0		0		0	
Upper Hunter Mainstem	8,600		0.0	0		0		0		0	
Total Acres	28,397	713	2.5	5	0.7	355	49.8	79	11.1	275	38.6

Table 33 Curve Number and Runoff-Depth Summary Table for Primary/Secondary Hydrologic Soil Groups (See Appendix)

Table 36 Agriculture/Rangeland Risks of Peak Flow Enhancement (See Appendix)

D4 KEY FINDINGS

- Lower Hunter Mainstem subwatershed could be at risk of increasing peak flows based on >12% of the subwatershed area in agriculture or range use. 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 more accurate estimate of agriculture or range use.
- Middle Hunter Mainstem subwatershed only has 2% of land area in agriculture/range use and is thus not at risk of enhancing peak flows.

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 Hunter Creek watershed 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 37 & 38

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 37 and 38.
2. Total linear distance of forest roads and rural roads were determined using GIS analysis. Results were entered in columns 5 of Tables 37 and 38.
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 37 and 38.
4. The percent of area occupied by forest and rural roads in each subwatershed was computed. Results were entered in column 7 of Tables 37 and 38.
5. A relative potential for forest and rural road impacts was assigned to each subwatershed. Results were entered into column 8 of Tables 37 and 38.

E4 RESULTS

Table 37 Forest Road Area Summary

Table 38 Rural Road Area Summary

E5 KEY FINDINGS

Tables 37 & 38

- The relative potential of impact to hydrology from roads, both in forested and rural areas, was rated Low for all subwatersheds except Lower Hunter Mainstem. The relative potential for impact, however, largely depends on the extent of roads identified in the analysis. In this assessment a significant amount of roads were not

Table 37 Forest Road Area Summary

1	2	3	4	5	6	7	8
Subwatershed	**Area (square mi)**	**Forested Area (acres)**	**Forested Area (square mi)**	**Total Linear Distance of Forest Roads (miles)**	**Roaded Area Col. 5 x *Std. Width (square miles)**	**Percent Area in Roads Col. 6/4*100**	**Relative Potential for Impact**
Big South Fork	6.07	3877	6.06	26.01	0.12	2.02	Low
Lower Hunter Mainstem	6.81	3784	5.91	18.78	0.09	1.49	Low
Middle Hunter Mainstem	12.11	7593	11.86	39.89	0.19	1.58	Low
North Fork Hunter	5.97	3815	5.96	8.40	0.04	0.66	Low
Upper Hunter Mainstem	13.44	8600	13.44	32.29	0.15	1.13	Low
Totals	44.38	27669	43.23	125.37	0.59	1.36	

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

Table 38 Rural Road Area Summary

1	2	3	4	5	6	7	8
Subwatershed	**Area (square mi)**	**Rural Area (Ag + Range) (acres)**	**Rural Area (Ag + Range) (square mi)**	**Total Linear Distance of Forest Roads (miles)**	**Roaded Area Col. 5 x *Std. Width (square miles)**	**Percent Area in Roads Col. 6/4*100**	**Relative Potential for Impact**
Big South Fork	6.07	1	0.00	0.00	0.00	0.00	N/A
Lower Hunter Mainstem	6.81	560	0.88	10.82	0.07	8.16	High
Middle Hunter Mainstem	12.11	152	0.24	0.97	0.01	2.68	N/A
North Fork Hunter	5.97	0	0.00	0.00	0.00	0.00	N/A
Upper Hunter Mainstem	13.44	0	0.00	0.00	0.00	0.00	N/A
Totals	44.38	713	1.11	11.78	0.08	6.98	

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

Note: Lower Hunter Mainstem Ag/Range Area reflects more a Rural Residential Landscape than Ag, Range or Urban 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.)*

- The relative potential of impact to hydrology from rural roads was rated high in the Lower Hunter Mainstem subwatershed.

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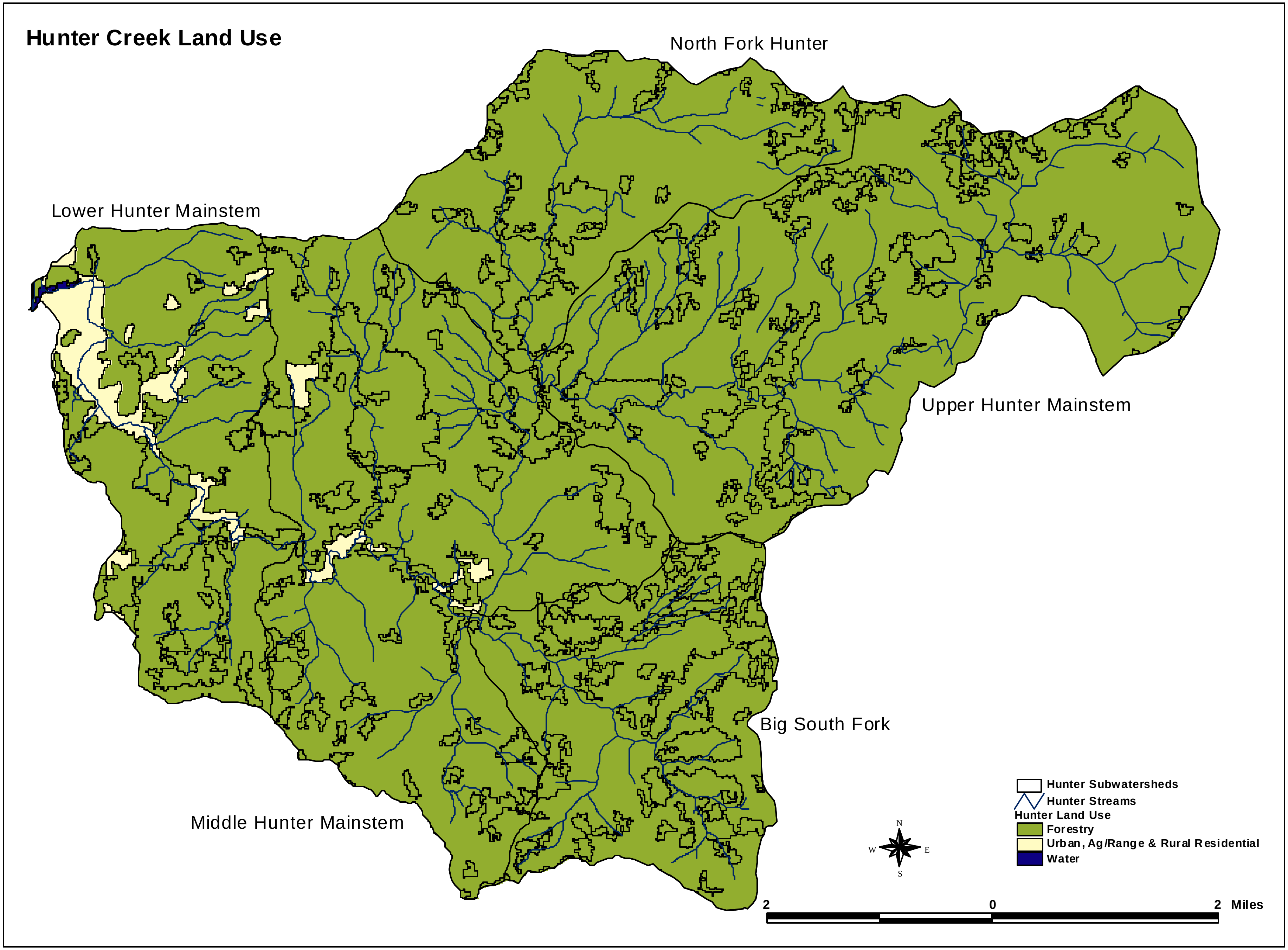
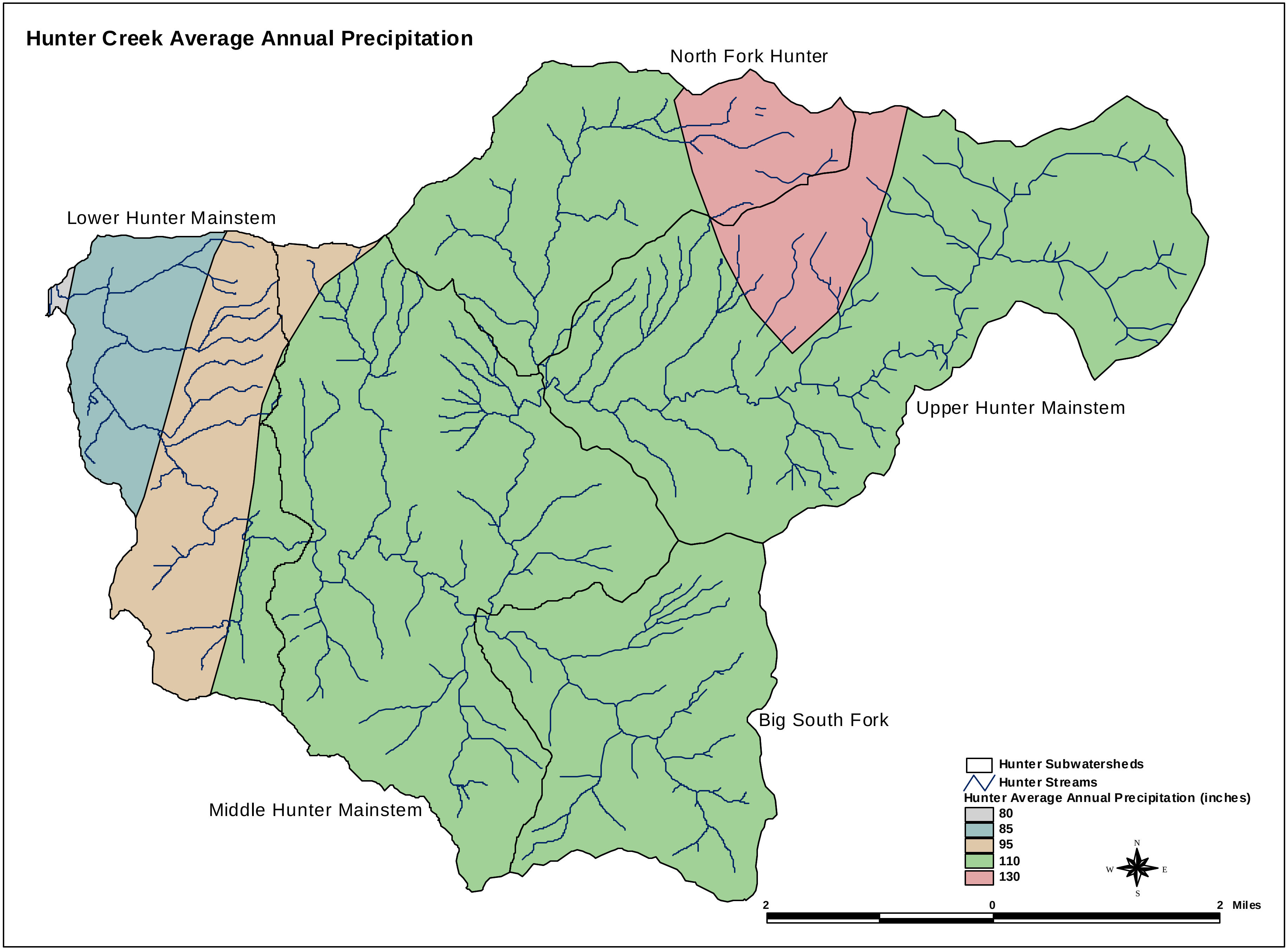
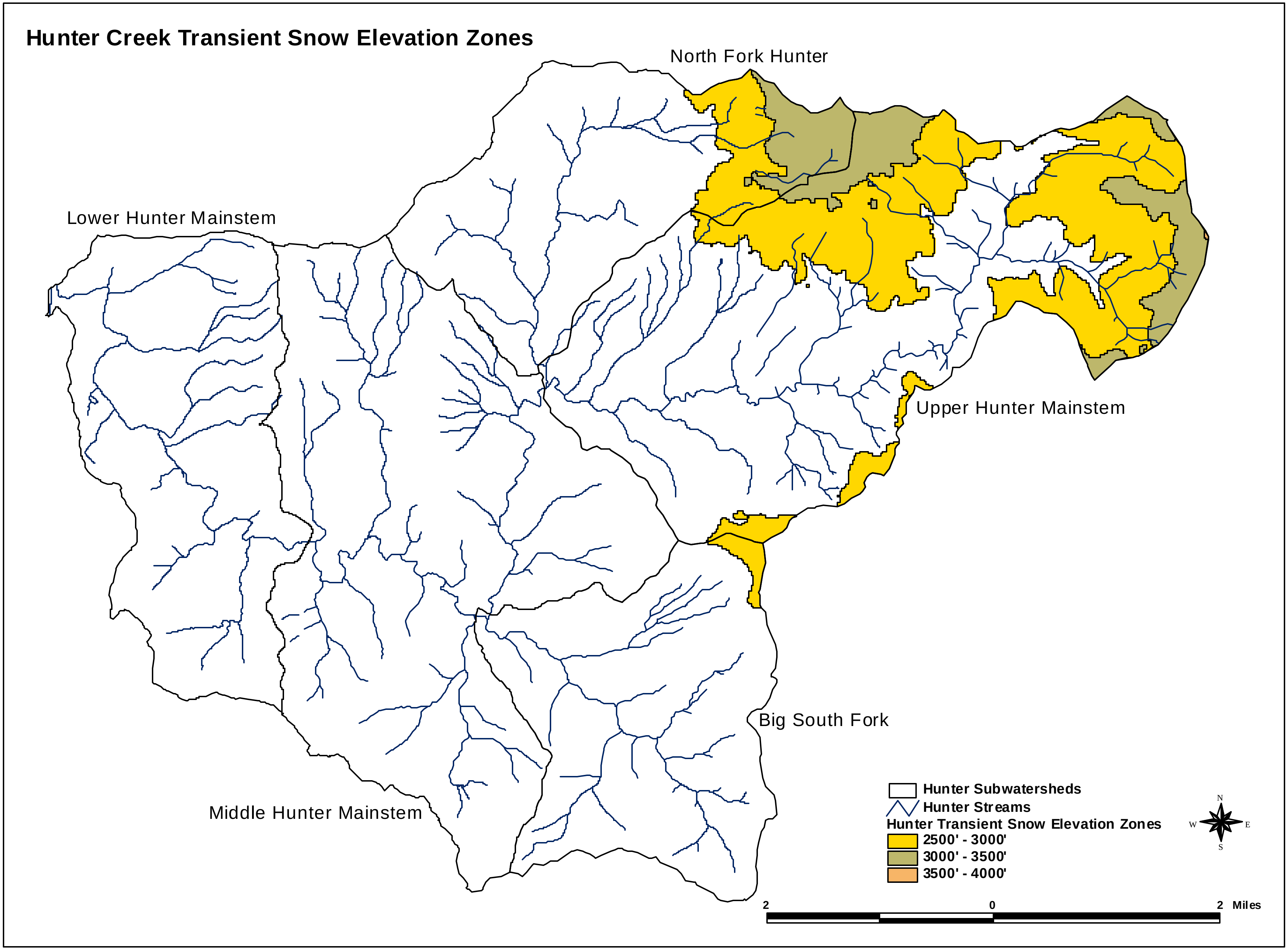
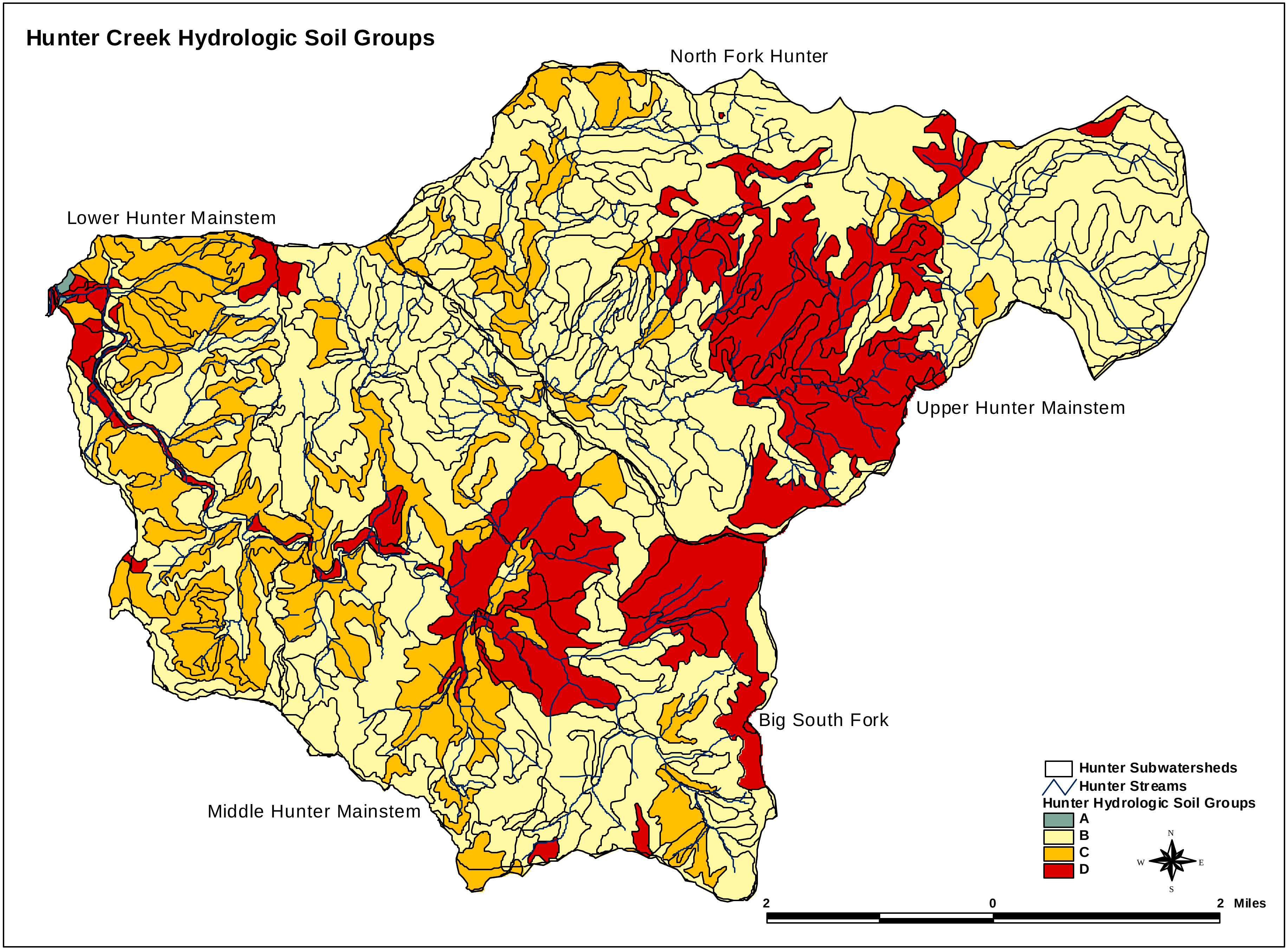

Hunter Creek Land Use
North Fork Hunter
Lower Hunter Mainstem
Upper Hunter Mainstem
Big South Fork
Middle Hunter Mainstem
Hunter Subwatersheds
Hunter Streams
Hunter Land Use
Forestry
Urban, Ag/Range & Rural Residential
Water
N
W
E
S
2
0
2 Miles


Hunter Creek Average Annual Precipitation
North Fork Hunter
Lower Hunter Mainstem
Upper Hunter Mainstem
Big South Fork
Middle Hunter Mainstem
Hunter Subwatersheds
Hunter Streams
Hunter Average Annual Precipitation (inches)
80
85
95
110
130
N
W
E
S
2
0
2 Miles


Hunter Creek Transient Snow Elevation Zones
North Fork Hunter
Lower Hunter Mainstem
Upper Hunter Mainstem
Big South Fork
Middle Hunter Mainstem
Hunter Subwatersheds
Hunter Streams
Hunter Transient Snow Elevation Zones
2500' - 3000'
3000' - 3500'
3500' - 4000'
N
W
E
S
2
0
2 Miles



Hunter Creek Hydrologic Soil Groups
North Fork Hunter
Lower Hunter Mainstem
Upper Hunter Mainstem
Big South Fork
Middle Hunter Mainstem
Hunter Subwatersheds
Hunter Streams
Hunter Hydrologic Soil Groups
A
B
C
D
N
W
E
S
2
0
2 Miles

XII 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 Hunter Creek watershed 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

Figure 4 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.
- Figure 4 illustrates the total out of stream water rights (CFS) by type of use for the Hunter Creek watershed.

Storage Rights

- Storage rights were totaled (Acre Feet) and summarized by type of use. (See Key Findings for results.)

Table 39 In-Stream Rights

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

Table 40 Streamflows

- Streamflows measured by the South Coast Watershed Council and Oregon Department of Water Resources during the summer months of 1998 and 1999 were listed.

Table 41 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 the watershed was listed. **Note:** WABs do not typically correspond to subwatershed boundaries.
- 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

Figure 4 Out-of-Stream Rights*

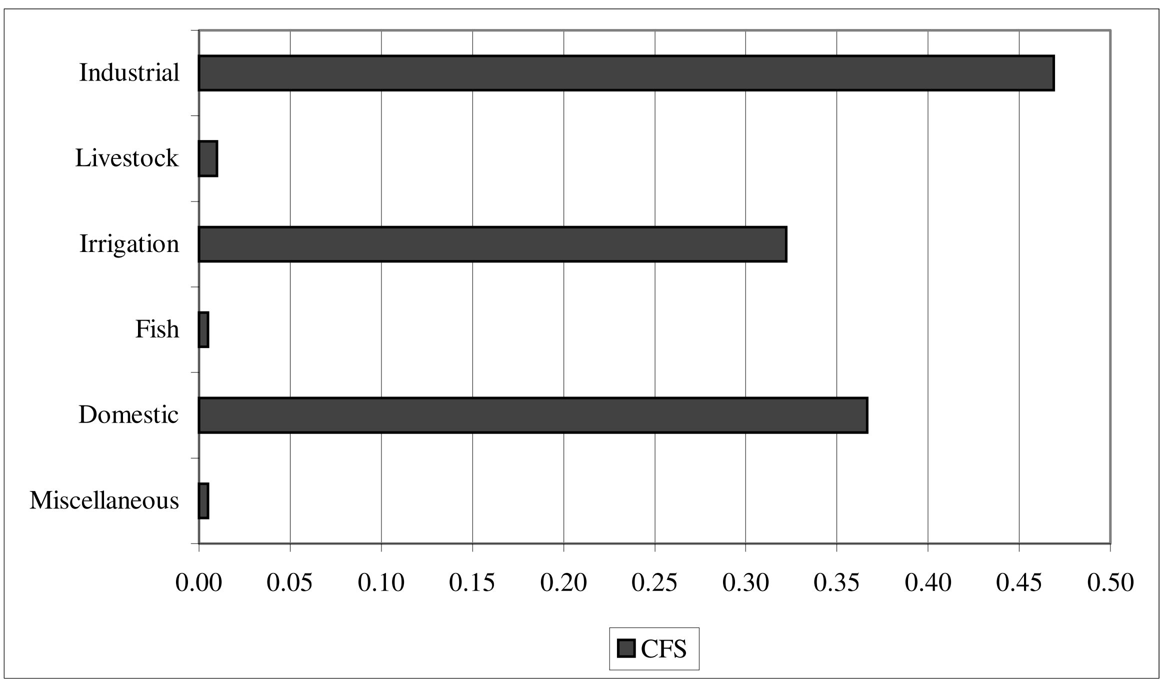


Table 39 In-Stream Water Rights

Location	Reach (From/To)	Certificate #	CFS July	CFS August	CFS September	Priority Date
Hunter Creek	Below Little South Fork / Tidewater	NA	7	7	7	5/22/64
Hunter Creek	Below Little South Fork / Tidewater	NA	7	7	7	4/1/80
Hunter Creek	North Fork River Mile 10 / River Mile 0	73083	27	17.1	14.1	11/8/90
Hunter Creek	Upstream End / North Fork	72885	4.94	3.1	3.76	1/29/93
Big South Fork	River Mile .9 / River Mile 0	72882	3.15	1.88	1.66	1/29/93
Little South Fork	River Mile 1.8 / River Mile 0	72883	2.1	1.19	0.71	1/29/93
North Fork	Headwaters / River Mile 0	72884	3.87	2.43	2.03	1/29/93

Table 40 Stream Flows

Location	2000	Flow (cfs)	1999	Flow (cfs)	1998	Flow (cfs)
North Fork Hunter Creek			August 12	1.7	July 25	1.9
Big South Fork					July 30	1.7
Little South Fork					July 30	0.4
Mainstem below Little South Fork *	July 25	12.8	July 7	17.4	July 22	9.5
Mainstem below Little South Fork *			August 12	10.5	August 5	7.4
Mainstem at RV Mobile Park					July 25	**8.5

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

** Some flow entering gravel feeding stagnant side channel; actual flow was somewhat higher

E Key Findings

Out-of-Stream Rights

- There are relatively few Out of Stream Rights for the Hunter Creek watershed. They total 1.1 CFS. Water rights allocated after the establishment of the 1964 In-Stream Rights are considered "junior rights"; these rights total 0.37 CFS.
- Industrial, Irrigation and Domestic use comprise the majority of water rights allocated in the Hunter Creek watershed.

Storage Rights

- Storage Rights include only three individual water rights that total 51.1 Acre Feet (AF). Of the total storage rights 50 AF are allocated for industrial use.

In-Stream Rights

- The 1964 In-Stream Right is 7 CFS during the summer months. All water rights considered “junior” to the 5/22/64 In-Stream Right may be regulated if streamflow falls below 7 CFS. The junior rights, however, are relatively insignificant because they represent little flow.

Water Availability Summary

- The net water available at the 50% exceedance level, from May to October, is less than or equal to zero for the entire Hunter Creek watershed.

Streamflow Restoration Priority Areas

- The Water Availability Basins (WAB) in the Hunter Creek watershed were not rated as priority WABs according to the ODFW/OWRD Streamflow Restoration Priority Areas.

REFERENCES

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

XIII WATERSHED SYNTHESIS

The Hunter Creek watershed is contained within the Southern Oregon Coastal Mountains, the Coastal Siskiyous, and a small portion of Coastal Lowlands. Gradients are steep to very steep, with high rates of erosion. Portions of the upper Hunter Creek watershed display the "serpentine gorge" feature similar to those in the Chetco watershed, where bedrock is exposed and forest species are distinctly different and less dense. Over 60 percent of the basin is privately owned, with 97 percent in forestry use.

Hunter Creek saw extensive logging in the 50's and 60's, with as many as 17 active mills in the Gold Beach/Hunter Creek area. Floods of 1955 and 1964 had considerable impact on the watershed and channel. Very large chinook salmon existed in the basin historically. Rural residential and light industrial development is prevalent in the lower mainstem.

Sediment mobility and sources are a great concern in Hunter Creek. Steep slopes, debris flows are common, and large wood is generally lacking. The Big South Fork of Hunter Creek has the highest density of stream crossings of any South Coast subwatershed. Lower Hunter and Middle Hunter subwatersheds ranked moderate/high for density of stream crossings. Lower Hunter Mainstem ranked moderate for roads on steep slopes. Channel widening is evident is some portions of the watershed, indicating excessive and unstable sediment loads.

Risk of peak flow enhancement is rated low for timber harvest and forest roads in all subwatersheds except Upper Hunter Mainstem, where more information is needed for rain-on-snow interactions. Risk due to agriculture/rural residential use is rated moderate in the Middle and Lower Hunter Mainstem. Risk due to density of rural roads is high in the Lower Hunter Mainstem.

Channel habitat typing of the private portions of Hunter watershed revealed more than 60 miles of stream confined by hillslopes, over eight miles in highly responsive/sensitive types, and just over three miles in low gradient confined channels.

Anadromous fish use in Hunter watershed is restricted to the lower end of the mainstem and lower tributaries for chinook and coho, with steelhead extending into the lower North Fork and Upper Hunter Mainstem. Some barriers to migration are recorded, one in Little South Fork and several in the Lower Hunter Mainstem. Limited ODFW stream survey data available from 1992 shows a general lack of wood, less than desirable pool quality, and moderate riffle habitat for spawning.

A survey of riparian vegetation reported a small amount of mature timber within the riparian area and seven miles of brush and pioneer species on the mainstem. Big South Fork has the highest potential for increases in shade. Heating within the Forest Boundary (serpentine gorge) may reduce the impact of increased shade in the lower portions of the mainstem.

Water use issues are fairly minor in Hunter Creek, with just over 1 cfs allocated as out-of-stream rights, and 7 cfs as in-stream right. The in-stream right is senior to twenty percent of the out-of-stream rights. Wells are numerous in the rural residential areas.

The Hunter Creek Mainstem is on the 303(d) list as water quality limited from the mouth to River Mile 16.5, and is being investigated for sedimentation. Water temperatures increase 10 to 14 degrees before leaving the National Forest Boundary, and are cooled somewhat at the confluence with the North Fork. Septic tanks may be impacting water quality, though no data is available from DEQ.

Hunter Creek has 25 acres of wetlands, almost exclusively in the lower watershed. Most are buffered by rural development, and most are altered. Six have restoration potential.

Limiting factors to fish production in the Hunter Creek watershed appear to be sediment transport and storage, lack of large wood, simplified and reduced estuary habitat, and high water temperatures.

APPENDIX

Table 13 Riparian Habitat Condition Summary

Original Data Source: AQIP =ODFW Aquatic Inventory Project
Rating Codes: D: Desirable, U: Undesirable, B: Between; ND: No Data

Source	Sub WA	Stream	Reach	Date	Width	Conifers # > 20 in dbh	Conifers # > 35 in dbh	Bench-	Opensky	Shade = 180 -	Bench-	Overall Riparian	Bank Erosion	Percent Secondary Channels
						Con_20plus	Con_36plus	mark		Opensky	mark	Benchmark	Bankerosi*	Pctscchnla*
AQIP	BS	BIG SOUTH FK HUNTER CREEK	1	8/31/92	3.8	ND	ND	ND	3	177	D	*	0	12.5
AQIP	BS	BIG SOUTH FK HUNTER CREEK	2	8/31/92	2.9	ND	ND	ND	7	173	D	*	0	21
AQIP	BS	BIG SOUTH FK HUNTER CREEK	3	8/31/92	4.6	ND	ND	ND	0	180	D	*	0	0
AQIP	LM	HUNTER CREEK	1	8/3/92	13.3	ND	ND	ND	59	121	D	*	0.4	5.7
AQIP	MM	HUNTER CREEK	2	8/5/92	9.9	ND	ND	ND	46	134	D	*	1.4	4.8
AQIP	UM	HUNTER CREEK	3	8/20/92	5.5	ND	ND	ND	37	143	D	*	9	1.8
AQIP	UM	HUNTER CREEK	4	8/24/92	2.7	ND	ND	ND	6	174	D	*	1.5	2.1
AQIP	NF	NORTH FORK HUNTER CREEK	1	8/31/92	4.2	ND	ND	ND	32	148	D	*	7.8	0.8

*Benchmarks do not exist for these parameters; however, they provide some interesting information on general observed conditions.

Subwatershed Codes:

UM	Upper Hunter Mainstem
LM	Lower Hunter Mainstem
NF	North Fork Hunter
MM	Middle Hunter Mainstem
BS	Big South Fork Hunter

Table 14 Pool Habitat Condition Summary

Original Data Source: AQIP = ODFW Aquatic Inventory Project
Rating Codes: D: Desirable, U: Undesirable, B: Between

Source	Date	Stream	Reach	Length Sampled	Land Use	Gradient	Sub WA	Width	Pool Area		Pool Frequency		Residual Pool Depth		Complex Pools		Overall Pool Rating
				Prichnll	Luse1		Sub		Pctpool	Bench-mark	Cwpool	Bench-mark	Residpd	Bench-mark	Compool_km	Bench-mark	
AQIP	8/31/92	BIG SOUTH FK HUNTER CREEK	1	507	ST	4.3	BS	3.8	35.7	B	2.3	B	0.8	B	ND	U	B
AQIP	8/31/92	BIG SOUTH FK HUNTER CREEK	2	473	ST	21.5	BS	2.9	12.1	B	7.5	D	0.7	U	ND	U	B
AQIP	8/31/92	BIG SOUTH FK HUNTER CREEK	3	96	ST	6.4	BS	4.6	24.9	B	2.5	B	0.6	U	ND	U	B
AQIP	8/3/92	HUNTER CREEK	1	9462	ST	0.5	LM	13.3	50.9	D	4.8	B	1.3	B	ND	U	B
AQIP	8/5/92	HUNTER CREEK	2	7029	ST	2.1	MM	9.9	53.7	D	3.8	B	1	B	ND	U	B
AQIP	8/20/92	HUNTER CREEK	3	7376	TH	7	UM	5.5	26.2	B	4.4	B	0.8	B	ND	U	B
AQIP	8/24/92	HUNTER CREEK	4	5084	ST	3	UM	2.7	35	B	12.1	B	0.6	U	ND	U	B
AQIP	8/31/92	NORTH FORK HUNTER CREEK	1	2537	TH	4.1	NF	4.2	22	B	8.6	B	0.9	U	ND	U	B

Subwatershed Codes:

UM	Upper Hunter Mainstem
LM	Lower Hunter Mainstem
NF	North Fork Hunter
MM	Middle Hunter Mainstem
BS	Big South Fork Hunter

Landuse Codes:

TH	Timber Harvest
ST	Second growth Timber

Table 15 Riffle and Woody Debris Habitat Condition Summary

Original Data Source: AQIP = ODFW Aquatic Inventory Project
Rating Codes: D: Desirable, U: Undesirable, B: Between; ND: No Data

					Width/Depth Ratio		Gravel (% area)		Silt-sand-organics (% area)		Overall Riffle Rating	LWD Pieces/100 m		Volume LWD/100 m		Key Pieces/100 m		Overall LWD Rating
Source	Sub	Date	Stream	Reach	WDRATIO	Bench-mark	PCTGRAVEL	Bench-mark	PCTSNDOR	Bench-mark		LWDPIECE1	Bench-mark	LWDVOL1	Bench-mark	KEYLWD1	Bench-mark	
					Wdratio		Pctgravel		Pctsndor			Lwdpiece1		Lwdvol1		Keylwd1		
AQIP	BS	8/31/92	BIG S FK HUNTER CR	1	87.5	U	34	B	19	B	B	6.1	U	4.6	U	ND	ND	U
AQIP	BS	8/31/92	BIG S FK HUNTER CR	2	11.3	D	20	B	20	B	B	9.5	U	27.5	B	ND	ND	B
AQIP	BS	8/31/92	BIG S FK HUNTER CR	3	-	ND	40	D	13	B	B	0	ND	0	ND	ND	ND	ND
AQIP	LM	8/3/92	HUNTER CREEK	1	110.3	U	41	D	29	U	U	1.2	U	0.4	U	ND	ND	U
AQIP	MM	8/5/92	HUNTER CREEK	2	49.6	U	29	B	22	U	U	1.5	U	7.5	U	ND	ND	U
AQIP	UM	8/20/92	HUNTER CREEK	3	33.6	U	23	B	14	B	B	2.6	U	3.6	U	ND	ND	U
AQIP	UM	8/24/92	HUNTER CREEK	4	24.6	B	30	B	20	B	B	6.4	U	14.8	U	ND	ND	U
AQIP	NF	8/31/92	NORTH FK HUNTER CR	1	38.6	U	21	B	0	D	B	28.9	D	124.3	D	ND	ND	D

Subwatershed Codes:

UM	Upper Hunter Mainstem
LM	Lower Hunter Mainstem
NF	North Fork Hunter
MM	Middle Hunter Mainstem
BS	Big South Fork Hunter

Table 28 Hunter Creek Wetland Attributes

Wetland ID	7.5 Minute Quad	Subwatershed	Size (ac.)	Connected	Cowardin Code	Cowardin Code	Buffer	Degree of Alteration	Color Code
1	Gold Beach	Lower Mainstem	6	Y	PEMR		R	HIGH	G
	Comments: Restoration - ditched and denuded - marginal pasture								
2	Gold Beach	Lower Mainstem	4	N	PSSC		R	HIGH	B
	Comments: Restoration - partially functioning - improve riparian and connectiveness								
3	Gold Beach	Lower Mainstem	3	Y	PEMC	PEMCx	R	HIGH	R
	Comments: Restoration - marginal pasture - riparian improvement along trib								
4	Gold Beach	Lower Mainstem	4	Y	PFOA		R	MODERATE	G
	Comments: Restoration - riparian								
5	GB/Cape S	Lower Mainstem	2.5	Y	PABFh	PSSC	R	HIGH	B
	Comments: Restoration - marginal ground - riparian along ditch								
6	Cape Sebastian	Lower Mainstem	2.5	Y	PEMFh		R	MODERATE	R
	Comments: Restoration - partially functioning - improve riparian and connectiveness								
7	Cape Sebastian	Lower Mainstem	2	Y	PSSCh		R	HIGH	G
	Comments: Little Restoration Potential - roaded and drained								
8	Sundown Mtn	Middle Mainstem	1	N	PUBH		FO	LOW	R
	Comments: Protect - Functioning								

Table 33 Curve Number and Runoff-Depth Summary Table for Primary/Secondary Hydrologic Soil Groups

1 Subwatershed	2 Primary / Secondary Hydrologic Soil Group	3 Cover Type/Treatment	4 Hydrologic Condition	5 Curve Number	6 Background Curve Number	7 Rainfall Depth (in)	8 Current Runoff Depth (in)	9 Background Runoff Depth (in)	10 Change From Background Col. 8-9
Lower Hunter Mainstem	B - Primary	Pasture, grassland or range - continuous forage for grazing	Good	61	55	8.6	4.1	3.49	0.61
	A - Secondary	Pasture, grassland or range - continuous forage for grazing	Good	39	30	8.6	1.71	0.58	1.13
	C - Secondary	Pasture, grassland or range - continuous forage for grazing	Good	74	70	8.6	5.95	5.33	0.62
	D - Secondary	Pasture, grassland or range - continuous forage for grazing	Good	80	77	8.6	6.57	5.95	0.62
Middle Hunter Mainstem	D - Primary	Pasture, grassland or range - continuous forage for grazing	Good	80	77	9.6	7.52	6.88	0.64
	B - Secondary	Pasture, grassland or range - continuous forage for grazing	Good	61	55	9.6	4.9	4.23	0.67
	C - Secondary	Pasture, grassland or range - continuous forage for grazing	Good	74	70	9.6	6.88	6.22	0.66

Table 34: Runoff Curve Numbers for Other Agricultural Lands [1]

Cover Type	Hydrologic Condition	Curve Numbers for Hydrologic Soil Group			
		A	B	C	D
Pasture, grassland, or range -continuous forage for grazing[2]	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow -continuous grass; protected from grazing and generally mowed for hay	---	30	58	71	78
Brush -brush-weed-grass mixture with brush the major element[3]	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30[4]	48	65	73
Woods -grass combination (orchard or tree farm)[5]	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods[6] - Shaded area can be used as background if the land was originally wooded	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30	55	70	77
Farmsteads -buildings, lanes, driveways, and surrounding lots	---	59	74	82	86

1 Average runoff condition and $l_a = 0.2$ S
2 Poor: <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.
3 Poor: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
4 Actual curve number is less than 30; use curve number = 30 for runoff computations.
5 Curve numbers shown were computed for areas with 50% woods and 50% grass (pasture) cover.
Other combinations of conditions may be computed from the curve numbers for woods and pasture.
6 Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.

Source: USDA Soil Conservation Service, TR55 (2nd edition, June 1986); Table 2-2b, page 2-6.

Table 35: Runoff Depth for Selected Curve Numbers and Rainfall Amounts[1]

Runoff Depth for Curve Number of….													
Rainfall	40	45	50	55	60	65	70	75	80	85	90	95	98
1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.15	0.27	0.46	0.74	0.99
1.40	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.13	0.24	0.39	0.61	0.92	1.18
1.60	0.00	0.00	0.00	0.00	0.01	0.05	0.11	0.20	0.34	0.52	0.76	1.11	1.38
1.80	0.00	0.00	0.00	0.00	0.03	0.09	0.17	0.29	0.44	0.65	0.93	1.29	1.58
2.00	0.00	0.00	0.00	0.02	0.06	0.14	0.24	0.38	0.56	0.80	1.09	1.48	1.77
2.50	0.00	0.00	0.02	0.08	0.17	0.30	0.46	0.65	0.89	1.18	1.53	1.96	2.27
3.00	0.00	0.02	0.09	0.19	0.33	0.51	0.71	0.96	1.25	1.59	1.98	2.45	2.77
3.50	0.02	0.08	0.20	0.35	0.53	0.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.00	0.06	0.18	0.33	0.53	0.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.50	0.14	0.30	0.50	0.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.00	0.24	0.44	0.69	0.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.00	0.50	0.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.00	0.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.00	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.00	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.00	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.00	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.00	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.00	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.00	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.00	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

1 Interpolate the values shown to obtain runoff depths for curve numbers or rainfall amounts not shown.

From USDA Soil Conservation Service, TR55 (2nd edition, June 1986) Table 2-1, page 2-3.

Table 36 Agriculture/Rangeland Risks of Peak Flow Enhancement

1 **Subwatershed**	2 Percent of Ag/Range Area in 1st Hydro Soil Group Table 32 Col. 4 (A, B, C or D)	3 Average Change from Background Table 33 Col. 10	4 Percent of Ag/Range Area in 2nd Hydro Soil Group Table 32 Col. 4 (A, B, C or D)	5 Average Change from Background Table 33 Col. 10	6 Percent of Ag/Range Area in 2nd Hydro Soil Group Table 32 Col. 4 (A, B, C or D)	7 Average Change from Background Table 33 Col. 10	8 Percent of Ag/Range Area in 2nd Hydro Soil Group Table 32 Col. 4 (A, B, C or D)	9 Average Change from Background Table 33 Col. 10	10 *Weighted Average Change from Background (Cols. 2x3 + 4x5 + 6x7 + 8x9)	11 Potential Risk of Peak Flow Enhancement
Lower Hunter Mnst	51.6%(B)	0.61	.9%(A)	1.13	13.2%(C)	0.62	34.3%(D)	0.62	0.62	Moderate
Middle Hunter Mnst	53.9%(D)	0.64	43.4%(B)	0.67	3.3%(C)	0.66			0.66	Moderate

*The weighted change is the additional runoff compared to assumed background level of 2 in/24 hr event storm intensity

Table 41 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
70890.00	28000000	Hunter Cr.	Pacific O.	Mouth	284.0	312.0	221.0	44.0	-13.0	-24.0	-0.3	-0.2	-0.2	-94.0	39.0	322.0
73204.00	28010000	Little S. Fk. Hunter Cr.	Hunter Cr.	Mouth	8.2	10.0	5.3	0.0	-13.0	-24.0	-0.3	-0.2	-0.2	-94.0	0.0	9.3
73202.00	28020000	Big S. Fk. Hunter Cr.	Hunter Cr.	Mouth	20.0	24.0	13.0	0.0	-13.0	-24.0	-0.3	-0.2	-0.2	-94.0	4.4	24.0
73205.00	28030000	N. Fk. Hunter Cr.	Hunter Cr.	Mouth	8.3	12.0	1.7	0.0	-13.0	-24.0	-0.3	-0.2	-0.2	-94.0	0.0	12.0
73206.00	28040000	Hunter Cr.	Pacific O.	Above N. Fk. Hunter Cr.	84.0	93.0	71.0	17.0	-13.0	-24.0	-0.3	-0.2	-0.2	-94.0	15.0	96.0

Shaded Area = Water not available at 50% exceedance level