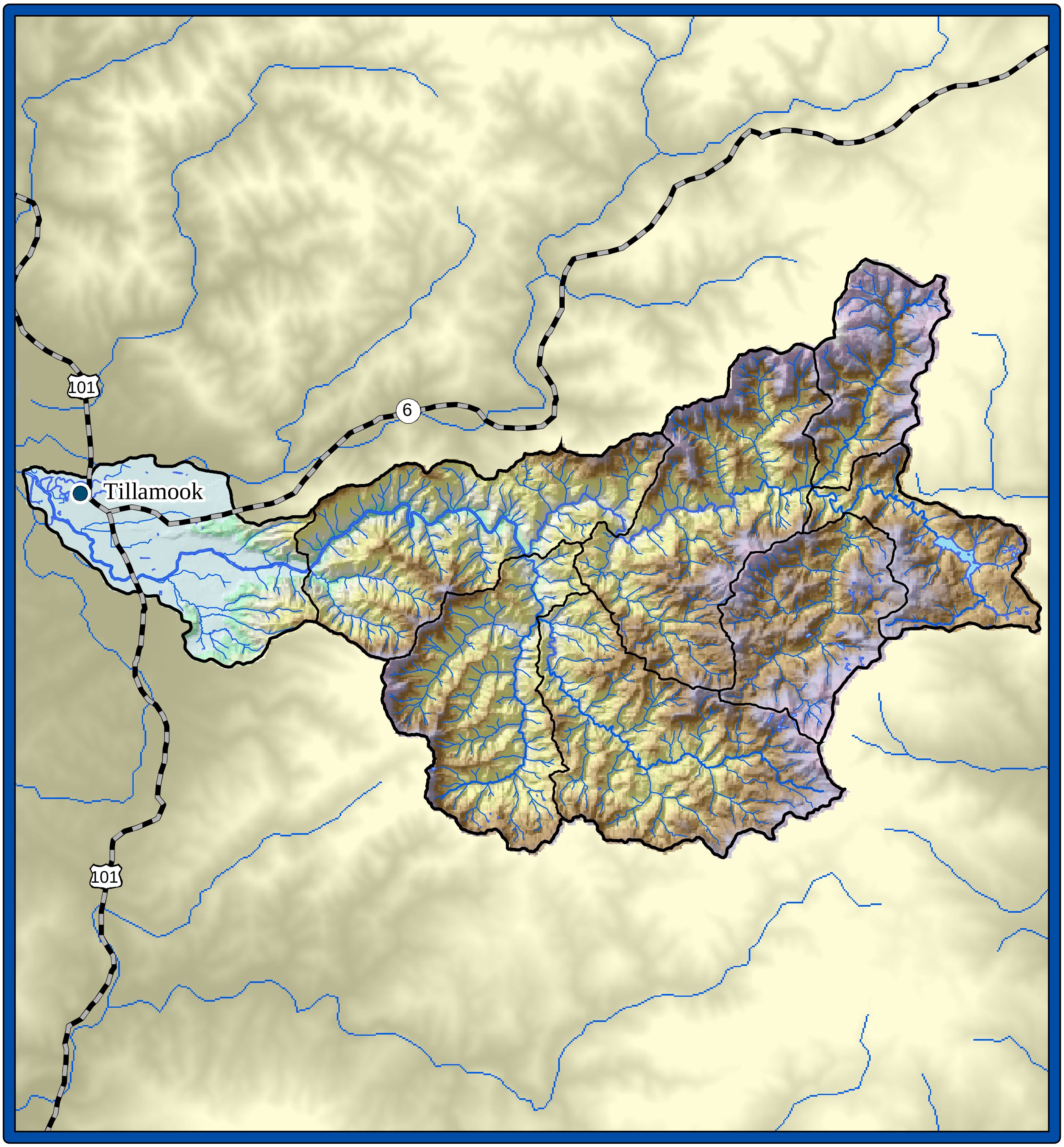
Trask River
Watershed Analysis



Oregon Department of Forestry
and
U.S.D.I. Bureau of Land Management

Prepared by
E&S Environmental Chemistry, Inc.

TRASK RIVER WATERSHED ANALYSIS

FINAL REPORT

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A Report by

E&S Environmental Chemistry, Inc.
P.O. Box 609
Corvallis, OR 97339

Kai U. Snyder
Timothy J. Sullivan
Deian L. Moore
Richard B. Raymond
Erin H. Gilbert

Submitted to

Oregon Department of Forestry
and
U.S. Department of Interior, Bureau of Land Management

John Hawksworth, Project Manager

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CHAPTER 1. CHARACTERIZATION

1.1 PHYSICAL

1.1.1 SIZE AND SETTING

The Trask River watershed is approximately 175 square miles (112,164 acres) in size and is located primarily within Tillamook County, with small portions in Washington and Yamhill counties (Figure 1.1). The Trask River is one of five major rivers in the Tillamook basin (which also includes the Tillamook, Wilson, Kilchis, and Miami rivers) that originate in the northern Oregon Coast Range and drain into Tillamook Bay. For the purposes of this analysis, the Trask watershed is subdivided into eight subwatersheds (6th field watersheds), which will be the basic units for many analyses in this report. Seven of the eight subwatersheds are located in the forested uplands of the Oregon Coast Range; the eighth subwatershed is located in the floodplains of the lower Trask River (Table 1.1). Barney Reservoir in the Middle Fork of the North Fork subwatershed is the primary municipal water supply for the cities of Beaverton, Hillsboro, and Forest Grove.

Table 1. 1. Subwatershed designations.

Subwatershed	Area (mi^2)	Mainstem Length (mi)[a]
East Fork of South Fork of Trask River	29.0	10.5
Elkhorn Creek	17.3	7.6
Lower Trask River	22.5	10.9
Middle Fork of North Fork of Trask River	13.2	7.9
North Fork of North Fork of Trask River	12.6	5.9
North Fork of Trask River	29.2	13.9
South Fork of Trask River	23.3	10.3
Upper Trask River	27.6	14.4
Total	174.7	81.3

[a] Mainstem streams are defined as 5th order and greater

1.1.2 TOPOGRAPHY

The Trask watershed drains a varied landscape, from steep-sloped, highly-dissected headwaters to low-gradient broad floodplains (Plate 1). Long ridges with steep slopes and numerous rock outcrops characterize the upland terrain. Many small, high-gradient streams with deeply incised channels originate from headwalls at higher elevations. The major streams within the watershed flow generally from east to west, from headwaters in the Coast Range to the alluvial fan of the lower Trask River. Watershed elevations range from sea level at the mouth of the Trask River to 3,534 ft at the headwaters of the North Fork of the North Fork of the Trask River. Hembre

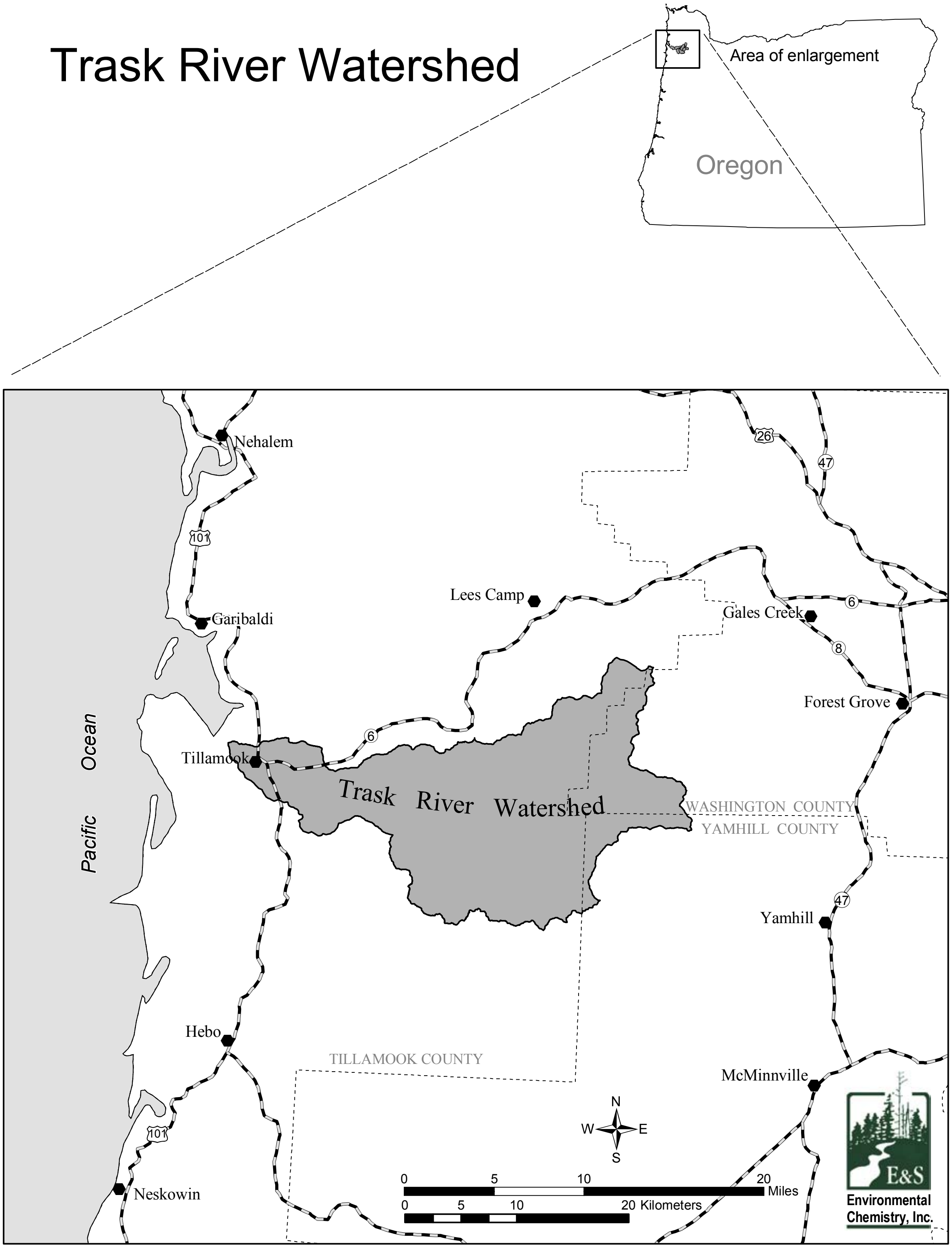

Figure 1. 1. Location of the Trask River watershed.

Ridge, Grindstone Ridge, and Blind Cabin Ridge border the upper watershed to the north and east. Grindstone Mountain (3,012 ft), Trask Mountain (3,424 ft), and Edwards Butte (3,170 ft) are prominent high points to the south.

1.1.3 ECOREGIONS

Ecoregions are areas similar in climate, physiography, geology, natural vegetation, wildlife distribution, and land use that shape and form the function of watersheds. The hierarchical system of defining distinct ecoregions strives to help resource managers and scientists by identifying natural divisions and functional ecological units across the landscape. According to the U.S. Environmental Protection Agency (U.S. EPA) system of ecoregion classification, the Trask watershed includes three ecoregions: Volcanics, Coastal Uplands, and Coastal Lowlands (Table 1.2). The majority of the watershed (86%) lies within the Volcanics ecoregion. This ecoregion is characterized by moderate- to steep-gradient streams and narrow valley floors with moderate to steep hillslopes. Stream densities are higher than those in adjacent areas underlain by sedimentary rock. Erosion rates are high, with a high occurrence of mostly shallow landslides that often result in debris flows. A small portion of the watershed (3%) lies within the Coastal Uplands ecoregion. This ecoregion is characterized by low-gradient, medium to large streams bordered by flat to steep slopes. Steep-gradient small streams in narrow steep-sided valleys are also present. Erosion rates are high and landslides may be either deep-seated in low-gradient areas or shallow in steep headwater channels. The Coastal Lowlands ecoregion is found primarily at the base of the Trask watershed, and comprises the remaining 11% of the area. This ecoregion is characterized by very low gradient, meandering streams, at times under tidal influence, and bordered by mostly flat floodplains. Erosion rates are low and sediment deposition is high due to the low gradient.

1.1.4 GEOLOGY AND GEOMORPHOLOGY

The Coast Range mountains were formed by the collision of a volcanic island chain with the North American continent 50 million years ago. The current geologic structure of the Trask watershed is characterized by uplifted volcanic and sedimentary rock due to subduction of the Juan de Fuca plate under the North American plate. Cycles of slow tectonic uplift have been followed by rapid submergence, resulting in catastrophic earthquakes approximately every 300 to 1,000 years (Komar 1992).

The sedimentary rock consists primarily of layered and interbedded sandstones and mudstones formed in a marine environment prior to uplift (Skaugset et al. 2002). The higher elevations of the Trask watershed are mostly underlain by igneous extrusive and intrusive rock (generally basalt and volcanic breccia) interlaced with siltstone and sandstone. High precipitation levels combined with relatively young geology have resulted in landforms that are very steep in places and highly dissected by streams and rivers. The steep uplands transition to the more gentle foothills of submarine and lower porphyritic basalt geology. At the mouth of the Trask River is

Table 1. 2. Description of U.S. EPA level IV ecoregion classifications in the Trask watershed.

Geology	Topography	Soils	Erosion	Climate	Land Use	Potential Natural Vegetation
1a. Coastal Lowlands						
Alluvial deposits on low terraces or dunes (spits) of wind-blown sand.	Low-gradient streams that often meander widely. Tidal influence. Tidal marshes flow through flat floodplains.	Deep silty clay loams to sand. Peat soil associated with tidal marshes.	Erosion rate low due to the low gradient. Mostly depositional areas.	Wet winters, relatively dry summers and mild temperatures throughout the year. Heavy precipitation during winter months. Mean annual precipitation 60 to 85 inches.	Dairy farms, urban/rural residential development, recreation, pastureland.	Douglas-fir, western hemlock, Sitka spruce, western red cedar, wetland plants, pasture grasses.
1b. Coastal Uplands						
Weak Sandstone.	Low-gradient medium and large streams; few waterfalls exist. Headwater small streams often steep and usually bordered by steep slopes. High stream density.	Mostly deep silt loam.	High erosion rate. Landslides include deep-seated earthflows in lower gradient areas and shallow landslides (often triggering debris slides) in steep headwater channels.	Wet winters, relatively dry summers and mild temperatures. Heavy precipitation. Mean annual precipitation 70 to 125 inches; up to 200 inches in higher elevations.	Forestry, rural residential development, recreation.	Douglas-fir, western hemlock, Sitka spruce, western red cedar, red alder, salmonberry, stink currant.
1d. Volcanics						
Volcanic, including basalt flows, dikes and sills, and concreted basalt materials.	Moderate-gradient medium and large streams; waterfalls may be common. Steep gradient small headwater streams with narrow valleys. Lower stream density than adjacent watersheds underlain by sedimentary rock.	Gravelly silt loam in lower gradient areas to very gravelly loam in steep areas.	High erosion rate. Landslides are usually shallow (often triggering debris slides) in steep headwater channels. Debris slides capable of traveling long distances.	Wet winters, relatively dry summers and mild temperatures throughout the year. Heavy precipitation. Mean annual precipitation 70 to 200 inches.	Forestry, rural residential development, recreation.	Douglas-fir, western hemlock, Sitka spruce, western red cedar, red alder, salmonberry, swordfern, vine maple, stink currant.

an extensive floodplain resulting from thousands of years of fluvial and estuarine deposits (TBNEP 1998a).

1.1.5 SOILS

Upland forest soils in the Trask watershed are predominantly shallow to moderately-deep and well-drained, silt loam soils. Both finely textured silt loam soils, and coarse, gravelly silt loam soils are common. According to the Soil Survey of Tillamook County (USDA 1964), these soils are grouped primarily into the Astoria-Hembre and Hembre-Kilchis-Astoria-Trask associations. The Weyerhaeuser soil survey groups them into the Grindstone, Jewell, and Dovre associations.

The Soil Survey of Tillamook County groups the lowland soils into the Nehalem-Brenner-Coquille association, which are deep, floodplain soils deposited over thousands of years by rivers and streams. They are highly fertile, but require drainage for maximum productivity. Alluvial terrace soils between the bottomland floodplain and the forested upland soils belong to the Quillayute-Knappa-Hebo association. They have high to medium organic content, but are less fertile than the floodplain soils (USDA 1964, TBNEP 1998a). Lowland soils were not mapped in the Weyerhaeuser soil survey.

The USDA Natural Resource Conservation Service (NRCS) is currently preparing an updated soil survey for Tillamook County, which is expected to be completed by 2005. Soil types for the forested uplands are already complete, but are not currently available in a digital format (John Shipman, NRCS, pers. comm., 2003).

1.1.6 EROSION AND SEDIMENT

There are two distinct zones of erosional processes in the Trask watershed: the steep, forested uplands, and the broad, lowland floodplain near the river mouth. The lowland floodplain zone includes the Lower Trask subwatershed, and the lower half of the Upper Trask subwatershed; all other subwatersheds are in the forested upland zone (Plate 1). On the steep slopes and shallow soils of the forested uplands, mass wasting is the dominant erosional process. Mass wasting includes a variety of erosional processes including shallow landslides, rock slides, debris slides, and debris flows in steeper terrain, and earth slides and earth flows on gentler slopes. Under natural conditions, geology, topography, and climate interact to cause landslides. Slope steepness is shown on Plate 2, giving an indication of the location of steep areas that are more prone to landslides.

Streambank erosion is also prevalent in the uplands, most notably in the East Fork of the South Fork and the Elkhorn Creek subwatersheds. Roads and off-highway vehicle (OHV) trails in the upland subwatersheds further increase the potential for erosion. Roads have been identified as the single greatest human-caused source of sediment (ODF 1998), but OHV trails are also believed to be an important contributor to erosion in the Middle Fork of the North Fork subwatershed (Hatton 1997).

Streambank cutting and sheet and rill erosion are the two primary erosional processes in the floodplain zone. Streambank erosion is the more prevalent of the two, and typically occurs in response to selective stratigraphic failure, soil saturation, or sloughing during high flow events.

Land use practices have caused stream channelization and modification of the riparian zone in some areas, thereby altering the natural patterns and rates of streambank erosion.

1.1.7 CLIMATE AND PRECIPITATION

The Trask watershed is exposed to a marine climate that is influenced by proximity to the Pacific Ocean and elevation. Westerly winds predominate and carry moisture and temperature-moderating effects from the ocean, resulting in winters that are moderate and wet, and summers that are cool and dry. Annual precipitation is high and occurs mostly during the winter months (Figure 1.2). The upper reaches of the Trask watershed generally receive from 125 to 200 inches of precipitation per year, while the lower reaches closer to the city of Tillamook receive between 80 and 125 inches. Intense winter storms occur periodically, accompanied by high winds and heavy precipitation. Snow falls at the high elevations during the winter, but often melts quickly with the warm rain that is typical of Pacific winter storms. Air temperatures in the Trask watershed are mild throughout the year with cooler temperatures at higher elevations. Due to the moderating effect of the Pacific Ocean, summer air temperatures in the lower reaches of the watershed may increase significantly only a few miles inland, relative to areas near the ocean. The average maximum temperature over a 30-year period in Tillamook County was 59.2° F (15.1°. C) and the average minimum temperature was 41.6° F (5.4° C). Over the 30 years studied, less than one day per year on average had a temperature over 90° F (32° C). The highest temperature recorded was 102° F (38.9° C; TBNEP 1998a).

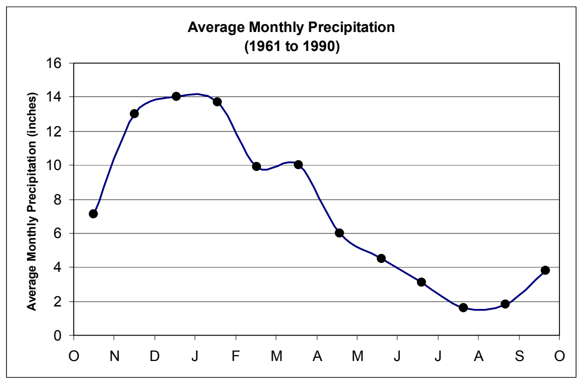

Figure 1. 2. Average monthly precipitation (in inches) near Tillamook.

1.1.8 HYDROLOGY

Streams in the Trask watershed are characteristically “flashy”. They respond very quickly to rainfall by rapidly increasing discharge due to the steep topography, high stream density, and intensity of precipitation. High flows typically occur between November and March and low flows from May to October.

Daily stream flow records have been collected near the mouth of the Trask River since 1930 by the U.S. Geological Survey (USGS). The annual low flow for the Trask River averages approximately 110 cubic feet per second (cfs), and the annual high flow is generally greater than 2,000 cfs. The 7-day average low and high flows with a 10% chance of occurring in any given year are 54 cfs and 8,000 cfs, respectively (Figure 1.3; ODEQ 2001).

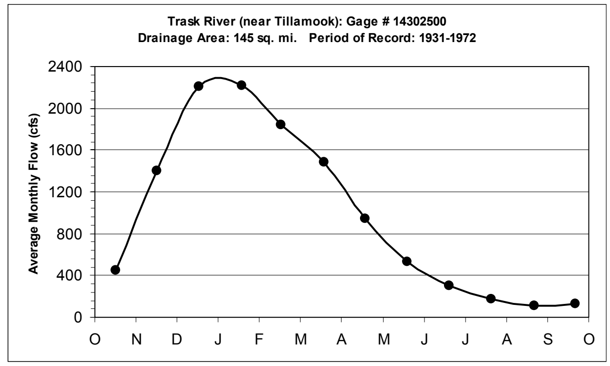

Figure 1. 3. Average monthly discharge near Tillamook.

Flooding frequently occurs in the lower portion of the Trask watershed, and has caused extensive property damage in the City of Tillamook. River flooding occurs most commonly in December and January during periods of heavy rainfall or snowmelt, or a combination of both. River flooding combined with tidal flooding can extend the flood season from November to February. The Trask watershed has a floodplain area of 3,600 acres, 3% of the total watershed area (TBNEP 1998a).

1.1.9 WATER QUALITY

Water quality in the Trask River is highly dependent on location within the watershed. The forested uplands generally have very different water quality issues than the pasturelands and urban areas of the lower reaches. Upland water quality issues revolve around water temperature, mainly in mainstem reaches, and turbidity levels, which increase in response to erosion; in the lowlands, fecal coliform bacteria (FCB), water temperature, and (locally) dissolved oxygen (DO) are issues of greatest concern.

Overall, the Trask River contributes proportionally more water pollution loading (e.g., bacteria, sediment, nitrogen) to Tillamook Bay than any other river in the Tillamook Basin (Sullivan et al. 1998 a,b; 2002). The estimated annual loading of FCB (2,000 to 3,200 x 10^{12} colony forming units (cfu)/year) was higher than the estimated FCB loading rates for the Wilson, Tillamook, Miami, or Kilchis rivers (Sullivan et al. 1998b). Estimated annual loading of total suspended solids (TSS; 185 x 10^6 kg/yr) was second only to the Wilson River (314 x 10^6 kg/yr). Inorganic nitrogen (N) loading was highest for the Trask River (1.1 x 10^6 kg/yr; Sullivan et al. 1998b).

FCB loading has been found to originate from urban, rural residential, and agricultural land use zones, in the lowland portion of the watershed (Sullivan et al. 1998a,b). The upper watershed has not been found to contribute significant amounts of FCB. Most of the inorganic nitrogen, however, originates in the upper, forested portions of the watershed (Sullivan et al. 1998a,b), although concentrations are not particularly high in the Trask River compared with other rivers in western Oregon, ranging from about 0.3 to 1.1 mg N/L.

The federal Clean Water Act requires implementation of Total Maximum Daily Load (TMDL) standards for rivers, lakes and streams identified as water quality limited for “beneficial uses”.

In the Tillamook basin, including the Trask watershed, “beneficial uses” identified by the TMDL include cold water aquatic life, water contact recreation, and shellfish harvesting in the bay. Water temperature is currently listed as being “limited” (as specified in section 303(d) of the Clean Water Act) from river mile 0 to 19.2 (from the mouth to the South Fork tributary junction). In addition, the Trask River has failed to meet standards for FCB and DO (from September 15 to May 31) in past years, and FCB is included in the TMDL. Targeted reductions in FCB concentrations in the lower mainstem Trask River of 94 to 99% overall are indicated by the TMDL (ODEQ 2002).

1.1.10 STREAM CHANNEL

Stream channels were divided into distinct channel habitat type (CHT) segments by the Tillamook Bay National Estuary Project (TBNEP) following Oregon Watershed Enhancement Board (OWEB) guidelines (TBNEP 1998b). Categories are based on geomorphic structure, including stream size, gradient, and side-slope constraint. CHT designations provide a useful summary of physical stream characteristics for determining habitat condition and restoration potential for fish and other aquatic species. The TBNEP estimated the quality of CHTs for supporting salmonid habitat, following the OWEB protocol (WPN 1999), based on Oregon Department of Fish and Wildlife (ODFW) data on pool area, pool frequency, gravel availability, and gravel quality. The MM (moderate gradient, moderately confined) CHT, which occurs only in the East Fork of the South Fork subwatershed, had the best habitat conditions in the Trask watershed. MC (moderate gradient, confined), MV (moderately steep narrow valley), VH (very steep headwater), and MH (moderate gradient headwater) CHTs all had some zones of intermediate habitat quality. Only the SV (steep narrow valley) CHT had uniformly poor habitat conditions. Overall, the East Fork of the South Fork subwatershed and the North Fork subwatershed had the most desirable CHT conditions, whereas the Middle Fork of the North Fork had the least desirable conditions (TBNEP 1998b).

1.2 BIOLOGICAL

1.2.1 VEGETATION CHARACTERISTICS

The vegetation in the Trask watershed has been greatly altered since settlement by Euro-Americans (Plate 3). Prior to settlement, vegetation included a substantial component of late-successional forest, with prairies, swamps, marshes, and tidally-influenced forest in the lowlands (Coulton et al. 1996). The original upland forest was primarily a mixture of western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), noble fir (*A. procera*), and Sitka spruce (*Picea sitchensis*; TBNEP 1998a, Franklin and Dyrness 1973). Since the 1850s, forests have been cleared and harvested, wetlands drained, and pastures created for dairy cattle. A series of catastrophic fires beginning in the 1930s burned much of the remaining forest (about 200,000 acres in the Wilson and Trask watersheds) and accelerated rates of erosion (TBNEP 1998a).

The majority of forested uplands in the watershed were re-planted 25 to 45 years ago with Douglas-fir for timber production. Currently, the forest is dominated by closed canopy, even-aged conifer and hardwood stands 25 to 45 years old (ODF 2003a,b). There are pockets of late-successional forest at the northwestern edge of the watershed, and some mixed stands of Douglas-fir and western hemlock are found scattered throughout the forest (ODF 2003a). Throughout the forest, hardwoods tend to dominate the riparian zones, and are mixed with Douglas-fir in the uplands. The lowlands are predominantly occupied by pasture lands, with rural residential and urban areas (Plate 3).

Riparian vegetation distribution and condition varies with land use throughout the watershed. The tidal mainstem of the Trask River has poor riparian conditions. Riparian trees are largely absent, and vegetation is comprised primarily of blackberries and non-native grasses. Riparian zones in agricultural areas are discontinuous and comprised of brush and young hardwoods. In forested areas, riparian vegetation is continuous and comprised of dense mature and young hardwoods. The upper watershed riparian areas contain a mixture of mature mixed conifer and hardwood stands and young dense hardwoods. Stream shade is not adequate in some reaches, especially throughout the lower and middle mainstem reaches of the Trask River, and summer mainstem temperatures often exceed state standards (TBNEP 1998b).

There are three main forest health concerns in the Trask watershed, the most prevalent of which is Swiss needle cast (SNC; *Phaeocryptus gaumanni*), a fungal infection affecting Douglas-fir. Approximately 40% of the state lands in the Tillamook District of the Trask watershed show symptoms of SNC. Plans for near-term timber harvest are largely concerned with reducing the impacts of SNC (ODF 2003a). The second largest forest health consideration is the vigor of trees planted from off-site seed stock. The third is *Phellinus weirii*, a root rot that is affecting between 5 and 10% of the forest in the Tillamook District (ODF 2003a).

Management of rare plants in the Trask watershed varies depending on land ownership. Rare plant designations on Bureau of Land Management (BLM) lands are managed under the policy guidelines of the Special Status Species program. The BLM has surveyed over 2400 acres in the Trask watershed (primarily in the Elkhorn Creek subwatershed) for Survey and Manage plant species and found none. One Survey and Manage lichen species, *Peltigera pacifica* is known to occur immediately adjacent to the Trask watershed and almost certainly occurs with the Trask watershed (Andy Pampush, BLM, pers. comm., 2003).

Based on reviews of the Oregon Natural Heritage Program's (ONHP) database of plant locations, consultations with the Oregon Department of Agriculture Rare Plant Program, and the Oregon Department of Forestry's (ODF) own work in the basin, Endangered, Threatened, Candidate, and Special Concern plant species on ODF land in the Trask watershed have been identified. See listing of species and additional information regarding rare plants on both BLM and ODF land in Section 3.2.3.4.

1.2.2 FISH AND WILDLIFE HABITAT

1.2.2.1 Aquatic

Anadromous salmonid fish species occurring in the Trask watershed include spring and fall chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), chum salmon (*O. keta*), summer and winter steelhead (*O. mykiss*), and sea-run cutthroat trout (*O. clarkii;* Table 3.17). Resident cutthroat trout also occupy most of the streams. Resident brook lamprey (western brook [*Lampetra richardsonii*] and/or Pacific brook [*L. pacifica*]) likely occur in the watershed but are not well-documented.

Coho is federally listed as Threatened under the Endangered Species Act. Chum salmon is listed as Threatened under the State of Oregon's Endangered Species Act; Pacific and river lamprey and coastal cutthroat are State Species of Concern. Steelhead is designated as a candidate for listing within this evolutionarily significant unit (ESU), but is not currently listed. The Oregon Coast ESU is one of 19 ESUs of salmon and steelhead that have had critical habitat designations withdrawn as of April 30, 2002. The National Oceanographic and Atmospheric Administration (NOAA) fisheries division is currently in the process of re-issuing critical habitat designations for these species.

The Magnuson-Stevens Act governs the conservation and management of ocean fishing and establishes exclusive U.S. management authority over all coho and chinook salmon (species of commercial interest) throughout their migratory range except when in a foreign nation's waters. The Pacific Fishery Management Council (off the coast of the continental United States), and the Pacific Salmon Commission (off the coast of Canada and Alaska) are the agencies responsible for managing anadromous fish species during the period of their life cycle spent in the ocean. Salmonid species in the Trask watershed most likely to be affected by regulatory actions are coho, chum, and chinook salmon, due to existing marine fisheries for these species. Steelhead and cutthroat trout are rarely caught in marine waters. A habitat conservation plan (HCP) for listed species and Species of Concern is currently under development for western Oregon state forests, and is expected to be completed in approximately two years. Interim policies for Threatened and Endangered (T&E) Species are included in the Interim State Forests Salmon Protection Policy Implementation Plan (IP), which is expected to be completed in 2003.

Key habitat for at-risk species such as coho, chinook, chum, steelhead, cutthroat trout, and Pacific lamprey is found within the Trask watershed. Core areas of coho habitat are located in the North Fork, South Fork, and East Fork subwatersheds. Elkhorn Creek is designated by the BLM as a Tier 1 Key Watershed that contributes directly to conservation of at-risk anadromous salmonids and resident fish species (BLM 1995).

Several salmonid species are stocked in the Trask watershed, including fall and spring chinook, coho, and rainbow trout (*Oncorhynchus mykiss*). Winter and summer steelhead, cutthroat trout, and largemouth bass (*Micropterus salmoides*) were formerly stocked. The current population of summer steelhead found in the Trask watershed consists entirely of hatchery strays from the Wilson River (Keith Braun, ODFW, pers. comm., 2003). Although details of their life history and habitat requirements differ substantially, all of these salmonid species depend upon the streams of the Trask watershed and Tillamook Bay for migration, spawning, and rearing.

Degradation of habitat and declines in fish populations have been attributed to several natural and human-caused events. High rates of erosion and sedimentation following a series of catastrophic wildfires in the Tillamook State Forest beginning in the 1930s were detrimental to fish populations (Coulton et al., 1996). Sedimentation continues largely due to road-related mass wasting and road surface runoff in the uplands and bank erosion in the lowlands (TBNEP 1998a). Extensive channel modifications, including dredging, diking, streambank armoring, and removal of large wood, have resulted in channelization of lowland reaches of the Trask River. Passage barriers have been introduced, for example the dam at Barney Reservoir and the hatchery weir on Gold Creek. Road culverts block fish passage at some locations. The disconnection of the river channel from surrounding floodplains and wetlands eliminates the exchange of nutrients and sediment that would occur naturally, and destroys important spawning and juvenile fish rearing habitat (Coulton et al., 1996).

Other native fish species present in the Trask watershed include various species of sculpin (*Cottus* sp.) and stickleback (*Gasterosteus* sp.). Adult sturgeon (*Acipenser* sp.) are occasionally found in the tidewaters of the Trask River (Keith Braun, ODFW, pers. comm., 2003). In addition, other aquatic species such as salamanders, frogs, and turtles occur in the Trask watershed. Several additional Species of Concern may be found in the watershed, including northern red-legged frog (*Rana aurora aurora*), Columbia torrent salamander (*Rhyacotriton kezeri*), and tailed frog (*Ascaphus truei*; Table 1.3).

1.2.2.2 Terrestrial

Threatened and Endangered bird species include the northern spotted owl (*Strix occidentalis caurina*), marbled murrelet (*Brachyramphus marmoratus*), and bald eagle (*Haliaeetus leucocephalus*). In the Tillamook District of ODF, there is a northern spotted owl cluster that includes portions of the Trask watershed. The cluster contains a single female owl and includes high quality habitat for the recovery and dispersal of the species. In the vicinity of the ODF owl cluster is a BLM Reserve Pair Area (RPA) that includes two owl sites and encompasses approximately 8,000 acres that includes the lower Trask River. This area contains several late-successional stands that provide high quality potential habitat for spotted owls, marbled murrelets and bald eagles. The dramatic reduction in old-growth forest as a result of the Tillamook Burn and past logging have been associated with a reduction in the populations of wildlife species that prefer late-successional forest, including the northern spotted owl.

There are 3,700 acres of marbled murrelet management area in the Tillamook District of ODF. However, there are no known nesting areas for marbled murrelets or bald eagles in the Trask watershed. These species may utilize the watershed area for other purposes. Currently, T&E species on ODF lands are managed according to interim policies until the completion of the Western Oregon State Forests HCP, which is expected to be completed by 2005. Wildlife species of concern that may have suitable habitat within the Trask watershed are listed in Table 1.3.

Table 1. 3. Wildlife species of concern with breeding and/or foraging habitat within the Trask watershed (ONHP 2001).

Species	Federal Status	ODFW Status	ONHP Heritage Rank
Bald eagle	Threatened	Threatened	Rare, threatened, and uncommon throughout Oregon
Marbled murrelet	Threatened	Threatened	Imperiled in Oregon
Northern spotted owl	Threatened	Threatened	Rare, threatened, and uncommon throughout Oregon
American peregrine falcon	--	Endangered	Critically imperiled in Oregon
Aleutian Canada goose	--	Endangered	Imperiled in Oregon
Dusky Canada goose	--	--	Imperiled in Oregon
Band-tailed pigeon	Species of Concern	--	Not rare, apparently secure in Oregon
Mountain quail	Species of Concern	Undetermined Status	Not rare, apparently secure in Oregon
Harlequin duck	Species of Concern	Undetermined Status	Imperiled in Oregon
Little willow flycatcher	--	Vulnerable	Unknown
Lewis' woodpecker	Species of Concern	Critical	Rare, threatened, and uncommon throughout Oregon
Pileated woodpecker	--	Critical	Not rare, apparently secure in Oregon
Purple martin	Species of Concern	Critical	Rare, threatened, and uncommon throughout Oregon
Western bluebird	--	Vulnerable	Not rare, apparently secure in Oregon
Northern red-legged frog	Species of Concern	Undetermined Status	Rare, threatened, and uncommon throughout Oregon
Tailed frog	Species of Concern	Vulnerable	Rare, threatened, and uncommon throughout Oregon
Columbia torrent salamander	--	Critical	Rare, threatened, and uncommon throughout Oregon
Clouded salamander	--	Undetermined Status	Rare, threatened, and uncommon throughout Oregon
White-footed vole	Species of Concern	Undetermined Status	Rare, threatened, and uncommon throughout Oregon
Red tree vole	Species of Concern	--	Rare, threatened, and uncommon throughout Oregon
Pacific western big-eared bat	Species of Concern	Critical	Imperiled in Oregon
Silver-haired bat	Species of Concern	Undetermined Status	Not rare, apparently secure in Oregon
Long-eared myotis (bat)	Species of Concern	Undetermined Status	Rare, threatened, and uncommon throughout Oregon
Fringed myotis (bat)	Species of Concern	Vulnerable	Imperiled in Oregon
Long-legged myotis (bat)	Species of Concern	Undetermined Status	Rare, threatened, and uncommon throughout Oregon
Yuma myotis (bat)	Species of Concern	--	Rare, threatened, and uncommon throughout Oregon
American marten	--	Vulnerable	Rare, threatened, and uncommon throughout Oregon
Pacific fisher	Species of Concern	Critical	Imperiled in Oregon
Oregon megomphix (snail)	--	--	Rare, threatened, and uncommon throughout Oregon
Marsh damsel bug	--	--	Imperiled in Oregon
Mulsant's water treader	--	--	Imperiled in Oregon
Evening fieldslug	--	--	Critically imperiled in Oregon

Indigenous large and medium-sized mammals found in the Trask watershed include beaver (*Castor canadensis*), elk (*Cervus elaphus*), deer (*Odocoileus hemionus columbianus*), black bear (*Ursus americanus*), and cougar (*Puma concolor*). However, the dense, young, even-aged forests that now predominate provide limited food for some sensitive species. Thinning and clear-cutting activities have improved forage conditions for deer and elk, and their populations are believed to be increasing. Elk numbers are currently very high within the watershed. Recent forest management policies introduced at both the state and federal levels strive to increase structural and age-class diversity in the future, and increase the distribution of late-successional forest and associated species (ODF 2003a,b).

The Trask watershed contains habitat for four terrestrial wildlife species that are covered by the BLM Survey and Manage provisions, three mollusks and one mammal:

Red tree vole	*Arborimus longicaudus*
Oregon megomphix	*Megomphix hemphilli*
Puget Oregonian	*Cryptomastix devia*
Evening field slug	*Deroceras hesperium*

Two of these species, the Oregon megomphix and the evening field slug, are also designated by the BLM's Special Status Species program as Bureau Sensitive species. Other terrestrial species that are covered by the BLM's Special Status Species program and for which habitat may be found in the Trask drainage include:

Peregrine falcon	*Falco peregrinus anatum*
Common nighthawk	*Chordeiles minor*
Purple martin	*Progne subis*
Columbia torrent salamander	*Rhyacotriton kezeri*

1.3 SOCIAL

1.3.1 POPULATION

The population of the Trask watershed is concentrated almost entirely in and around the City of Tillamook, within the Lower Trask River subwatershed. The remaining population consists of scattered farm residences in the Lower Trask River subwatershed and sparse settlement of the lower and middle reaches of the mainstem Trask River valley. With a population of 24,262 in 2000, Tillamook County grew by 12.5% from 1990 to 2000 (U.S. Census Bureau 2002), a growth rate that is expected to remain steady over the coming years (TBNEP 1998a).

Since 1950, the population of Tillamook County has increased by 30%. The population declined during the 1960s, then rose sharply in the 1970s, generally paralleling changes in the timber industry (Coulton et al. 1996). After remaining steady in the 1980s, the population began to grow again in the 1990s. Recent population growth has been attributed more to quality of life concerns and an influx of retirees than to changes in natural resource industries (Davis and Radtke 1994).

1.3.2 OWNERSHIP

Land ownership in the Trask watershed is divided among private landowners, and local, state, and federal agencies. Over half of the watershed (58%) is owned by the State of Oregon. These lands comprise nearly 65,000 acres that are located in the mid to upper watershed. Private industrial landowners own the next largest portion of the watershed at 21% (24,044 acres), followed by private non-industrial landowners at 12% (13,665 acres). Private industrial lands are concentrated in the forested upper southeast and northeast corners of the watershed, and in the forested regions of the lower watershed. Private non-industrial lands dominate the lower, mostly agricultural part of the watershed, with some small blocks of land along the middle reach of the mainstem of the Trask River. The remaining portions of the watershed are owned by the BLM (8%) and by local government (1%). BLM lands are scattered throughout the middle and upper parts of the watershed. Local government owns Barney Reservoir in the upper watershed and a small block of land in the foothills of the lower watershed.

1.3.3 LAND USE

The vast majority of the Trask watershed is utilized for forest use (91%), with agricultural use as the next largest zoning category at 6%. The remainder of the watershed is a combination of urban use (1%), rural residential use (1%), and other miscellaneous uses (1%; Plate 4).

State forest land in the Trask watershed is managed by ODF according to the Northwest Oregon Forest Management Plan. Under that plan, a forest land management classification system (FLMCS) is being developed as specified in OAR 62-035-0050, and will remain in draft form until the proposed HCP is approved in 2005. The FLMCS places state forests into three broad categories: 1) General Stewardship, 2) Focused Stewardship, and 3) Special Stewardship. The General Stewardship classification is the least restrictive, and specifies management of forest resources using integrated management strategies and techniques. Focused Stewardship lands require supplemental planning, modified management practices, or compliance with legal or contractual requirements above those required on General Stewardship lands. The Special Stewardship classification is the most restrictive, and is required if a legal or contractual constraint precludes integrated management, if forest resources require protection that precludes the integrated management of forest resources, or if lands are committed to a specific use and management activities are limited to those that are compatible with the specific use. Of the Focused Stewardship lands, the majority are classified as Aquatic and Riparian Habitat (85%). Five percent are dedicated to recreation, 4% to visual, and 2% each to deeds restrictions and wildlife habitat.

The BLM's mandate under the Federal Land Policy and Management Act of 1976 is to manage the public lands for multiple use, while protecting the long-term health of the land (BLM 1995). Management guidance and policy is provided by the Northwest Forest Plan, and implemented by the Salem District Resource Management Plan. The Northwest Forest Plan establishes both Land Use Allocations, and the Aquatic Conservation Strategy (ACS) for land use planning. Land Use Allocations in the Trask include Adaptive Management Areas (AMAs) and Adaptive Management Reserves (AMRs). The management objectives for AMAs are to develop and test new management approaches integrating ecological and economic health, to restore and maintain late successional forest habitat and riparian zones, and to provide a stable timber supply (BLM 1995). AMAs account for 73% of BLM lands in the Trask watershed. AMRs are managed with particular attention to northern spotted owl and marbled murrelet habitat requirements, and include both the guidelines of AMAs, as well as additional measures to protect Late Seral Reserves. AMRs make up the remaining 27% of BLM land in the Trask watershed. Within the AMR area in the Trask, a RPA has been designated for two spotted owl sites along the northern edge of the Upper Trask subwatershed, requiring specific measures to assist the survival and recovery of this species.

In accordance with the ACS, BLM land in the Trask watershed has been classified as a federal Tier 1 Key Watershed, because it contains high quality habitat for at-risk aquatic species, and is believed to have high potential for restoration. Key Watersheds are given special consideration, and require watershed analysis prior to many management activities. In addition to the Key Watershed status, the ACS establishes Riparian Reserves (RR), which are streamside areas where the primary emphasis of management is concerned with riparian-dependent resources, and special Standards and Guidelines apply. The width of RRs is based on ecological and geomorphic factors, including fish presence and streamflow seasonality. Riparian Reserves overlap with AMAs and AMRs in the riparian zones, and generally the guidelines that provide the most conservative protection are applied.

1.3.4 HUMAN USES

1.3.4.1 Forestry

Forested land, which makes up approximately 91% of the Trask watershed, has supported profitable timber harvest and wood products industries since the 1880s. Forested lands in the Trask watershed were predominantly privately owned until the Tillamook Burn fires, after which the county foreclosed on most of the private commercial forest lands due to delinquent taxes. Subsequently, Tillamook County deeded the land to the State of Oregon. The volume of harvested timber peaked in the 1950s due to salvage logging, exceeding 610 million board feet in 1953 (ODF 1995). Following the salvage logging and replanting of the Tillamook Burn in the 1950s, most timber harvest has come from private and federal land (TBNEP 1998a).

According to the Tillamook District IP, approximately 40% of ODF land in the Trask watershed is showing severe symptoms of SNC infection (ODF 2003a). These stands are the focus of management activity, as directed by the Board of Forestry Intent Statement Number 6, which instructs the Tillamook District to harvest severely affected SNC stands in the next 20 years (ODF 2003a). Between 2003 and 2011, approximately 320 to 455 acres of partial cut and 10,160 to 14,515 acres of clearcut will take place. According to IP estimates, the proportion of the landscape in closed single canopy (CSC) will have been reduced by 2011 from 82% to 53%, and regeneration (REG) structure will have increased from <1% to 26%. Long-term desired future conditions (DFC) are 15% CSC and 10% REG (ODF 2003a).

In the Forest Grove District, the western portion of the Sunday Creek Management Basin drains into the Trask Watershed. Management activities include harvesting of 350 to 700 acres, and altering the proportion of REG from <1% to 6%. The DFC target is 9% REG. In addition, 5,000 to 6,000 acres may receive fertilization during the planning period (2003 to 2011).

1.3.4.2 Agriculture

Agricultural land makes up approximately 6% of the Trask watershed, and agriculture has contributed to the economy of the Tillamook region since settlement by Euro-Americans. Dairy production began in 1852, immediately following the onset of settlement.

Commercial production of cheese began around 1900, and Tillamook soon developed a reputation as an important producer of cheese on the West Coast. Over the past 50 years, the number of farms has declined as smaller farms have been consolidated into larger commercial farms (Coulton et al. 1996). Dairy products make up 82% of agricultural income in Tillamook County. Small woodlots and cattle and calves constitute 11% and 5% of total agricultural income, respectively (TBNEP 1998a).

1.3.4.3 Urban and Rural Residential

Urban lands within the Trask watershed consist entirely of the city of Tillamook (Plate 4). Over the last several decades, the economic base of Tillamook County has shifted from a heavy reliance on timber, agriculture and fishing to a greater diversity of business and industry. Retail has been the top industry sector in recent years (U.S. Census 1990), likely due to increasing tourism and population growth in the area. Approximately 25% of the jobs in Tillamook County are related to tourism (Southern Oregon Regional Services Institute 1996).

Rural residential lands are scattered across the lower Trask River floodplain, and extend up into the forested watershed along the valley bottom. New homes in Tillamook County are increasingly targeted for upper income individuals who are looking for second or vacation homes near the coast, and these communities have become increasingly popular for retirees and second homeowners.

1.3.4.4 Recreation

The Trask watershed has been a tourist and recreational destination since the turn of the 20th century. Hiking, sport fishing, wildlife viewing, hunting, off road vehicle use, kayaking, mountain biking, horse riding, and picnicking are all popular recreational activities (ODF 2003a,b; Coulton et al. 1996).

Most recreational activity is seasonal, with the majority of activity in the spring, summer and fall. Kayaking is popular in the spring and fall, and picnicking and swimming are common in the summer. Off-highway vehicle use is the most popular year-round activity on the forested land of the Trask watershed (ODF 2003a).

CHAPTER 2. REFERENCE CONDITIONS

2.1 INTRODUCTION

The temperate coniferous forest community emerged in the Oregon Coast Range approximately 11,000 years ago, at the beginning of the Holocene Epoch (Spies et al. 2002). Throughout the Holocene, forest composition shifted following wet and dry cycles, largely due to changes in the length of the average fire interval. The current forest composition has prevailed for about 2,400 years, punctuated by episodic natural disturbances (Worona and Whitlock 1995, Spies et al. 2002). The primary ecosystem disturbance processes have been major floods events, windstorms, and stand-replacing fires. Over the past several millennia, catastrophic flood events have occurred on average about once every 300 years, while stand-replacing fires occurred on average about once every 175 years (Spies et al. 2002). The impacts of disturbance have been unevenly distributed across the landscape, both in space and time. Consequently, a complex mosaic of ecosystem conditions had developed prior to Euro-American settlement.

Because of the episodic and unpredictable timing of these disturbances, uncertainty is inherent to any discussion of reference conditions. It is not possible, and meaningless from a management standpoint, to reconstruct the site-specific conditions that prevailed at a given time or place. Instead, it is more valuable to reconstruct the range of conditions that were likely to have prevailed at the landscape scale. Rather than assessing the current ecological condition of our forests based on their age, which is a few thousand years in length and represents only a few generations of conifers, we should consider the compositional diversity and structural complexity that arose from many thousands of years of adjusting to changing climatic conditions and episodes of disturbance (c.f. Spies et al. 2002). This can help to establish realistic benchmarks for use in future management. These benchmarks can be used to help assess ecological functions and processes that support desired conditions, and to establish management priorities for enhancing these functions and processes. However, it should always be recognized that these reconstructions are imperfect approximations subject to the strengths and weaknesses of their underlying assumptions.

This reference conditions chapter will reconstruct conditions existing prior to Euro-American settlement. It will then examine some of the changes that occurred following settlement.

2.2 AQUATIC

2.2.1 HYDROLOGY AND WATER QUANTITY

Prior to Euro-American settlement, the majority of the Trask watershed was heavily forested with a mosaic of late-seral old-growth coniferous forest, hardwoods, and regenerating coniferous forest subsequent to natural disturbance (c.f., Maddux 1976, Teensma et al. 1991, Coulton et al. 1996, Chen 1998). Interception of precipitation and evapotranspiration were probably high. Flooding of the watershed occurred annually, inundating the numerous floodplains, wetlands, and swamps that were present in the lowlands. Large flood events were recorded on the major

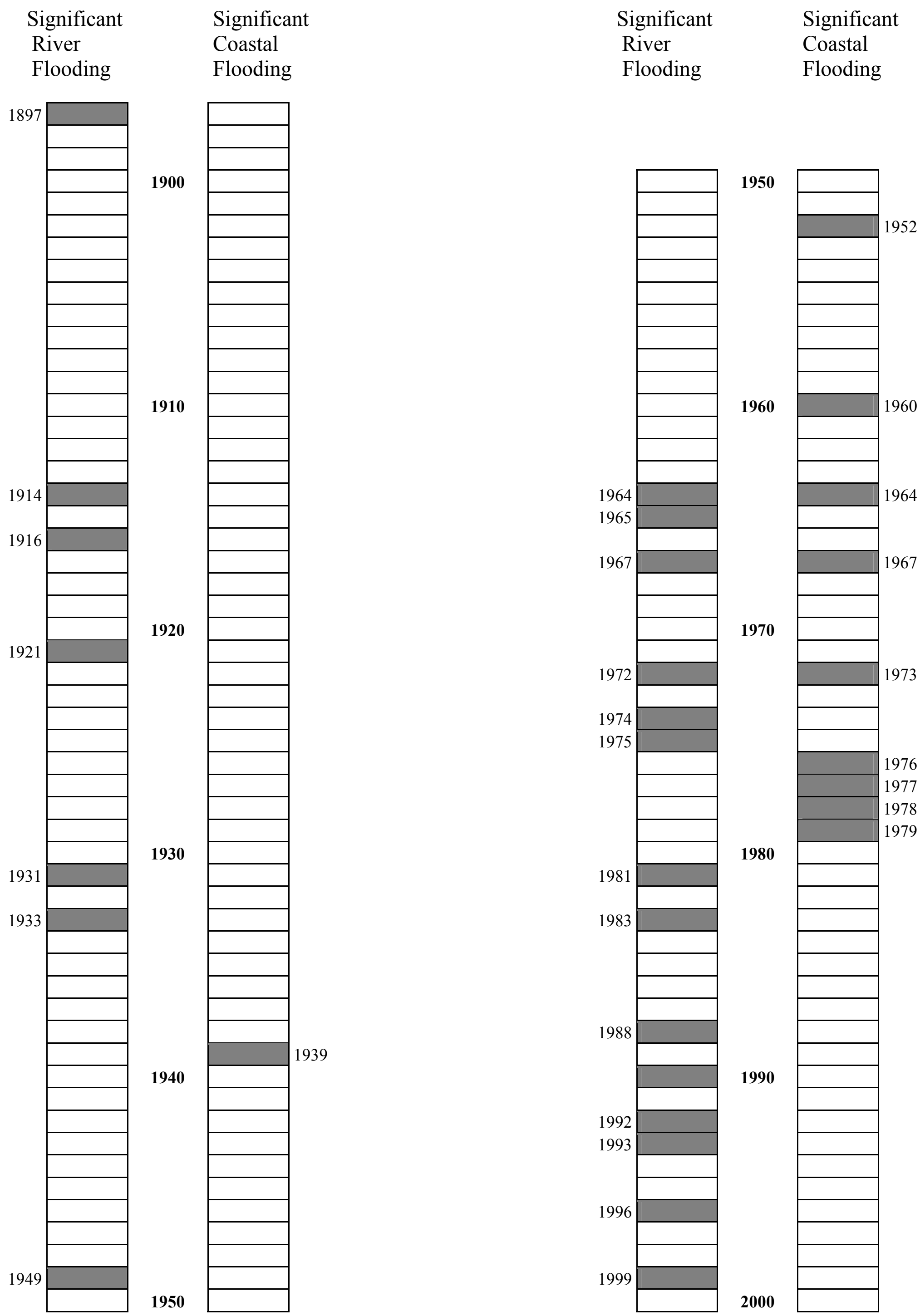

Figure 2.1. Generalized flood history of Tillamook Basin rivers and coastline. Significant flooding is defined as flooding sufficient to have resulted in newspaper coverage or other documentation. (Source: Coulton et al. 1996; modified to include floods subsequent to 1995)

rivers of the Tillamook Basin during 21 winters between 1897 and 2000 (Figure 2.1; Coulton et al. 1996).

Debris jams were common on the lower portion of the Trask River, and contributed to frequent overbank flooding (Coulton et al. 1996). In 1897, the U.S. Army Corps of Engineers (USACE) recommended that debris jams and sunken logs be removed, and banks “trimmed” along the Trask River to “permit it to carry the flood waters without flooding the farm lands” (USACE 1897, Coulton et al. 1996). Flood events also transported sediment to Tillamook Bay (Coulton et al. 1996). According to USACE reports from 1902 and 1907, “a considerable quantity of gravel, sand, and mud is annually deposited in the bay and channels by tributary streams” (Gilkey 1974). This could reflect pre-settlement conditions, or could partly be a consequence of fires in the late 1800s.

The Tillamook Burn, a series of fires between 1933 and 1951, dramatically altered forest conditions in the Trask watershed. According to one study, the 1933 burn increased total annual discharge by about 9% and the annual peakflow by about 45% (Anderson et al. 1976). Increases in peak flows following fires generally last about a decade (Agee 1993) Logging and road construction immediately following the Tillamook Burn probably served to further increase peak flows.

2.2.2 EROSION

Shallow rapid landslides, including debris slides and debris flows, have accounted for the majority of erosion in the Oregon Coast Range (Skaugset et al. 2002). Most landslides have occurred during episodic large storm events. The frequency of historic slides has not been extensively studied in the Trask watershed and is not well known. Nevertheless, timber harvesting and road-related disturbances over the past 150 years are known to have accelerated erosion above natural rates throughout the Oregon Coast Range. Clearcut timber harvesting has been associated with a 0.8 to 5 times increase in landslide occurrence on steep slopes, as compared with mature forests (Swanson et al. 1977, Ketcheson and Froehlich. 1978, Robison et al. 1999). The increase in landslide occurrence has been found to persist for about 10 years, until forest canopy cover and fine root re-establishment (Robison et al. 1999). Road-associated landslides have occurred 10 to 50 times more frequently than natural (non-road) landslides on a unit-area basis, and the volume of landslide deposits has been at least 4 times larger on average (Swanson et al. 1977, May 1998, Skaugset et al. 2002). Sediment delivery to the stream channel from landslides and debris flows is higher today than in pre-settlement times due to the additional contribution of sediment from roads.

The density and frequency of earthflows prior to Euro-American settlement is unknown, although it is unlikely that conditions have changed substantially. Surface erosion is very uncommon in the Oregon Coast Range under forested conditions. In unmanaged forests, surface erosion is generally negligible, except following stand-replacing fires (Swanson et al. 1982, Skaugset et al. 2002). It is likely that most of the land use-related erosion and sediment impacts since pre-settlement times in the Trask watershed were the result of increased landslides, road construction, and salvage logging.

2.2.3 WATER QUALITY

Water quality conditions in the Trask watershed at the time of Euro-American settlement are undocumented. However, based on descriptions of the landscape at the time, it is likely that water temperatures in the mainstem reaches of the Trask River and its tributaries were lower than they are today. Early records indicate that the streambanks and lowland floodplains were mostly wooded, with many large trees present to provide adequate shade to moderate streamwater temperature (Coulton et al. 1996).

Bacterial conditions in the upper watershed, however, are less certain. In the lower watershed, current bacterial levels exceed water quality standards due to dairy, urban, and rural residential sources of contamination. Beaver ponds have been associated with high levels of fecal bacteria in smaller tributary streams (Sullivan et al. 2002). Beaver ponds are known to have occurred throughout the watershed in pre-settlement times (Coulton et al. 1996).

Chronic turbidity and suspended sediment concentrations were probably lower in pre-settlement times than they are today. This was largely because of the absence of roads and to a lesser extent the absence of logging and other anthropogenic watershed disturbances. However, large episodic disturbance events, such as fires and floods, would have resulted in periodic spikes in turbidity and suspended sediment levels (c.f., Agee 1993).

Primary sources of nutrient loading in the streams prior to Euro-American settlement included decaying salmon carcasses subsequent to spawning and nitrogen fixation associated with plants such as red alder in the riparian zone. The timing of nutrient input has been altered and the pulse of nutrients subsequent to spawning has been reduced. Nitrogen and phosphorus loading due to salmon mortality were higher historically, and have been replaced by other sources of nutrient loading.

2.2.4 STREAM CHANNEL

Stream channel conditions in the Trask River watershed prior to Euro-American settlement were notably different than they are today. Throughout the Oregon Coast Range, including the Trask watershed, stream channel morphology has been greatly simplified, especially in lowland areas. Over the past 150 years, the availability of gravel, wood, riparian forest, floodplains, sloughs, backwater areas, and pool habitat has declined in response to the reduction in channel complexity.

Stream channels in the lowlands have likely experienced the greatest change. Prior to Euro-American settlement, the main channel was highly sinuous, with many braided channels, secondary channels, oxbows and backwaters (Coulton et al. 1996). Extensive beaver ponds were also documented in the floodplain of the lower Trask River (Coulton et al. 1996). Riparian zones were heavily wooded with a diversity of species, and many large trees were present. Loss of late-successional riparian vegetation throughout the watershed has resulted in a reduction in woody debris and consequent in-stream channel complexity in the lowlands (Coulton et al. 1996, Reeves et al. 2002).

In the uplands, channel structure was also more complex prior to Euro-American settlement. There were more pools, pools were deeper, and large logs and woody debris jams were common in the stream channel (Reeves et al. 2002). Streamside vegetation included a greater diversity of species and age classes, including large conifers which provided large woody debris to the stream channel.

2.2.5 AQUATIC SPECIES AND HABITAT

Accounts by early settlers proclaimed the incredible abundance of salmon and trout. According to one account from the early 1900s, "The Trask was full of trout and salmon… The moment the freshets came with the fall rains, the river bed would be darkened by a horde of frantic fish fighting their way upstream to their spawning grounds" (Maddux 1976). Coho salmon (*Oncorhynchus kisutch*) were one of the most abundant anadromous fish in the Tillamook Basin in pre-settlement times (Coulton et al. 1996). Coho were harvested intensively in Tillamook Bay with gill nets from the late 1800s through 1961, when the gill net fishery was permanently closed. Catch records were not kept in the early years following settlement, but in the 1930s the annual gill net catch ranged from 25,000 to 74,000 and averaged about 46,000 fish. By the late 1980s, the total combined annual harvest of naturally-produced Tillamook Bay coho in the ocean (commercial and sport fisheries), estuary (sport fishery), and fresh water (sport fishery) was estimated to have been reduced to less than 10% of the 1930s levels (Bodenmiller 1995).

In addition to coho salmon, the Trask River has witnessed substantial declines in the populations of chinook (*Oncorhynchus tshawytscha*) and chum (*O. keta*) salmon, steelhead (*O. mykiss*) and cutthroat (*O. clarkii*) trout, and Pacific lamprey (*Lampetra tridentata*). Pink salmon (*O. gorbuscha)* have been extirpated from the Oregon Coast, although it is uncertain whether or not stable populations existed historically.

Early cannery records indicate that as many as 28,000 spring and fall chinook salmon were packed annually from Tillamook Bay from 1893 through 1919. From 1923 through 1946, commercial landings remained relatively stable ranging from 12,000 to 31,000 fish and averaged about 17,000 fish (Nicholas and Hankin 1988). The commercial catch declined from 1947 until the fishery was closed in 1961. The decline may have been related in part to increased regulatory restrictions on the fishery (TBNEP 1998a).

Tillamook Bay historically supported the Oregon Coast's largest chum salmon fishery, and chum may have been the most abundant fish in the bay. An undated report by Kenneth A. Henry of the Fish Commission of Oregon, entitled *Tillamook Bay Chum Salmon*, states that harvests of chum between 1928 and 1950 ranged from a low of 178,000 lbs to a high of 2,804,000 lbs in 1928, with an average of 791,826 lbs. Assuming approximately 10 lbs per fish, the catch would range from 17,000 to 280,000 fish, with an average of 79,000 (Dave Plawman, ODFW, pers. comm., 2003). Oregon is near the southern edge of chum salmon distribution, which may, in part, account for the large interannual variability in run sizes that have been observed in Tillamook Basin streams over the years. The gill net fishery in Tillamook Bay held up longer than any of the other Oregon chum fisheries but was permanently closed in 1961 (TBNEP 1998a).

No reliable information on the historic abundance of steelhead in the Trask watershed is available. Steelhead were gillnetted commercially in Tillamook Bay from the late 1890s through the 1950s. However, harvest data for steelhead were not recorded in a reliable manner until after the fishery had been restricted to the early part of the steelhead run. Rough estimates of total coastwide steelhead run size made in 1972 and 1987 were similar (Sheppard 1972, Light 1987), suggesting that overall abundance remained relatively constant during that period. Light (1987) estimated total run size for the major stocks on the Oregon Coast (including areas south of Cape Blanco) for the early 1980s at 255,000 winter steelhead and 75,000 summer steelhead. With about 69% of winter and 61% of summer steelhead of hatchery origin, Light estimated that the naturally-produced runs totaled only 79,000 winter and 29,000 summer steelhead (note that most of the Oregon coastal summer steelhead are in the Umpqua and Rogue River systems; TBNEP 1998a).

Population levels have been so depressed that all salmonid species on the Oregon Coast have been considered for listing under the Federal Endangered Species Act (Reeves et al. 2002), and the coho salmon was listed as a Threatened species in 1998. Additionally, a number of amphibians are listed by the State of Oregon as species of special concern due to declines in abundance, including the northern red-legged frog (*Rana aurora aurora*), tailed frog (*Ascaphus truei*), and Columbia torrent salamander (*Rhyacotriton kezeri*).

The decline in suitable aquatic habitat is frequently cited as an important reason (along with ocean conditions and overharvest) for the decline in fish populations (Nehlsen et al. 1991, Bisson et al. 1992, Reeves et al. 2002). High-quality aquatic habitat was abundant in the Trask watershed prior to Euro-American settlement, both in the stream channel and in backwater and wetland areas. The diversity of habitat conditions for fish and other aquatic species was provided by the historic array of physical elements in the stream channel, including logs, woody debris, boulders, and gravel. Woody debris was common both in the uplands and in the lowland channels and floodplains. Woody debris jams could be quite extensive; for example, two wood jams in the lowlands of the nearby Wilson River each measured 800 feet in length (Coulton et al. 1996).

Early settlers removed debris jams and woody debris from channels and straightened channels to improve navigation and to allow timber to be transported downstream to mills during log drives. Between 1890 and 1920, over 9,300 snags were removed from the lower portions of the rivers entering Tillamook Bay, including the Trask River, for navigational purposes (Benner and Sedell 1987, Gonnar et al. 1988). Once the debris jams were cleared, the frequency of localized flooding was reduced, and "structures could safely be built closer to the river" (Farnell 1980). The presence of wood jams in the lowland portion of the Trask River had functioned historically to increase the frequency and timing of overbank flooding, creating hydrological connections between riverine, estuarine, and terrestrial areas (Coulton et al. 1996).

2.3 TERRESTRIAL

2.3.1 LANDSCAPE VEGETATION PATTERN

2.3.1.1 North Coast Region

Temperate coniferous forest communities replaced subalpine forests and tundra in the Oregon Coast Range approximately 11,000 years ago, as the Earth's climate warmed and entered the present interglacial period (Spies et al. 2002). Historic cycles of wet and dry periods have been accompanied by shifts in the length of the average fire interval, altering forest community composition. Present day forest communities in the Oregon Coast Range have been generally similar for the past 3,000 years, although climatic variation has caused gradual shifts in species dominance (Worona and Whitlock 1995, Spies et al. 2002).

Early explorers encountered areas of closed-canopy forests that contained large trees throughout the Oregon Coast Range. Lewis and Clark described the mountains at Nehalem as "covered with a verry [sic] heavy growth of pine and furr [sic], also the white cedar or arbor vita and a small proportion of the black alder, this alder grows to the height of sixty or seventy feet and from 2 to 3 feet in diamiter [sic]." Recent studies have estimated the coverage of old-growth forest in the Oregon Coast Range prior to Euro-American settlement to be 40% to 46%, on average, in a patchy mosaic that included canopy gaps, shrubs, hardwoods, and regenerating coniferous forest, maintained by localized natural disturbance (Teensma et al. 1991, Wimberley 2000).

2.3.1.2 Trask Watershed

Based on USGS land survey records and the descriptions of early settlers, a large proportion of the Trask River watershed prior to Euro-American settlement was late-seral old- growth coniferous forest, dominated by western hemlock (*Tsuga heterophylla*), Douglas-fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), and Sitka spruce (*Picea sitchensis;* Maddux 1976, Coulton et al. 1996). However, although broadly characterized as late-seral old-growth, unmanaged forest in the Oregon Coast Range prior to settlement was generally a patchy mosaic of mixed-age and mixed-species stands (Spies et al. 2002). Fine-scale variation was caused by outbreaks of disease, windthrow, small fires, and mass soil movements, resulting in patches of tree regeneration, shrubs, hardwoods, standing dead trees, down trees, and decaying logs (Wimberley 2000, Spies et al. 2002). Although portions of the Trask watershed had burned prior to settlement, late seral forest was abundant. Subsequent to settlement (though not necessarily the result of settlement), the Tillamook Burn and other fires burned the majority of the forested region of the Trask watershed (Coulton et al. 1996, Chen 1998).

Descriptions of the coastal lowlands of the Tillamook Basin by early explorers depicted heavy forest interspersed with broad prairies. The tidelands were largely forested with Sitka spruce, western red cedar, and western hemlock (Figure 2.2), and extensive forested floodplains and wetlands were punctuated by sloughs and swamps. Native Americans are believed to have maintained prairie lands through burning, for the purpose of providing favorable conditions for game species and other food sources (Coulton et al. 1996).

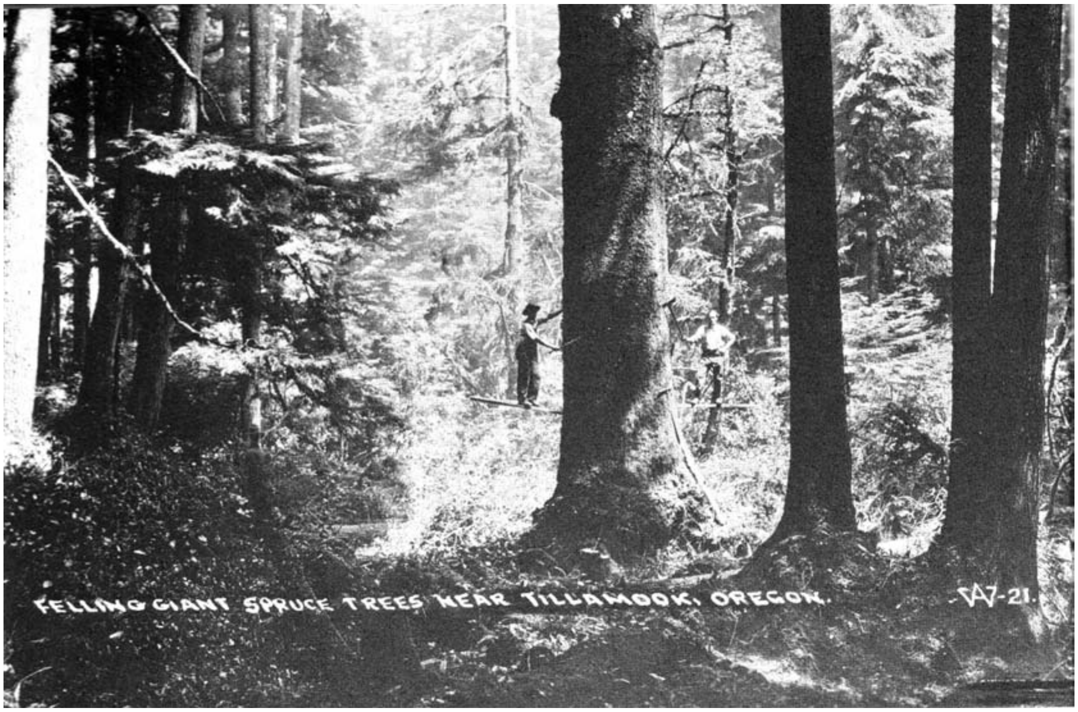

Figure 2.2. Historical floodplain forest in the Tillamook Basin. (Source: Huckleberry 1970)

2.3.1.3 Sensitive Plant Species

The pre-settlement distribution of plant species that are currently rare and the focus of concern is undocumented. They tend to have narrow habitat requirements. The presumed greater variability of vegetation age-class and species composition during pre-settlement times suggests that suitable conditions for sensitive species were probably more common historically than they are today. In addition, invasive non-native species, which can adversely impact sensitive species, would not have been introduced into the watershed in pre-settlement times.

2.3.2 WILDLIFE SPECIES AND HABITAT

2.3.2.1 Terrestrial Habitat

The mosaic of vegetation and habitat types that was distributed throughout the landscape of the Oregon Coast Range prior to Euro-American settlement supported a broad diversity of wildlife. Historical documents describe a great abundance of game species, including rabbit, deer, elk, and fish, as well as large predators, such as bear and cougar (Maddux 1976, Coulton et al. 1996). One account of life in the Trask watershed (likely in the lower watershed) in the early 1900s proclaimed, “Meat, then, while a major menu item, was no more of a problem than the effort expended in the going after it... Deer were so plentiful, in fact, you could just about have venison year round, if you desired,” and “…in the summer there were large flocks of wild pigeons,” and “…the hills surrounding the Trask were alive with bears and cougar.” (Maddux 1976). However, in addition to game species and predators, myriad other bird, mammal, reptile, and amphibian species were present. The prevalence of late-seral conditions provided an abundance of habitat for many species that are uncommon today, including northern spotted owl (*Strix occidentalis caurina*), marbled murrelet (*Brachyramphus marmoratus*), pileated woodpecker (*Dryocopus pileatus*), and red tree vole (*Arborimus longicaudus*).

Dead wood is a particularly important habitat element that was abundant prior to Euro-American settlement. Dead wood, such as snags and down logs, provided habitat for many species of wildlife. Snags provided cavities for bats, flying squirrels, and many species of woodpeckers and other cavity-nesting birds (Hayes and Hagar 2002). Down logs are especially important habitat for small mammals and amphibians, and provided den sites for several species of forest carnivores. In general, the large diameter logs and snags that were more prevalent in historic times provided habitat for a greater variety of species than the smaller logs that are more common today (Hayes and Hagar 2002).

Similarly, large trees are especially desirable for some wildlife species. The deeply fissured bark of Douglas-fir and other large tree species provided roosting sites for bats, and foraging sites for brown creepers (*Certhia Americana)* and nuthatches (*Sitta* sp.). Large branches provided important nest sites for marbled murrelets and red tree voles (Hayes and Hagar 2002).

Pre-settlement stand characteristics, which included greater diversity in tree density, species composition, canopy structure, and tree diameter, had direct influence on wildlife presence and abundance. Well-developed understory vegetation provided forage for many bird species, as well as nesting sites and cover for ground-nesting species.

2.3.2.2 Riparian, Wetland, and Estuarine Habitats

Riparian, wetland, and estuarine conditions in the lower watershed prior to Euro-American settlement were very different than they are today. Survey notes from the original township surveys in 1856 and 1857 described the riparian zones along the major rivers of the Tillamook Basin, including the Trask, as being lined with large trees. Trees in a bottomland area at rivermile 2.5 of the Trask River were recorded as western hemlocks ranging from 16 to156 inches in diameter, spruce from 32 to 84 inches, alder from 16 to 18 inches, and an 8 inch maple (Coulton et al. 1996).

Riparian zones in pre-settlement watersheds of the Oregon Coast Range were characteristically patchy, with a mixture of hardwoods, conifers, and shrub-dominated openings. They contained many large conifers, including an abundance of western red cedar in the mid-sized stream valleys, although alder were common as well (Maddux 1976, Coulton et al. 1996). In addition, snags and down logs were very common in the riparian zone. In general, the riparian forest was increasingly dominated by conifers higher in the watershed. Larger streams generally had a greater mix of species, and exhibited greater complexity associated with disturbance by floods, debris flows, earthflows, and less frequently by fires. Mass soil movement delivered sediment, boulders, and wood to the medium-sized streams from the steep, smaller stream channels (Spies et al. 2002).

The lowland riparian zone contained a diversity of wetland habitats, including brushy and wooded swamps, grassy swamps, grassy tidal marshes, tidally-influenced forest, and valley floodplain bottomlands (Coulton et al. 1996). As the Trask River approached Tillamook Bay, the floodplains of the Trask, Wilson, and Tillamook rivers merged, and channels crossed between these drainages. Between 1851 and 1920, nearly all floodplains and wetlands were ditched, drained, and converted to pasture in the Trask watershed (Coulton et al. 1996).

The Tillamook Bay estuary has been significantly altered since the time of Euro-American settlement, and many of these changes impact the health of salmonid fish that spawn and rear in the upper watershed. The tidally-influenced zone of the bay has been reduced by about 11% since 1867, due to artificial filling and sedimentation. The estuary was important for growth and development of anadromous salmonids, which is critical to their survival in the ocean (Pearcy 1992). In addition, woody debris and wood jams were abundant. During the late 1800s and early 1900s, the majority of this wood was removed to improve navigation, facilitate log drives, and reduce flooding. Woody debris and wood jams were important habitat elements for juvenile fish and many other species, and helped to maintain the natural seasonal flood cycle (Coulton et al. 1996).

At the same time that riparian and wetland habitat was declining, beaver ponds were systematically eradicated from the watershed. Beaver ponds were extensive in the lowland floodplains of the Tillamook Basin, as well as in small stream channels (primarily at tributary junctions) in the uplands prior to Euro-American settlement (Coulton et al. 1996, Spies et al. 2002). Modifications caused by beaver created habitat conditions that supported many other plant and wildlife species.

Finally, carcasses from spawned-out salmon were an important source of nutrients for riparian vegetation, especially at locations where nitrogen-fixing trees, such as red alder, were less abundant (Helfield and Naiman 2002). Salmon carcasses provided a seasonal pulse of nutrients that increased aquatic and riparian productivity.

2.4 SOCIAL

2.4.1 HISTORICAL CHANGES IN LANDSCAPE PATTERN

The pre-settlement coastal landscape mixture of forest and prairie was probably managed by Native Americans through burning (Coulton et al. 1996). Following Euro-American settlement, land in the lower watershed was prepared for agriculture. Prairies and tidelands were cleared of trees, logs, and brush; rivers were diked, and wetlands drained. Timber was harvested along the tidal flats and major rivers, and then further into the foothills and upland forests. Log drives were used to transport timber to mills. These drives scoured river channels of riparian vegetation and reduced channel complexity. Logging was also associated with extensive road building within the Trask watershed. A timeline of human use of, and impacts on, resources within the Trask watershed and surrounding Tillamook Basin is shown in Table 2.1.

Table 2.1. Timeline of significant events.

11,000-14,000 BP	Climate warms, polar ice caps melt, and present day forest species associations become established. First humans arrive in Pacific Northwest.
1000 AD	Oldest dated village site in the Tillamook Basin.
1579 AD	Evidence suggests Sir Francis Drake visits Nehalem Bay in Tillamook County.
1788 AD	John Meares describes Tillamook Bay and the prairies and lowland forests. Names Tillamook Bay "Quicksand Bay".
	Robert Gray successfully enters the Bay one month later.
Early 1800s	Small pox and other diseases introduced by contact with Europeans decimate Native American population.
1806	Lewis and Clark estimate Tillamook tribal population to be about 2,200.
	Note that Tillamook have firearms and metal implements.
1845	Earliest documented major fire occurs in the northern Oregon Coast Range.
1849	Tillamook tribal population estimated at approximately 200, reduced largely by disease.
1851	First Euro-American settler, Joseph Champion, arrives at Tillamook.
1852	Henry W. Wilson brings the first cattle to the area.
	Elbridge Trask applies for the first land claim of 640 acres.
1853	Tillamook County established.
1863	Three sawmills open in the Tillamook Basin (all would close by 1870).
1866	The City of Tillamook is founded. It is incorporated in 1891.
1867	U.S. Army Corps of Engineers calls for estuary and river channel improvements.
1868	Large fire burns higher elevations away from the beach and bay.
1872	Trask Toll Road completed, connecting Tillamook and Yamhill.
1880s	Permanent logging and lumber operations begin in Tillamook Bay watershed.
	Regular dredging begins in Bay.
1888	Delivery of lumber to San Francisco by ocean steamer begins on a regular basis.
1892	Extensive diking and draining of lowlands begins.
1894	Peter McIntosh arrives in Tillamook, sparking the cheese industry.
	The timber industry considered Tillamook County's most important.
1900s	Drainage and diking districts formed.
1909	Tillamook County Creamery Association formed.
1911	Railroad linking Tillamook to Portland completed.
1913	Tillamook Clay Works was established to supply farmers with drain tile.

1923	20 sawmills operating in the County.
1933	First of the Tillamook Burn fires. Subsequent fires in 1939, 1945, 1951.
1937	Wilson River Salvage Road opened, followed by Trask River logging road 2 years later.
1940s	Salvage logging begins on a large scale.
1942	Logging companies estimate salvage of 2 billion board feet over next 3 years.
1949	Oregon Department of Forestry begins re-forestation of Tillamook Burn.
1953	610 million board feet harvested from Tillamook Basin. Salvage logging peaks.
1959	Salvage logging operations draw to a close.
1969	Fecal bacteria contamination first identified in bay waters.
1975	Trask watershed found to contain 2,168 miles of road.

2.4.2 HUMAN USES PRIOR TO EUROPEAN SETTLEMENT

The Tillamook Indians occupied many permanent and semi-permanent villages on the floodplain prairies and foothills surrounding Tillamook Bay. The earliest known Tillamook village site was estimated to be 1,000 years old, based on carbon dating (Coulton et al. 1996). One of four main native groups along the Oregon coast that split from the Chinooks to the north, the Tillamooks established themselves as a distinct cultural group as early as 1670 A.D. (Sauter and Johnson 1974). Villages were principally located at the mouths of rivers entering the Tillamook Bay. The village of Tow-er-quot-ton was located on Hoquarten Slough (Minor et al. 1980. Lewis and Clark estimated the Native American population in the Tillamook Basin to be 2,200 in 1805.

The Trask watershed was part of an area of advanced cultures with intricate social and ceremonial systems based upon a wild food subsistence economy (Newman 1959). Abundant marine, riverine, and terrestrial resources allowed the groups of the Northwest coastal areas to subsist in permanent and semi-permanent villages without the need for agriculture. The subsistence activities of the Tillamooks were largely oriented toward water resources. Salmon and steelhead were caught in great numbers in the many rivers entering the bay. Temporary fishing camps were set up during the seasonal salmon runs, and one such camp was located at the Dam Hole on the Trask River (river mile 12.7). Fish weirs and traps were used, at times spanning the entire river, and trapped fish were taken with dip nets, gigs, harpoons, or hook and line (Sauter and Johnson 1974). Marine life such as crabs, clams, mussels, barnacles, and octopus were harvested from the estuary and coastal tide pools. Seals and sea lions were harpooned or clubbed on off-shore rocks, and the occasional beached whale was salvaged whenever possible. The eggs and young of birds such as brant, coot, various ducks, and other waterfowl were also reported as food resources of the Tillamooks (Minor et al. 1980).

The Tillamooks did not frequent the upland forested areas, since most of the resources they needed were near the coast (Taylor 1974). Large game such as deer and elk were plentiful along the coast and in the foothills and valleys of the Coast Range, but reportedly were only taken to supplement the largely marine diet of the Tillamooks. They also relied heavily on roots, berries, and fruits, as well as seaweed for salt. Seasonal availability largely determined the exploitation of food resources. Summer and fall were principally times of fishing and berry gathering, whereas fall to spring was a time for shellfish gathering. Many species of fish and game could be taken year round to augment diminishing supplies as needed. Most subsistence activities were carried out near permanent or semi-permanent villages and local areas were most heavily exploited. Occasionally, Tillamooks would travel further afield on special hunting, fishing, or collecting expeditions (Minor et al. 1980).

A significant human impact on the landscape by Native Americans was the use of fire to maintain valley and upland prairies for the purpose of increasing access to game and improving the growth of herbaceous food plants. The prairies that were first observed and recorded by early explorers and settlers may have been remnant features of a valley landscape controlled by the use of fire by Native Americans. There is evidence that during the first 50 years of Native American contact with Europeans prior to settlement there may have been a re-establishment of forests in these prairie areas as the Native American populations were decimated by disease, decreasing the amount of burning (Coulton et al. 1996). The presence of large stands of Sitka spruce and western hemlock on the tidelands surrounding the bay at the time of settlement may have been partly a result of reduced burning by Native Americans (Coulton et al. 1996).

2.4.3 EUROPEAN SETTLEMENT

Evidence exists that Sir Francis Drake may have visited Nehalem Bay in Tillamook County as early as 1579 (Sauter and Johnson 1974). In July of 1788, John Meares described the Tillamook Bay and nearby Cape Meares, but was unable to enter the bay due to a long sandy bar located across the entrance (Nokes 1998). One month later, on August 14th, Captain Robert Gray entered Tillamook Bay, finding a passage through the sand bar. During their short stay in the bay, one of the crewmen was killed in an altercation with the Native Americans and the bay was dubbed Murderers Harbour (Coulton et al. 1996). It was around this time that contacts between whites and native people became numerous or consistent, and by 1800 all coastal groups likely had Euro-American trade goods in their possession. Lewis and Clark noted that the Chinook and Tillamook had firearms and metal implements in 1806 (Newman 1959).

In the early to mid 1800s, the Tillamook group experienced a dramatic decline in population due largely to smallpox and other Euro-American diseases. From 1829 to 1832, the Chinook tribes to the north of Tillamook Bay lost 90% of their population to an outbreak of disease, which may have spread south to the Tillamook group (Coulton et al. 1996). The population of the Tillamooks was reduced from 2,200 in 1805 to 400 in 1845, and 200 in 1849 (Swanton 1968).

Tillamook County's first white settler was Joseph C. Champion, who arrived on a whaling boat in 1851 and was reported to have lived in the hollowed trunk of a dead Sitka spruce tree (Reynolds 1937). In the spring of 1852, Elbridge Trask settled 640 acres of land on the river that now bears his name (Orcutt 1951). By the end of 1852, three families and six bachelors were living in the area, and 80 settlers had moved into the newly formed Tillamook County by 1854 (TBNEP 1998a).

2.4.3.1 Agricultural Operations

Early settlers of the Tillamook area were initially drawn to the prairies surrounding the bay, as these lands proved relatively easy to cultivate. As the more desirable open areas of the tidelands and surrounding prairies became less available, settlers moved into the foothills and valley bottoms of the surrounding rivers, clearing the land of trees and brush. By the turn of the century, most of the lowland forest areas had been cleared of trees and stumps to make room for more farms. Significant portions of the lower intertidal and freshwater wetland areas were also converted to pasture by the early 1900s (Coulton et al. 1996).

The number of farms increased steadily from the 1850s until 1900, when the land area in farms in the Tillamook region, and for Oregon in general, began to decrease. By 1900, Tillamook County had among the highest number of owner-operated farms in the state. The subsequent decrease in the number of farms was associated with increasing value of timber, and the sale of some farms to timber companies (Coulton et al. 1996). From 1930 to 1940, however, the rural farm population of Tillamook County increased by 16% while the overall population of the County increased by only 4%. Through the 1940s, the number of farms steadily increased and the average size of farms decreased (Arpke and Colver 1943). Many farmers during this time were working in the timber industry, and falling back on farming during the seasonal and cyclical periods of unemployment typical of timberwork. The number of farms fell in the 1950s as forest and range lands were sold to timber companies and part-time farms were converted and combined into larger commercial farms (Coulton et al. 1996).

In 1852, Henry W. Wilson brought the first cattle into the area, laying the foundation for the dairy industry. Peter McIntosh came to Tillamook County in 1894 and taught the art of cheese making (Reynolds 1937). Shortly afterward, a number of small cheese-making factories began operation. The Tillamook County Creamery Association, a cooperative formed in 1909, has helped the dairy industry to grow by minimizing the effects of unstable milk prices, giving farmers dividends on the sale of cheese, and reducing the cost of feed and farm equipment. In 1911, the completion of a railroad connecting Tillamook to Portland greatly facilitated the profitability and the distribution of dairy products manufactured in Tillamook.

From 1910 to 1940, annual milk production increased from 4 million to 10 million gallons, and cheese production from 3 million to 11 million pounds (Arpke and Colver 1943). Increased milk production was achieved largely by improving herd quality rather than by expanding herds beyond the capacity of available pasturelands. Dairy products were a major source of income for about two-thirds of all farms in 1939, and accounted for nearly 72% of gross agricultural income (Arpke and Colver 1943). Other livestock products such as hogs, sheep, chickens, and eggs provided relatively little income and were mostly consumed locally. Mink farming in the late 1930s was profitable and in 1937 pelts from 60 farms yielded an estimated income of $150,000. Field crops consisted primarily of hay and were produced mostly for local consumption (Arpke and Colver 1943).

Between 1920 and 1975, the number of dairy cows in Tillamook was fairly stable at 15,000. Then, between 1975 and 1995 there was a 70% increase to 25,000 cows, likely resulting in increased waste contamination of the rivers. Fecal bacteria contamination of bay waters was first identified in 1969, when regular water quality monitoring began.

2.4.3.2 Timber Operations

Logging was not considered an industry during the early years of settlement in Tillamook County. Trees were considered a hindrance to farming and maintenance of pasturelands and were felled and burned or taken to the tidelands to be washed away by the tides. Several small sawmills, run solely to provide lumber for local building needs, began operating in 1863, but all closed by 1870. Sawmills began operating again around 1880, and logging activities extended into the foothills and along the major rivers. Logs were pulled to mills by oxen in summer or floated down rivers during the rainy season (Coulton et al. 1996).

Following the construction of a sawmill at Hobsonville, an early market for milled lumber was found in San Francisco in the 1880s. By 1888, the steamer Tillamook was making monthly trips to San Francisco, delivering lumber and returning with mill and logging supplies (Farnell 1980). Figure 2.3 illustrates the historical chronology of sawmills in Tillamook County from the 1860s to the 1980s. At the turn of the 20^{th} century, the tidelands surrounding the Tillamook Bay were still forested with large amounts of Sitka spruce and western hemlock. Demand for spruce for airplane stock during World War I resulted in extensive harvest of tideland forests (Coulton et al. 1996).

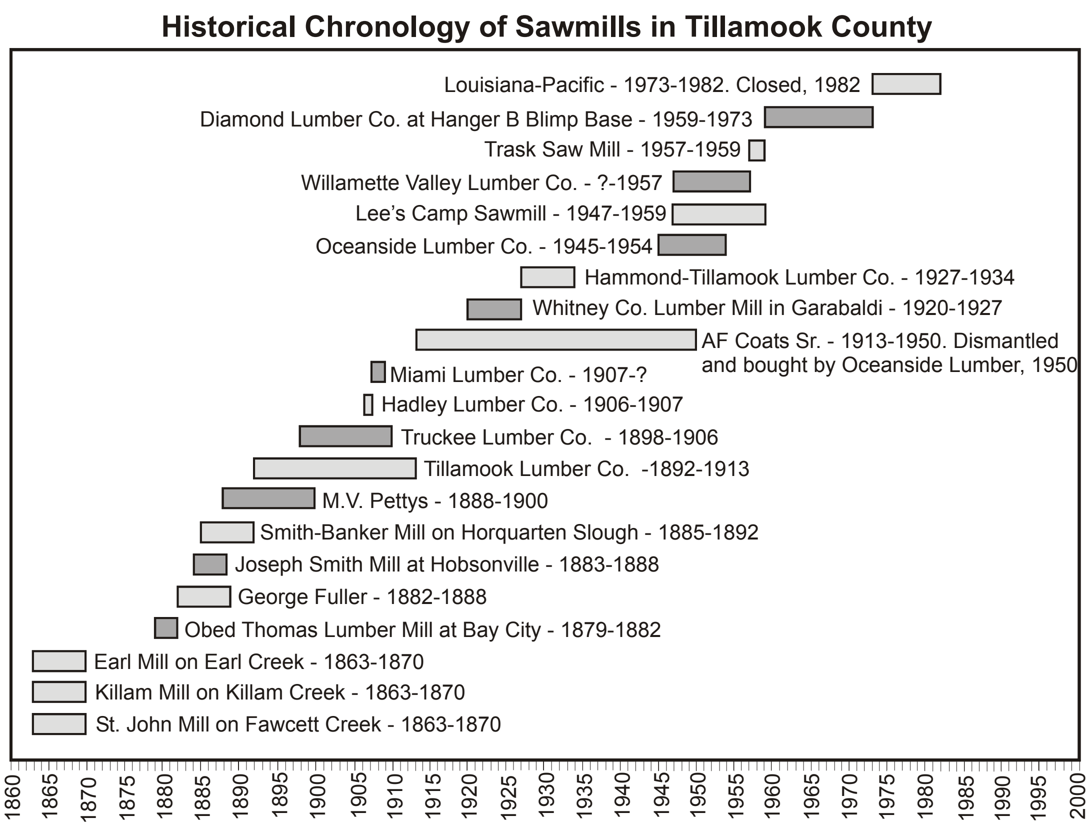

Figure 2.3. Historical chronology of sawmills in Tillamook County. (Source: Coulton et al. 1996)

By 1894, the timber industry was considered Tillamook County's most important industry (Levesque 1985). Private timber companies acquired much of the valuable forest resources with the help of the Donation Land Act of 1850, the Homestead Act of 1862, and the Timber and Stone Act of 1878 (Levesque 1985). As the value of timber increased, many homesteads in the foothills or river valleys that had initially been settled and cleared for agriculture were bought by timber companies and allowed to revegetate. The completion of the Southern Pacific Railroad line from Tillamook to Portland in 1911 allowed timber to be easily transported to mills in the Willamette Valley. Logging activities accelerated thereafter, with initially no effort to reforest harvested lands.

In 1940, forest products industries employed 22% of all workers in Tillamook County, nearly as many as agriculture (Arpke and Colver 1943). Large-scale logging and sawmill operations were just getting started when the fire of 1933 and the Great Depression provided a setback to the industry. From 1911 to 1925, an estimated 120 million board feet (Mbf) were cut annually. Annual sawlog production averaged 161 Mbf over the next 4 years, peaking at 250 Mbf in 1929. In the early 1930s, production declined to 120 Mbf annually, with a low of 43 Mbf in 1932. Production rebounded and averaged 249 Mbf from 1935 to 1939, about two-fifths of which was timber salvaged from the burn. Driven largely by wartime demands, production reached a high of over 400 Mbf by 1941. In 1942, logging companies estimated they would salvage 2 billion board feet of burned timber over the next 3 years (Arpke and Colver 1943). From 1925 to 1939, Douglas-fir accounted for 75 to 80% of the total sawlog output. Other conifers logged were western hemlock, Sitka spruce, and western red cedar (Table 2.2). Only a small percentage of sawlogs were cut or otherwise processed at local mills in Tillamook County. An estimated 90% of annual sawlog output was milled outside the county, along the Columbia River or in the Willamette Valley (Arpke and Colver 1943).

Table 2.2. Sawlog production in Tillamook County, by species, 1925-1941 (Mbf).

	Annual Averages			
Species	1925-29	1930-34	1935-39	1941
Douglas-fir	118,000	83,000	197,000	307,000
Western hemlock	19,000	15,000	26,000	49,000
Sitka spruce	20,000	7,000	14,000	32,000
Western red cedar	3,000	5,000	10,000	5,000
Balsam fir	68	309	1,000	5,000
Western white pine	232	-	-	-
Hardwoods	868	981	1,000	6,000
Total	161,000	112,000	249,000	404,000

Source: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, unpublished data.

From 1933 to 1951, a series of catastrophic wildfires swept across the Tillamook Basin, altering the forest and logging practices significantly. The fires killed most of the old-growth forests in the Trask watershed, burning some areas repeatedly (TBNEP 1998a). Salvage logging operations following the Tillamook Burn began in 1937 and continued at a high level throughout 1941 to meet the needs of the war effort (Figure 2.4). Following the 1939 fire, the new availability of gas and diesel-fueled equipment increased the efficiency of log salvage operations. Because many miles of roads were built during the salvage logging effort, smaller logging operations could now afford to log areas already cut over by the larger operations. This practice of "relogging" allowed salvage logging operations to continue for many years, until finally drawing to a close about 1960. Reforestation efforts began in November 1949, but were hampered for six years by ongoing salvage logging operations (Coulton et al. 1996).

At the time of the 1933 Tillamook fire, large private timber companies from the Great Lake States had acquired most of the valuable timber in Tillamook County. These companies were seeking new resources of raw material and had found vast areas of untouched old-growth available in the northwestern states. After the 1933 burn, however, many of the private land holdings reverted back to county ownership for delinquent property tax payments. In the 1940s and 1950s, these lands were deeded to the state to reforest and manage.

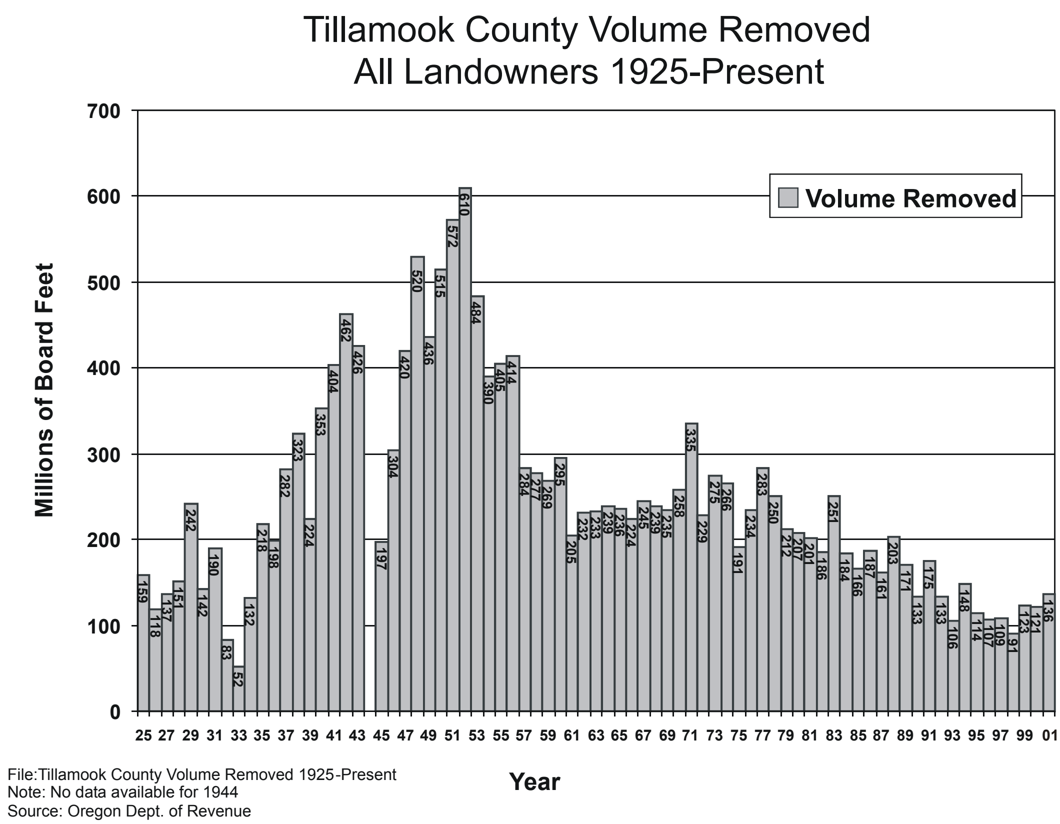

Figure 2.4. Timber harvest data for Tillamook County, Oregon.

2.4.3.3 Road Building

Transportation was a big problem for early Tillamook settlers, as they were surrounded by steep mountains to the north, south and east, and by ocean to the west. Some early roads in Tillamook County evolved from trails of the Native Americans, but it wasn't until the late 1800s that a road connecting Tillamook and the Willamette Valley was completed through the Coast Range. The Trask Toll Road, completed in 1872, was one of the earliest roads to cross the Coast Range between the Tillamook Basin and the Willamette Valley. Notorious for being rough, narrow and steep, the road ran a distance of 45 miles from Tillamook to Yamhill. Within the Trask watershed, the road followed the Trask River from Tillamook until reaching the historic Trask House, at which point it climbed steeply to the drainage divide and descended the east side of the Coast Range (Stoller 1991). Stagecoach roads provided the only land route between Tillamook and Portland until the railroad was built in 1911.

Road building increased significantly during the salvage logging following the Tillamook Burn. In the early years of salvage logging, the rugged and steep terrain made road construction difficult. Records indicate there were many problems simply maintaining roads against the elements. Photographs also show that the easiest access to downed timber was often along river corridors, and roads were built by excavating into the hillside and side-casting earth into stream channels (Coulton et al. 1996).

The Trask River logging road opened in 1939. During and after World War II, the use of gas and diesel machinery increased the rates of road building in the Trask watershed and made more remote areas accessible. Many railroad tracks were also torn up and replaced by logging roads during this time (Coulton et al. 1996). Additionally, road building on steep slopes was made possible by the use of mechanical bulldozers. A sedimentation study conducted in the Tillamook Basin found 2,168 miles of road in the Trask watershed in 1975 (Coulton et al. 1996). As the number of roads increased, so did their impact on the environment. Figure 2.5 depicts the increase in road stream crossings in the Tillamook Bay watershed from 1937 to 1970.

2.4.3.4 Wetland Conversion

Riparian and floodplain wetland ecosystems in the lower watershed have been altered dramatically since the time of settlement due to levee construction and land drainage. Such changes affected the health of salmonids that spawn and rear in parts of the upper watershed. Drainage and diking districts were formed in the 1900s to legally sponsor measures to reduce flooding of the valley areas of the Tillamook Basin (Coulton et al. 1996). Reduced flooding would mean that more pastureland would be available for dairy farms.

The Tillamook Clay Works was established in 1913 to supply clay tiling to farmers, allowing them to drain wetlands and wet meadows so that dairy herds could be turned out to pasture earlier in the season (Coulton et al. 1996). By 1940, dikes and tide gates were used to drain 2,297 acres of land. An additional 8,000 acres was recommended for draining at the time, as well as the clearing of 4,000 acres of hillside land (Arpke and Colver 1943). By 1950, seven

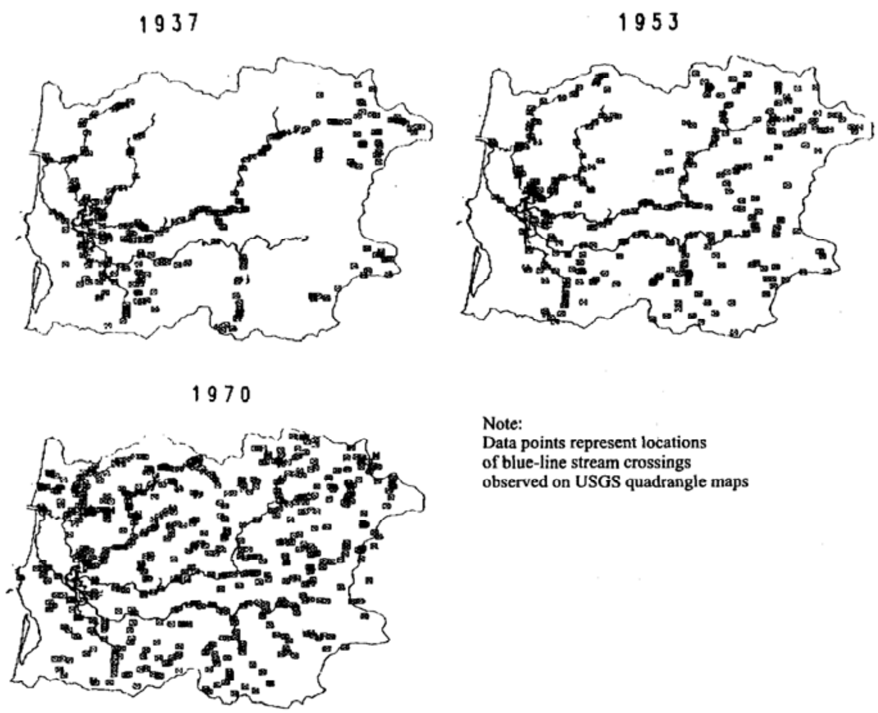

Figure 2.5. Stream crossing locations in the Tillamook Bay watershed. (Source: Coulton et al. 1996)

Table 2.3. Time periods for drainage district organization and acres drained.

Time Period	Drainage Districts Reporting	Acres Drained
Before 1900	--	--
1900-1909	--	--
1910-1919	4	3,423
1920-1929	2	1,671
1930-1939	--	--
1940-1949	1	549
Source: Data from the U.S. Department of Agriculture (1952).		

drainage districts in the Tillamook Basin had drained a total of 5,643 acres, and a majority of this land had been cleared and drained by the 1920s (Table 2.3).

The use of levees, dikes, and tile drains to control flooding and drain wetlands resulted in a disconnection of the river from its surrounding floodplain. The lower river became channelized and lost structural complexity as high flow energy was concentrated in a single channel, rather than dissipated over the floodplain. Levees and dikes reduced lower elevation flooding and in turn reduced the levels of sediment and organic nutrient deposition on the floodplain. The lack of flood water overflow may have reduced the seasonal recharge of alluvial aquifers, which in turn may have caused changes in plant and wildlife habitat due to changing soil moisture availability (Coulton et al. 1996).

Salt marshes in the Tillamook Basin have been altered and degraded, mainly due to agricultural development. Conversion of salt marsh to pastureland through diking and draining in the Tillamook Basin has left only about 15% of the original marshlands intact (http://www.harborside.com/~ssnerr/EMI%20papers/marshes.htm).

2.4.3.5 Channel Modification

The first Euro-American settlers in the Trask watershed were homesteaders who farmed the valley bottoms, and logged streamside forest to build structures and create pastures (Maddux 1976, Coulton et al. 1996). Log drives scoured channel bottoms, caused bank erosion, and destroyed riparian vegetation (Farnell 1980, Coulton et al. 1996, Reeves et al. 2002). In the 1960s and 1970s, logs and woody debris were removed with the misguided intention of improving habitat conditions for fish (Reeves 2002). The resulting loss of natural complexity has contributed to a decline in the abundance of aquatic, riparian and upland fish and wildlife species (Coulton et al. 1996, Reeves et al. 2002).

Dredging of the lower Trask and other rivers of the Tillamook Basin was conducted until 1974 for navigational and flood prevention purposes, and to maintain the Port of Tillamook Bay. In 1867, the USACE called for channel improvements along the upper estuary and river channels, so that boats could access timber located further from the Bay (Coulton et al. 1996). Low dikes along the lower Trask River were constructed from river sediments dredged from the river mouths. Extensive dredging and diking was conducted along the lower Trask River and Hoquarten Slough.

An important potential impact of river channel modification is increased erosion. A 1978 study on erosion in the Tillamook Bay watershed evaluated 111,288 feet of streambank along the Trask River and rated 1.5% to be a Critical Erosion Area. The study also found that 19% of the streambank that was evaluated had been armored or rip rapped (Tillamook Bay Task Force 1978).

It was the responsibility of the USACE to remove “snags” when the wood posed a threat or impeded navigation. Wood removal from channel areas in the Tillamook Basin has been documented since the 1890s. Between 1890 and 1920, the USACE removed about 9,300 snags from river channels around Tillamook Bay for navigational purposes. Most of these snags were removed near the mouth of the Tillamook River and Hoquarten Slough, with some from the lower channels of the Trask River (Coulton et al. 1996). Large wood jams were also prevalent further up the Trask River and were often released using dynamite. The clearing of wood jams probably reduced the frequency of floodplain inundation during flood events.

Historic logging practices had a dramatic impact on stream channels of the Trask River. Unlike many other coastal streams, there is no record of the use of splash dams on the Trask River. However, log drives provided logging companies with a cost effective means of transporting lumber to mills. They may have been conducted on the North and South Forks of the Trask, the lower portion of Bark Shanty Creek, and the mainstem Trask from the bay to the confluence of the North and South Forks, although there is some dispute regarding the accuracy of this information. (Figure 2.6). In the neighboring Wilson watershed, the practice involved storing logs on the stream banks until winter high flows, and then pushing them into the water for transport downstream. Riparian trees were cut and snags were removed from the channel to facilitate log transport. As a result, channels and banks were heavily scoured, and large amounts of sediment were generated and transported downstream (TBNEP 1998b). Records exist in the Wilson watershed of lawsuits brought by riparian landowners for damage done to riverbanks and obstruction of boating channels by log drives. It is implied in these lawsuits that logging companies were sending two years worth of logs down the river channel at one time (Coulton et al. 1996). It is important to note that the Tillamook Basin may have used log drives to a lesser extent than surrounding coastal basins due to the relatively late development of export capabilities, reducing the early demand for logs by export sawmills (Farnell 1980).

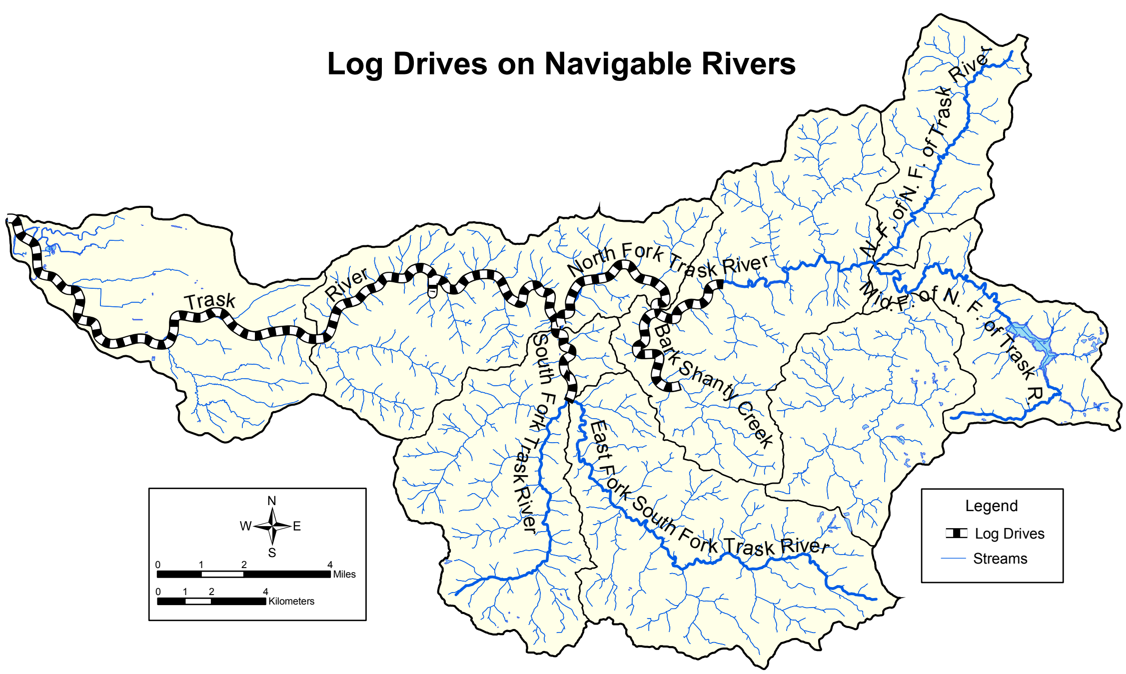

Figure 2.6. Log drives in the Trask watershed, c. 1880-1910 (Source: Coulton et al. 1996)

2.4.3.6 Expansion of Urban and Rural Residential Land Uses

The City of Tillamook was founded in 1866 and incorporated in 1891 (Arpke and Colver 1943). The population of Tillamook has grown steadily over the years, mirroring the growth of Tillamook County (Figure 2.7). In 1940, the city had a population of 2,751, about one-fifth of the county total (Arpke and Colver 1943).

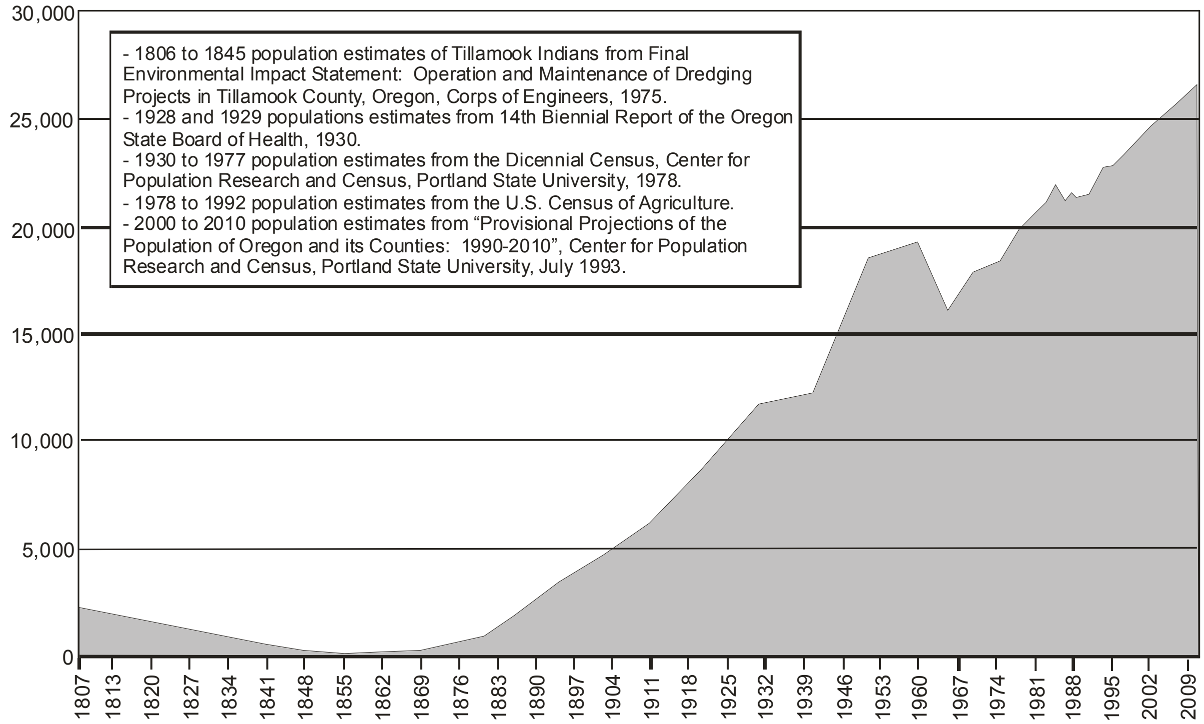

Figure 2.7. Population trends in Tillamook County. (Source: Coulton et al. 1996)

During the 1880s, the focal point of business was along Hoquarten Slough where the boats landed. By 1910, Tillamook had a fire department, a municipal water system, and a telephone company, and the first paved streets were completed in 1911. By 1941, an airport was completed south of Tillamook, and in 1942 a major military airbase was established, covering over 1,000 acres.

Urban land use in Tillamook County has historically focused on providing services for the timber and dairy industries. However, over the last several decades the economy has shifted to a greater diversity of business and industry. Tourism has recently played a more important role, accounting for approximately 25% of the jobs in Tillamook County (Southern Oregon Regional Services Institute 1996). Rural residential land uses are expanding throughout the county, as new homes are increasingly targeted toward upper income individuals looking for second or vacation homes near the coast. A recent influx of retirees has also contributed to the growth of rural and urban residential land uses.

2.4.4 EFFECTS OF NATIVE AMERICANS AND EUROPEAN SETTLERS UPON FIRE REGIMES

Prior to European settlement, there is little documentation of fires in the Tillamook area. Maps of forest stand age distribution in 1850 showed that the Oregon coast was a matrix of forests of different ages, suggesting that fire was relatively common prior to Euro-American settlement. Also, an area of 100- to 200-year growth in the Tillamook basin indicated possible fire disturbance in the mid 1600s (Coulton et al. 1996). The presence of natural stands of Douglas-fir within the Tillamook basin may also indicate the influence of the historic fire regime. Mature Douglas-fir are more resistant to fire than other conifer species in the area, and Douglas-fir seedlings germinate better on mineral soil than on forest litter and grow better in sun than shade (Coulton et al. 1996).

Fire was used regularly by the Tillamook Indians to facilitate both hunting and berry gathering. Fire improved hunting conditions by clearing areas of small trees and brush, making travel easier and providing new browse each spring to attract deer and elk. Fire was also used to flush game into traps, or into the range of waiting hunters (Sauter and Johnson 1974). Areas of huckleberry, salal, and blackberry were also burned regularly to improve berry growth and productivity (Boyd 1999). An early Oregon pioneer, Jesse Applegate, observed that the Tillamooks had a custom to "burn off the whole country" late in the autumn every year, to facilitate the harvest of wild wheat (Coulton et al. 1996). The existence of prairies in the floodplain and at higher elevations around the bay, recorded by early settlers, may be an indication of earlier burning by Native Americans.

Settlers who did not want new crops or buildings to be jeopardized by fire halted burning by Native Americans in the 1850s. However there is evidence that fires continued to consume increasing amounts of land after Euro-American settlement. Settlers preparing land for agriculture would often burn slash in the late summer months, resulting in the spread of uncontrolled fires. A timber cruise conducted in the Tillamook Bay watershed in 1908 noted areas of recent and older burns. From evidence collected during these cruises, Coulton et al. (1996) concluded that "Large portions of the Kilchis, Wilson, and Trask River valleys had been burnt by the turn of the century…" and "Several of the burns appear to be associated with clearing activities for Euro-American settlements and are typically located along the major rivers and wagon roads."

From 1933 to 1951 a series of catastrophic wildfires, dubbed the Tillamook Burn, hit the forested uplands of the Oregon Coast Range. Beginning in 1933, a major fire occurred every six years, burning hundreds of thousands of acres of forest, and killing billions of board feet of timber. A second fire was sparked in the summer of 1939 and burned much of the same area as the 1933 fire, as well as new timber mostly to the south. Six years later a third fire started on the South Fork of the Wilson River. Unburned slash and snags of the previous two fires provided fuel as the fire covered 180,000 acres. A fourth and smaller fire occurred in 1951 and was located primarily within the Trask watershed (ODF 1997). Together, the four fires burned about 350,000 acres of timber, with some areas burned two or three times.

The Tillamook Burn resulted in increased rates of erosion and sediment delivery to streams. Subsequent salvage logging compounded erosion problems as poorly drained roads and extensive soil disturbance resulted in accelerated surface erosion and mass failures. Hydrologic processes were also disrupted, as the infiltration and water storage capacity of the forested uplands was reduced, especially in areas that burned repeatedly, altering the timing and magnitude of stream flow.

CHAPTER 3. CURRENT CONDITIONS

3.1 AQUATIC ECOSYSTEMS

3.1.1 HYDROLOGIC CHARACTERIZATION

The Trask River watershed is climatically influenced by proximity to the Pacific Ocean and by elevation. Mean annual precipitation in the Trask River watershed ranges from about 85 inches (in.) in lowland areas to over 155 in. within the uppermost portions of the watershed. The median value is about 110 in. Monthly precipitation exceeds 12 in. in November, December, and January (Figure 1.1). Mean annual precipitation in the Trask River subwatersheds ranges from 89 (Middle Fork of the North Fork of the Trask River subwatershed) to 148 in. (East Fork of the South Fork of the Trask River subwatershed).

Air temperatures are mild, especially in close proximity to the ocean. Mean monthly summer air temperatures range only from 56˚F in June to 59˚F in August. Estimated annual evapotranspiration (ET) for Pacific Coast Douglas-fir/hemlock forest is about 30 in. (Chow 1964), ranging from relatively high ET during summer months to about one inch per month in winter (U.S. EPA 2001).

Rain events are the primary peak flow generating process in the Trask River watershed. There is generally little snowpack development below 2000 ft elevation in the Coast Range (U.S. EPA 2001). Snow pack that does develop in the coastal mountains is usually only on the highest peaks and is of short duration.

Snowpack is monitored in the nearby Wilson River watershed at Saddle Mountain and Seine Creek. The Saddle Mountain SNOTEL station is located at approximately 3,200 ft elevation and has a mean snow water content of 6 in. (http://www.wrcc.wri.edu). The snow water content at the Saddle Mountain station only exceeded 15 in. during four years in the period 1979 to 1999, with a maximum of 25 in. The lower elevation site, Seine Creek, located at 2,000 ft, has a mean annual snow content of 2.5 in. and it is periodic in nature. Only 25% of the Trask River watershed is above 2,000 ft elevation and only 1% is above 3,000 ft, suggesting that snow contributions to flooding only occur in extreme snow accumulation years. The hydrologic analysis for this assessment, therefore, focuses on the effects of land use practices on hydrology using rain events as the primary hydrologic process.

Topography in the Trask River watershed is characterized by steep headwaters that lead quickly into low gradient floodplains. The Oregon Coast Range, including the Trask River watershed, is influenced by a strong orographic effect on precipitation as demonstrated by the large differences between lowland and upland precipitation totals (Table 3.1). Because of the limited water storage as snowpack, discharge is seasonal and follows the precipitation cycle. The Trask River has been monitored for discharge by the U.S. Geological Survey (USGS) from 1931 to the present, with a data gap between 1973 and 1995 (http://waterdata.usgs.gov). The gage is located upstream of Cedar Creek, near the City of Tillamook. The Trask River demonstrates a typical coastal river discharge pattern with the majority of discharge occurring from November through April (Figure 3.1). Discharge during individual years sometimes deviates dramatically from the

Table 3.1. Topographic features and precipitation amounts for the Trask River watershed based on GIS calculations. Annual precipitation was estimated from the PRISM model (Daly et al. 1994).				
Subwatershed	Area (mi^2)	Mainstem Length (mi)	Max Elev. (ft)	Ave Precip. (in.)
East Fork of South Fork of Trask River	29	10.5	3412	148
Elkhorn Creek	17	7.6	3419	102
Lower Trask River	22	10.9	1982	94
Middle Fork of North Fork of Trask River	13	7.9	2743	89
North Fork of North Fork of Trask River	13	5.9	3534	102
North Fork of Trask River	29	13.9	3375	110
South Fork of Trask River	23	10.3	3175	121
Upper Trask River	28	14.4	3052	116
Total	175	81.3	3534	110

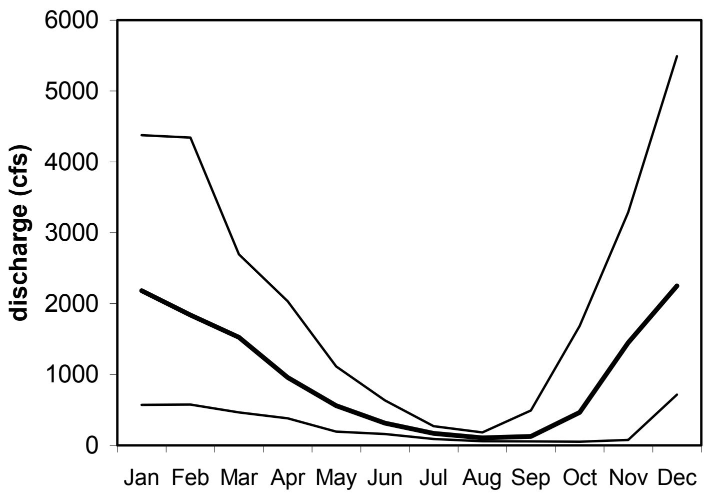

Figure 3.1. Trask River discharge at the USGS gaging station for the period of record (1931 to 1972 and 1996 to 2001) . The top line is the maximum mean daily flow, the center line is the mean daily flow, and the bottom line is the minimum mean daily flow (Data from USGS).

"average" pattern, however. Summer flows are low, averaging generally below 300 cfs. Flood events occur primarily in December through March.

The Oregon Water Resources Department lists peak flow estimates for return periods as follows:

5 yr - 16,500 cfs	50 yr - 25,700 cfs
10 yr - 19,200 cfs	100 yr - 28,700 cfs

Average monthly discharge ranges from 107 cfs in August to 2,188 cfs in December. Low flow during late summer and early fall is an important water quality and fisheries concern. Decreased flow can contribute to seasonal increases in water temperature, decreased pool depth and dissolved oxygen (DO) concentration, and associated detrimental impacts on fish and other aquatic biota.

3.1.1.1 Flooding

Flooding is a natural process that contributes to both the quality and impairment of local environmental conditions. Consequently, flood management attempts to reduce flood hazards and damage while protecting the beneficial effects of flooding on the natural resources of the system. Flooding causes, impacts, and management options are discussed in the Tillamook Bay environmental characterization report (TBNEP 1998a).

Trask River flooding tends to occur most commonly in December and January during periods of heavy rainfall or snowmelt, or a combination of both. River flooding combined with tidal flooding can extend the flood season from November to February. The lowland valleys are the most prone to flooding during these periods. Although rain-on-snow events are infrequent in the Coast Range, these events have contributed to some of the major floods, including the floods of 1955/56, 1964/65, and 1996/97. Large floods (e.g., 10-yr return period) are relatively rare events, however, and we have no data to suggest that current land use practices have exacerbated the flooding effects from rain-on-snow events.

The Trask River watershed has the second largest floodplain area in the Tillamook Bay basin, at almost 6.6 mi^2. Within the Trask River watershed, the Federal Emergency Management Agency (FEMA) 100-yr floodplain occurs only in the Lower Trask River subwatershed, but occupies 29% of the area of that subwatershed. One of the primary natural functions of the floodplain is to reduce the severity of peak flows, thereby reducing downstream impacts and flood hazards. However, much of the floodplain area in the lower sections of the Trask River and adjacent watersheds has been altered. The floodplain has been largely disconnected from the rivers and their tributaries through the construction of dikes and levees, reducing floodplain storage of flood waters.

Flooding is an important management issue in the Trask River watershed. Significant flooding has occurred in the Trask River during 20 years within the last century (Figure 2.1). The highest peak flow recorded during the period of record was 30,000 cfs in 1922. Values above 20,000 cfs were also recorded in 1934, 1956, 1965, 1972, 1996, 1999, and 2000 (no data were collected from 1973 to 1995).

3.1.1.2 Groundwater

There are no designated critical groundwater areas or groundwater-limited areas within the Trask River watershed. Groundwater data specific to Oregon Department of Forestry (ODF) and Bureau of Land Management (BLM) lands within the watershed are not available.

3.1.1.3 Human Impacts on Hydrology

Human activities in the watershed can alter the natural hydrologic cycle, potentially causing changes in water quality and the condition of aquatic habitats. Changes in the landscape can increase or decrease the volume, size, and timing of runoff events and affect low flows by changing groundwater recharge. Important examples of human activities that have affected hydrology in the Trask River watershed are timber harvesting, urbanization, conversion of forested land to agriculture, and construction of road networks. The focus of the hydrologic analysis component of this assessment is to evaluate the potential impacts from land and water use on the hydrology of the watershed (WPN 1999). It is important to note, however, that this assessment only provides a screening for potential hydrologic impacts based on current land use activities in the watershed. Quantifying those impacts would require a more in-depth analysis and is beyond the scope of this assessment.

Increased peak flows in response to management are a concern because they can have deleterious effects on aquatic habitats by increasing streambank erosion and scouring (Furniss et al. 1991, Chamberlain et al. 1991). Furthermore, increased peak flows can cause downcutting of channels, resulting in a disconnection of the stream from the floodplain. Once a stream is disconnected from its floodplain, the downcutting can be further exacerbated by increased flow velocities as a result of channelization.

All subwatersheds were screened for potential land use practices that may be influencing the hydrologic processes that contribute to increased peak flows and streambank erosion (WPN 1999). For this assessment, we focus on the two principal land use activities that can affect the hydrology of upland portions of this watershed: forestry and forest roads. In lowland areas, agriculture and urban or residential development can also be important.

Forestry practices have the potential to influence the magnitude of flooding, but it is difficult to quantify such effects because of the large natural variability in discharge. This difficulty has contributed to over a century of debate in the United States concerning the role of forest conservation in flood protection (Naiman and Bilby 1998). Studies in the Oregon Coast Range found no appreciable increase in the highest peak flows that could be attributed to clearcutting (Rothacher 1971, 1973; Harr et al. 1975). However, current evidence suggests that elevated peak flows and “flashiness” for small to moderate storm events can result from logging and road building activities. Potential effects include reduced evapotranspiration, decreased infiltration and subsurface flow, and increased runoff (Jones and Grant 1996, Naiman and Bilby 1998). Such changes may result in modified peak- and low-flow regimes and subsequent effects on in-stream aquatic habitat quality. However, quantitative information is not available regarding the magnitude of the changes in hydrology of the Trask River that might be attributable to forestry.

Logging can also affect snow accumulation and the patterns and amounts of snowmelt. For a given pattern of snowfall, forested areas are generally expected to release less meltwater, and to release it more slowly, as compared with open areas such as clearcuts (U.S. EPA 2001).

Although large floods are most important from a flood hazard standpoint, smaller magnitude peak flows are also important in shaping the stream channel (Naiman and Bilby 1998). High flows constitute a natural part of the stream flow regime and are largely responsible for transporting sediments and determining channel morphology. Increases in the magnitude of moderate peak flows can contribute to channel incision, bank building, and erosion.

Road construction associated with timber harvest has been shown to increase wintertime peak flows of small to moderate floods in Oregon Coast Range watersheds (Harr 1983, Hicks 1990). The Oregon Watershed Enhancement Board (OWEB) watershed assessment manual evaluates potential road impacts based on road density. Watersheds with a greater than 8% roaded area are considered to have a high potential for adverse hydrologic impact, those with 4 to 8% have a moderate potential, and those with less than 4% have a low potential. Using these criteria, roads in the Trask River watershed were considered to have a low to moderate potential for altering peak flows. Lowest road densities were found in the Middle Fork of the North Fork of the Trask River subwatershed and in the South Fork of the Trask River subwatershed (2.8 mi/mi^2 each). Highest densities (5.6 mi/mi^2 each) were found in the Lower Trask River and the North Fork of the North Fork of the Trask River subwatersheds. However, this analysis was based on geographic information system (GIS) maps which show relatively low road density throughout the watershed. There are many legacy roads that were constructed for salvage logging following the Tillamook Burn that are unmapped, and if accounted for, would probably result in higher road densities. In addition, the density of roads alone is generally a poor predictor of the potential for roads to influence hydrology.

Although road density provides a general impression of the relative area dedicated to roads in a given watershed, it does not distinguish roads on steep slopes from those on flat ground, or roads on hilltops from roads near streams. Road-slope position provides a more detailed view of which roads may be influencing the stream network. ODF has classified its roads into valley, midslope, and hilltop slope positions. In the Trask River watershed, the majority of inventoried ODF roads are on midslope positions. (For a more detailed presentation of this topic, see section 3.2.1.1. Road Density and Hillslope Position).

Past fires, including the Tillamook Burn, were associated with changes in the hydrologic regime (c.f., Coulton et al. 1996). In general, a large proportion of the vegetation must be removed from a watershed before significant increases in peak flows are observed. According to one study, the 1933 Tillamook fire increased the annual peak flow of two watersheds by 45% and the total annual flow by 9% (Anderson et al. 1976). The effects of fire on peak flows generally persist until vegetation is re-established, which is usually within a decade following the fire (Agee 1993). Fires in the past several decades have not burned large areas of the Trask River watershed, so we do not expect that there are significant effects of fire on hydrology in the watershed today.

The Lower Trask River subwatershed has a relatively large area of agricultural land use (51%) and limited urban land use. Land cover in the Tillamook bottomland changed significantly following Euro-American settlement in the early 1900s (Coulton et al. 1996). It is likely that agricultural practices and urbanization have changed the infiltration rates of the soils in this area, some of which are poorly drained. Existing flood control features used to protect floodplain land uses have simplified natural streamflow processes in many places and reduced the complexity of in-stream habitats that support fish and aquatic organisms. Agricultural areas throughout the lower watershed have been drained by subsurface tile drains. These installations reduce water storage and increase peak flows in lowland areas, but quantitative data are lacking. Loss of historical floodplain acreage and land cover (such as wetlands and forested valley bottoms) have likely had significant impacts on hydrologic conditions. Disconnecting the floodplain from the river has resulted in the loss of flood attenuation capacity, increased peak flows, downcutting of channels, and increased flow velocities in the lower watershed.

3.1.2 WATER QUANTITY

In-stream water rights were established by the Oregon Water Resources Department (OWRD) for the protection of fisheries and aquatic life in five of the Water Availability Basins (WABs) within the Trask River watershed (Table 3.2). In addition, ODFW established in-stream water rights in 1991 in all of the 13 OWRD WABs within the Trask River watershed for the protection of anadromous and resident fish. These in-stream rights are mostly junior to the consumptive water rights in the watershed. A summary of the in-stream water rights data by WAB and by subwatershed is given in Table 3.2. In-stream water allocations during the critical months of July through October are largest in the Trask River above Gold Creek and Trask River at Tillamook Bay WABs.

The OWRD and Oregon Department of Fish and Wildlife (ODFW) have prioritized streamflow restoration throughout Oregon based on salmonid recovery, in support of the Oregon Plan for Salmon and Watersheds. In the Trask River watershed, the mainstem of the Trask River, most of the North Fork, and all of the Middle Fork of the North Fork have been identified as “highest” priority for flow restoration. All other streams in the Trask River watershed were identified as “moderate” priority (www.wrd.state.or.us/programs/salmon/01priorities.pdf).

Consumptive water rights in the Trask River watershed are summarized in Table 3.3. Fish culture, municipal water use, and pollution abatement together represent 84% of the total consumptive water rights. The only other substantial water right category is irrigation (12.9% of total). The Watermaster has needed to regulate water during three years since 1991 (1994, 2001, 2002), in each case towards the end of summer. Irrigation rights run from March through October, but irrigation in the watershed is generally negligible before July. The only significant water use between November and July is municipal use (Greg Beaman, Tillamook County Watermaster, pers. comm., March, 2003). The Trask basin is a municipal watershed for the cities of Tillamook, Hillsboro, Forest Grove, Beaverton, and several smaller communities in Washington and Yamhill counties. Among the subwatersheds of the Trask River watershed, the largest number of water rights (61) is in the Lower Trask River subwatershed, but the largest potential diversion is in the Middle Fork of the North Fork of the Trask River (69 cfs at Barney Reservoir; Table 3.4).

Table 3.2. In-stream water rights in the Trask River watershed, by Water Availability Basin and by subwatershed. (Data from OWRD)

Water Availability Basin (WAB)	Subwatershed[a]	Purpose[b]	Priority	CFS			
				Jul	Aug	Sep	Oct[c]
Bark Shanty Creek	North Fork of Trask River	A	2/13/1991	9	5	5	10
Clear Creek at Mouth	North Fork of Trask River	A	2/13/1991	7	4	4	7
North Fork above Bark Shanty Creek	North Fork of Trask River	A	2/13/1991	81	50	50	91
		S	5/9/1973	15	15	15	40/80
East Fork of South Fork	E. Fork of S. Fork of Trask River	A	2/13/1991	27	19	19	35
Edwards Creek at Mouth	South Fork of Trask River	A	2/13/1991	5	3	2	4
South Fork above E. Fork of S. Fork	South Fork of Trask River	A	2/13/1991	10	6	5	10
South Fork at Mouth	South Fork of Trask River	A	2/13/1991	50	30	28	52
		S	5/9/1973	30	30	30	60/140
Green Creek at Mouth	Lower Trask River	A	2/13/1991	1	0	0	1
Trask River at Tillamook Bay	Lower Trask River/Upper Trask River	A	2/13/1991	157	103	97	170
		S	5/9/1973	85	85	85	150/270
North Fork at Mouth	Upper Trask River	A	2/13/1991	81	50	50	91
		S	5/9/1973	25	25	25	60/120
Trask River above Gold Creek	Upper Trask River	A	2/13/1991	157	103	97	170
		S	5/9/1973	60	60	60	120
Middle Fork of North Fork	M. Fork of N. Fork of Trask River/Elkhorn Creek	A	2/13/1991	28	17	18	31
North Fork of North Fork	N. Fork of N. Fork of Trask River	A	2/13/1991	13	8	8	14

[a] Two of the WABs occur within more than one watershed
[b] A - Anadromous and Resident Fish Rearing; S - Supporting Aquatic Life
[c] The water right changes on October 15th within 4 of the WABs

Table 3.3. Consumptive water rights within the Trask River watershed (Data from OWRD).				
Use	Description	Number of Water Rights	Water Diversion (cfs)	% of Total
AG	Agriculture	1	0.04	0.03
DI	Domestic Irrigation	9	0.1	0.06
DN	Domestic Non-commercial	7	0.1	0.05
DO	Domestic	42	4	2.72
FI	Fish Culture	6	49	34.96
FP	Fire Protection	3	0.1	0.08
ID	Irrigation and Domestic	1	0.1	0.05
IR	Irrigation	46	17	11.89
IS	Irrigation - Supplemental	2	1.3	0.94
LV	Livestock	5	0.1	0.09
MU	Municipal	1	39	27.67
PA	Pollution Abatement	1	30	21.45
Total		124	140	100

Table 3.4. Breakdown of consumptive water rights by subwatershed (Data from OWRD).		
Subwatershed	Number of Water Rights	Diversion (cfs)
East Fork of South Fork of Trask River	1	0.005
Elkhorn Creek	0	-
Lower Trask River	61	30
Middle Fork of North Fork of Trask River	2	69
North Fork of North Fork of Trask River	0	-
North Fork of Trask River	0	-
South Fork of Trask River	23	30
Upper Trask River	37	11
Total	124	140

During dry seasons, water withdrawals may have deleterious effects on in-stream habitats by reducing flows. For example, appropriated water represents 25 to 26% of modeled in-stream flows (based on a 50% exceedence) in the Trask River at the mouth during the months of July and October, and 40% of modeled in-stream flows during August and September. This suggests that the impacts of water appropriation can be substantial if the water rights are fully utilized. At the 80% exceedence level, half of the expected flow during August and September is allocated to consumptive water use. The Oregon Water Resources Department has developed models to assess the potential impacts of water withdrawals on stream flows (Robison 1991). These model outputs are available to the public on the OWRD website (http://www.wrd.state.or.us). They use predicted water loss based on the type of use for the appropriated water. Losses are then compared to predicted in-stream flows, based on two exceedence levels. We have presented in Table 3.5 both the 50% and 80% exceedence levels, which represent stream flows that would be expected to be this low at least 50% and 20% of the time, respectively (higher flows expected 50% and 80% of the time, respectively). These exceedence levels should provide reasonable benchmarks for evaluating the likelihood of adverse effects of water withdrawal.

There is concern for dewatering in the Trask River watershed in general, based on current water availability model outputs for the 50% exceedence level. Six of the WABs had water rights greater than 25% of the predicted in-stream flows. The mainstem Trask River and the North Fork system (Middle Fork of North Fork, North Fork above Bark Shanty Creek, and North Fork at mouth) exhibited relatively high potential for dewatering.

During the driest months (August and September), the mainstem Trask River at its mouth at Tillamook Bay is only expected to carry about 40 to 43 cfs at the 80% exceedence level and 61 to 64 cfs at the 50% exceedence level, after subtracting out all consumptive water rights. This is not nearly enough to satisfy the in-stream water rights for the protection of fish and aquatic life. In the Middle Fork of the North Fork WAB and the lower elevation WABs (Trask River at Tillamook Bay, Trask River above Gold Creek, and North Fork at mouth), in particular, summer flows are inadequate to meet consumptive and in-stream allocations (Table 3.5). However, in practice not all water rights are utilized.

The largest number of consumptive water rights appropriated in the Trask River watershed is for domestic use (58 water rights), followed by irrigation (49 water rights). Most of the irrigation water rights are appropriated in the Lower Trask River subwatershed, and most of the domestic water rights are appropriated in the Upper Trask River subwatershed. Although irrigation and domestic use account for about 76% of the consumptive water rights, they only represent 16% of the total appropriated water for consumptive purposes (Table 3.3). The largest amount of water storage is in Barney Reservoir (9,900 cubic feet) in the Middle Fork of the North Fork of the Trask River subwatershed, of which 80% is for domestic use by the cities of Hillsboro and Forest Grove, and the remainder for pollution abatement.

3.1.3 STREAM CHANNEL

3.1.3.1 Stream Morphology and Sediment Transport Processes

Stream channel structure is strongly influenced by channel confinement, stream gradient, and stream size (Naiman and Bilby 1998). For example, unconfined channels develop floodplains that disperse energy from high flows, and allow channel migration. Confined channels, on the other hand, translate high flows into higher velocities, resulting in accelerated rates of erosion. These characteristics control stream conditions such as bedload material, sediment transport, and

Table 3.5. Water availability summary for Water Availability Basins within the Trask River watershed. (Source: OWRD WARS database)												
Water Availability Basin	Net Water Available (cfs)[a]											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
50% Exceedence Level												
South Fork above E. Fork of S. Fork	20	12	0	0	0	0.1	0.0	0.1	0.1	0.1	0.3	10.9
Edwards Cr. at Mouth	7	3	0	0	0	0.1	0.1	0.1	0.1	0.1	0.3	2.2
Bark Shanty Cr.	63	57	46	20	10	4	0.1	0.1	0.1	0.2	32.1	57.2
South Fork at Mouth	273	236	163	25	-0.1	0.2	0.3	0.2	-1	-88	82.9	245
East Fork of South Fork	227	206	169	91	21	28	4	0.2	0.2	0.4	136	210
Middle Fork of North Fork[b]	-83	-93	-26	-39	-39	-39	-39	-39	-39	-39	-106	-93.4
North Fork of North Fork	44	37	25	0	0	0	0	0	0	0	5.9	36
Clear Cr. at Mouth	28	23	14	0	0	0	0	0	0	0	3.2	23.2
North Fork above Bark Shanty Cr.	375	340	363	222	105	34	10	-14	-14	-47	211	350
North Fork at Mouth	368	318	314	129	-39	-7	-39	-38	-38	-68	146	336
Trask River above Gold Cr.	1030	925	821	465	148	97	21	-33	-35	-80	568	971
Trask River at Tillamook Bay	1020	903	750	320	-41	91	-32	-39	-36	-83	444	959
Green Cr. At Mouth	-0.01	-0.01	-0.01	-0.01	-0.02	-0.07	-0.17	-0.11	-0.03	-0.03	-0.05	-0.01
80% Exceedence Level												
South Fork above E. Fork of S. Fork	-50	-38	-41	-23	-10	-7	-4	-2	-2	-5	-43.1	-45.2
Edwards Cr. at Mouth	-27	-21	-20	-11	-4	-4	-2	-1	-1	-2	-19.1	-24.9
Bark Shanty Cr.	11	21	14	1	1	-1	-3	-1	-2	-5	-6.2	17.9
South Fork at Mouth	-10	36	0	-69	-40	-29	-15	-7	-9	-114	-116	21.8
East Fork of South Fork	65	93	73	35	-6	10	-5	-4	-5	-17	15.2	87
Middle Fork of North Fork[a]	-222	-190	-109	-92	-66	-51	-45	-42	-44	-54	-201	-197
North Fork of North Fork	-13	-3	-10	-22	-11	-6	-3	-1	-2	-7	-32.8	-5.6
Clear Cr. at Mouth	-12	-5	-10	-14	-7	-5	-3	-1	-1	-4	-25.5	-6.4
North Fork above Bark Shanty Cr.	58	119	178	107	48	5	-5	-21	-24	-81	-20.2	112
North Fork at Mouth	-45	30	77	-18	-108	-46	-58	-47	-50	-111	-157	21.1
Trask River above Gold Cr.	259	384	387	209	37	24	-16	-51	-56	-155	6.71	367
Trask River at Tillamook Bay	127	268	253	40	-150	2	-77	-60	-57	-166	-182	228
Green Cr. At Mouth	-4	-3	-2	-1	-0.3	-1	-0.5	-0.3	-0.1	-0.3	-2.04	-3.41

[a] Expected streamflow minus consumptive use and instream water rights
[b] Barney Reservoir is in this subwatershed

aquatic habitat quality. Segregating stream segments into channel habitat types (CHTs), based on stream morphology (i.e., low-gradient confined, very steep headwater, alluvial fan, etc.), provides an overall indication of the quality and distribution of various stream and associated riparian habitats throughout the watershed.

Streams in the Trask River watershed (blue line streams on USGS 1:24,000 topographic maps) were divided into CHTs by Bruce Follansbee and Ann Stark for the Tillamook Bay National Estuary Project (TBNEP) and the Tillamook Bay Watershed Council, using OWEB guidelines (cf. TBNEP 1998b, WPN 1999). Division into habitat types was based on stream characteristics from USGS 1:24,000 topographic maps, and field sampling was conducted to verify habitat types (Bruce Follansbee, pers. comm., 2003). Certain stream reaches which appeared to not have been classified consistent with current OWEB methods were reclassified by ODF personnel. These corrections mostly applied to moderate gradient headwater (MH) channels. Additional field-based assessment will be required for site-specific activities that are dependent on CHT characterization. A map of the CHTs is available on the ODF website.

Topography in the Trask River watershed is characterized by steep uplands that transition abruptly into low-gradient lowlands. The majority of streams (59%) fall into the two steepest categories, steep narrow valley (SV) and very steep headwaters (VH), for all subwatersheds except the Lower Trask (Table 3.6). These CHTs contain steep, flashy, first- and second-order streams, dominated by cobble or bedrock. Waterfalls, cascades, and scour pools are commonly found along these types of streams. Moderate gradient, moderately confined (MC) and moderately steep narrow valley (MV) types are also common, accounting for another 20 to 30% of the stream segments in the upper watershed. These types are characterized by a single, confined channel, with little or no floodplain development. MV streams may contain a moderate amount of large woody debris (LWD), while MC streams in unmanaged watersheds typically contain low amounts of LWD. Substrate may be bedrock, small cobble or coarse gravel.

The upland subwatersheds contain approximately 4 to 7% of moderate gradient, moderately confined (MM) stream channel, which is considered among the most responsive to restoration. MM channels usually are associated with medium to large streams and are found mainly in the middle portion of the watershed. They typically exhibit a complexity of physical conditions, ranging from gravel riffles to large boulders, providing a diversity of habitat opportunities. LWD is expected to be abundant in the absence of removal by debris flows, floods, or human activities. Beaver ponds may be common. The Upper Trask subwatershed contains a notably higher proportion of MM stream channel than the other subwatersheds (15% - essentially the entire mainstem; Table 3.6).

Only the Lower Trask subwatershed has a high proportion of low-gradient channel types, including floodplain channels, such as small, medium and large floodplains (FP1, FP2, and FP3), as well as estuary and ditches. In unmanaged landscapes, floodplain channels are typically sinuous, braided, and dominated by smaller substrate materials such as silt, sand, and gravel.

During surveys of stream channel characteristics and aquatic habitat conducted by ODFW in the Trask River watershed, the percent of actively eroding streambank was recorded (Plate 5, Table 3.7). The highest levels of streambank erosion were observed in the East Fork of the South Fork and Elkhorn Creek subwatersheds, each having an average of 30% streambank erosion. Third

Table 3.6. Channel habitat types in the Trask River watershed, grouped by their sensitivity to watershed disturbance.

Subwatershed	Stream Length (mi)	Percent of Channel Habitat Type in Sensitivity Category[a]											
		Low			Moderate				High				Variable
		%SV	%VH	%LC	%MC	%MH	%MV	%D[b]	%FP1	%FP2	%FP3	%MM	%EL
East Fork of South Fork of Trask River	72.2	26.0	36.2	0.8	8.9	2.7	20.8	0.0	0.0	0.0	0.0	4.6	0.0
Elkhorn Creek	34.8	32.8	27.0	0.0	24.4	12.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0
Lower Trask River	61.4	7.2	7.8	0.0	0.0	7.9	0.4	4.2	6.3	11.8	43.8	3.6	6.8
Middle Fork of North Fork of Trask River	28.8	39.5	24.2	0.0	26.6	3.1	0.0	0.0	0.0	0.0	0.0	6.7	0.0
North Fork of North Fork of Trask River	29.6	25.8	50.9	0.0	21.2	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0
North Fork of Trask River	69.1	27.0	42.6	0.0	18.1	3.0	9.3	0.0	0.0	0.0	0.0	0.0	0.0
South Fork of Trask River	56.5	15.8	53.9	0.0	16.2	0.0	9.9	0.0	0.0	0.0	0.0	4.2	0.0
Upper Trask River	56.5	16.3	51.2	0.0	12.7	0.0	4.5	0.0	0.0	0.4	0.0	15.0	0.0
Total	408.9	22.1	37.0	0.1	14.1	3.4	7.8	0.6	0.9	1.8	6.6	4.5	1.0

[a] CHT designations are: SV-Steep Narrow Valley; VH-Very Steep Headwater; LC-Low Gradient Confined; MC-Moderate Gradient Confined; MH-Moderate Gradient Headwater; MV-Moderately Steep Narrow Valley; D-Ditch; FP1-Low Gradient Large Floodplain; FP2-Low Gradient Medium Floodplain; FP3-Low Gradient Small Floodplain; MM-Moderate Gradient Moderately Confined; EL-Large Estuary

[b] CHT designated as D (ditch) was created by TBNEP personnel rather than a type listed in the OWEB guidelines.

Table 3.7. Average percent streambank erosion for ODFW surveyed stream reaches, by subwatershed.			
Subwatershed	Ave. Percent Bank Erosion	Total Surveyed Miles	Total Stream Length[a] (mi)
East Fork Of South Fork Of Trask River	30	29	177
Elkhorn Creek	30	9	105
Lower Trask River	23	10	89
Middle Fork Of North Fork Of Trask River	4	6	81
North Fork Of North Fork Of Trask River	4	6	77
North Fork Of Trask River	7	16	193
South Fork Of Trask River	12	14	151
Upper Trask River	2	19	197
Total	14	109	1070

[a] Total stream length estimates were taken from the ODF GIS stream layer

highest was the Lower Trask subwatershed at 23%. In all other subwatersheds, streambank erosion was less than 10%, with the exception of the South Fork subwatershed, at 12%. The Upper Trask subwatershed showed the lowest rate of streambank erosion (2%), although only the mainstem was surveyed. Streambank erosion in the mainstem streams throughout the upper watershed was relatively low, in the 0 to 5% category; higher rates of erosion were more apparent in the small, steep tributary streams. For the Trask River watershed as a whole, streambank erosion averaged 14% (Table 3.7, Plate 5).

3.1.3.2 Effects of Human Influences Upon Stream Morphology

Human activities that have occurred on ODF or BLM lands and influenced stream morphology include log drives, yarding in channels during timber harvest, road construction, beaver eradication, reservoir construction, and stream cleaning. Most of such activities occurred before the land came into public ownership. Log drives occurred most frequently from below river mile (RM) 10 to the bay (Farnell 1980). It is unknown exactly how far upstream log drives were conducted. Logs were stored on the banks until high flows, and then pushed into the rivers and transported downstream to be milled. Impacts associated with log drives included bank erosion, damage to riparian vegetation, mechanical erosion of channel substrate, and sediment deposition (USFS 1985, Coulton et al. 1996).

During the salvage logging following the Tillamook Burn, road construction is reported to have impacted stream channels, although specific locations in the Trask River watershed were not determined. Roads were frequently constructed near streams, resulting in sedimentation of the streams by sidecast material (Coulton et al. 1996, Levesque 1985). Historic photographs show roads constructed directly in the streambed, although it is unknown how common such practices were, and whether they occurred in the Trask River watershed (Coulton et al.1996, photos archived at the Tillamook County Pioneer Museum). In 1990, FEMA determined that many of the old salvage logging roads in the Tillamook basin had used under-sized culverts, log culverts, or had poor alignment to the natural grade, and were therefore susceptible to erosion. FEMA initiated efforts to repair or abandon old roads (FEMA 1990, Coulton et al. 1996). Sedimentation conditions associated with old roads have improved, and active management of roads to reduce erosion is ongoing. More information on the current status of roads in the Trask River watershed is presented in Section 3.2.1.

Removal of wood from streams has altered stream morphology (Coulton et al. 1996). Large logs, stumps and root wads affect stream morphology by creating debris dams and pools, trapping sediment, and providing physical complexity. These functions create critical habitat for aquatic organisms (Reeves et al. 2002). Unfortunately, we were not able to find specific information regarding stream cleaning activities that occurred historically in the Trask River watershed. Recent surveys of the stream system by ODFW indicate a lack of LWD, and related physical complexity throughout most of the watershed. For a more detailed description of stream habitat conditions, see Section 3.1.6.1.

In the lower watershed outside of ODF and BLM lands, additional human alterations of stream morphology have included channelization, straightening, bank armoring, diking, and dredging. In the 1978 Tillamook Bay Task Force study, 111,288 feet of streambank was evaluated, of which 19% had been rip-rapped. Of the total streambank surveyed, 1.5% was identified as a "Critical Erosion Area".

3.1.3.3 Stream Enhancement Projects

In 1998 and 1999, a major effort was made to improve aquatic habitat for salmonids within the Trask River watershed. Entitled "Operation Stump Drop", almost a million pounds of woody debris (cut stumps and large trees with attached root wads) was strategically placed by helicopter in streams throughout the East Fork of the South Fork of the Trask River subwatershed by ODF and ODFW. The LWD was either anchored in the stream channel or cabled to the streambank to enhance riparian habitat (provide winter refuge, slow stream velocity, stabilize banks, increase pool depth, and retain gravels). The South Fork Trask River, East Fork of the South Fork Trask River, Rock Creek, Headquarters Camp Creek, Stretch Creek, Boundary Creek, Blue Bus Creek, South Creek, Summit Creek, Edwards Creek, Bill Creek, and four unnamed tributaries were included in the restoration efforts.

Monitoring took place in some streams throughout the East Fork of the South Fork of the Trask River subwatershed from July 1998 to May 2000 to assess the effectiveness of the restoration work on salmonid habitat. The effort appears to have had positive impacts on channel habitat complexity and juvenile salmonid survival (Plawman and Thom 2000). Evaluation of data from pre- and post-treatment sites revealed an increase in pools and woody debris (dammed pool area and depth increased and wood pieces and volume increased). The results also suggested that key wood piece density is an important element for overall wood retention in stream systems during high flows. In 2001, the East Fork of the South Fork of the Trask River, Boundary Creek, and Pothole Creek were part of another wood emplacement effort. Additional habitat enhancement may be conducted in conjunction with future timber sales in accordance with the ODF Forest Management Plan (FMP) and Tillamook/Clatsop Implementation Plan (IP).

The BLM is planning to conduct in-stream habitat enhancement projects in the Elkhorn Creek subwatershed, including placement of LWD and boulders in the stream channel. Because of the mixed land ownership in areas identified for habitat enhancement, opportunities for cooperative projects with ODF and private landowners will be pursued.

3.1.4 EROSION AND SEDIMENT

3.1.4.1 Overview of Erosion and Sediment Processes

In the Trask River watershed, there are two distinct zones of erosional activity: the steep, forested upland, and the broad, lowland floodplain near the river mouth (Plate 1). All subwatersheds, except the Lower Trask subwatershed, are centered in steep, upland terrain. The lowland floodplain of the Lower Trask subwatershed merges with floodplains from the neighboring Wilson and Tillamook rivers near Tillamook Bay.

On the steep slopes and shallow soils of the forested uplands, mass wasting is the dominant erosional process (Skaugset et al. 2002). Generally referred to as landslides, mass wasting includes debris slides, rock slides, and debris flows in steeper terrain, and slumps and earthflows on gentler slopes. A landslide is defined as “the movement of a mass of rock, debris, or earth down a slope” (National Research Council 1996). Landslides often gather large amounts of organic material, such as downed logs and woody debris, as they travel downslope. Debris flows are the primary erosional mechanism responsible for depositing sediment and woody debris into streams (Mills 1997, Skaugset et al. 2002). Earth slides and earthflows are usually slow-moving and highly variable in size, although rapidly moving earthflows have been observed in the Tillamook basin (Mills 1997).

The majority of erosion and sediment movement occurs episodically during infrequent, large flood events. The flood of February, 1996 and smaller floods of 1998 and 1999, which caused extensive damage throughout western Oregon, deposited a large quantity of sediment into Tillamook Bay, and re-focused attention on mass wasting and erosional processes. Although landslides occur under natural conditions, human activities have been shown to increase the rate of erosion in many coastal watersheds in Oregon (WPN 1999, Naiman and Bilby 1998, Robison et al. 1999). In particular, road-cuts may undercut slopes and concentrate runoff along roads, and road-fills on steep slopes may give way, initiating landslides (NRC 1996). Road ditches intercept and redirect the flow of water, sometimes exacerbating erosion and accelerating the rate of runoff. Vegetation removal, such as by logging or wildfire, may also increase the likelihood of landslide occurrence. However, landslide rates vary greatly and predicting landslide occurrence at a given site is difficult.

High levels of sediment deposition associated with landslides and debris flows may negatively impact many aquatic organisms, including threatened salmon species (Skaugset et al. 2002). However, landslides and debris flows can have both positive and negative effects on fish in streams. A landslide from a forested hillside will generally contain soil, gravel, organic material, and a substantial amount of woody debris. This mixture causes significant changes in the affected stream reach (Chesney 1982). In the short term, a debris flow can scour a channel and remove beneficial prey (benthic macroinvertebrates) and channel structures. Over the long term, these events deliver woody debris, organic matter, and gravel that maintain productive aquatic habitat and serve to reset gravel conditions in the stream ecosystem (Spies et al. 2002).

3.1.4.2 Mass-wasting and Slope Stability in the Trask River watershed

No recent comprehensive aerial photo or on-the-ground inventories of landslides have been conducted in the Trask River watershed. Limited available data on landslide occurrence are presented in Table 3.8. Most records of landslide occurrence are in the East Fork of the South Fork and the South Fork Trask subwatersheds. The most recent and comprehensive information on landslides in the Tillamook basin is ODF's study of the storm impacts and landslides of 1996 (Robison et al. 1999). In this study, 62 landslides were recorded in a 4.5 mi^2 area in the Wilson River watershed. Fifty non-road landslides were identified, with a density of 11.1/mi^2. The average volume of sediment contributed by these slides was estimated to be 11.8 yd^3/ac.

Table 3.8. Landslide activity in the Trask River watershed, based on available data.

Subwatershed	Debris Avalanche	Earthflow	Landslide	Total
East Fork Of South Fork Of Trask River			51	51
Elkhorn Creek			59	59
Lower Trask River		89		89
Middle Fork Of North Fork Of Trask River	1			1
North Fork Of North Fork Of Trask River			1	1
North Fork Of Trask River			43	43
South Fork Of Trask River	1	12	46	59
Upper Trask River		19	11	30
Total	2	120	211	333

A 1978 study by the U.S. Department of Agriculture (USDA), prepared for the Tillamook Bay Task Force, estimated sediment yield for the entire Tillamook Basin. They determined that upland erosion rates in the Tillamook basin increased due to human activities, but the exact amount of increase was unclear. The USDA (1978) study used the Universal Soil Loss Equation (USLE), which results in unreliable estimates of sediment yield on forested land, particularly in locations where the soil has a high infiltration rate, such as is commonly found in the uplands of the Trask River watershed (TBNEP 1998a).

Another study in 1978 used false-color infrared photographs to identify human-induced and natural landslides in the Tillamook area (Benoit 1978). Of the 4,680 landslides identified, 4,440 (95%) were classified as "human-induced". Landslides were considered human-induced if they occurred near roads, fire lines, timber harvest or salvage activities. In the Trask River watershed

1,092 human-induced and 30 natural landslides were recorded. However, the coarse criteria for determining human influence is likely to have resulted in some naturally-caused events having been incorrectly labeled as human induced. Robison et al. (1999) also concluded that aerial photo studies tend to misrepresent landslide rates.

3.1.4.3 Human Impacts on Erosional Processes and Sediment Production

There are two primary sources of human impact on erosional processes and sediment production in the upper Trask River watershed: roads and timber harvest units. Information regarding the current conditions and impacts of roads in the watershed is provided in Section 3.2.1.

We have not found studies that have investigated the effects of clearcutting and timber harvest on erosion in the Trask River watershed, specifically. However, nearly all studies from other watersheds of the effects of timber harvest on the rate of landslides have found higher rates in harvest units than in forest. Studies from elsewhere in the Oregon Coast Range have estimated a two- to four-fold increase in the rate of landslides associated with clearcuts, when compared to forest (Sidle et al. 1985, Robison et al. 1999). ODF data suggested an average increase in the rate of landslides of 42% during the first decade following clearcutting (Robison et al. 1999, Skaugset et al. 2002). Aerial photo-based studies have been found, however, to underestimate the number of landslides under forest canopy (Pyles and Froehlich 1987, Robison et al. 1999). The association between increased rate of landslide occurrence and vegetation removal appears to be strongest in the first 10 years following vegetation removal, declining as the site is revegetated. Also, there is some evidence that debris flows originating in clearcuts are more likely to reach mainstem streams than debris flows of forest origin (May 1998).

There are 12 rock pits in the Trask River watershed, where rock is excavated, primarily for road construction and maintenance. Five rock pits are located in the North Fork of the Trask subwatershed, three in the Upper Trask, two in the East Fork of the South Fork Trask subwatershed, and one each in the Elkhorn Creek and South Fork subwatersheds. Information regarding the influence of rock pits on erosion is not available (Tony Klosterman, pers. comm., 2003).

3.1.4.4 Effects of Sedimentation on Barney Reservoir

We have not been able to find information regarding sedimentation effects on Barney Reservoir. Representatives of the Barney Reservoir Commission and the Joint Water Commission were unaware of any studies or concerns regarding sedimentation for Barney Reservoir. One consulting scientist observed that during his fieldwork above the reservoir he saw very few signs of erosion, and described the terrain as rock-dominated. He was of the opinion that sedimentation issues were not likely to be significant (Forest Olsen, CH2M Hill, pers. comm., 2003).

3.1.5 WATER QUALITY

3.1.5.1 Streams on the 1998 ODEQ 303(d) List

Water bodies or stream segments are placed on the 303(d) list if they fail to meet water quality standards, established to protect designated beneficial uses, after all practicable measures have been taken to treat or control point source discharges. For water bodies included on the 303(d) list, a maximum allowable daily load of the constituent responsible for the listing is determined (the Total Maximum Daily Load, or TMDL) and fractions of that allowable load are allocated to dischargers, both point and non-point, in the basin.

Beneficial uses for the purpose of water quality regulation are determined by the Oregon Department of Environmental Quality (ODEQ) for each of 19 river basins. The Trask River is included in the North Coast basin, and is combined with the Lower Columbia River basin for regulatory purposes (OAR 340-41-202). Beneficial uses for the North Coast basin are:

Public and private domestic water supply[1]
Industrial water supply
Irrigation
Livestock watering
Anadromous fish passage
Salmonid fish spawning and rearing
Resident fish and aquatic life
Wildlife and hunting
Fishing
Boating
Water contact recreation
Aesthetic quality

The water quality requirements to meet these uses differ. For example, the requirements for domestic water supply may be more stringent in some aspects than those for livestock watering. Frequently the most sensitive beneficial use is considered when making decisions regarding designation of a water body as water quality limited. The underlying assumption is that if the water body meets the criteria for the most sensitive use, it will meet criteria for other uses as well. For most of the Trask River watershed, the most sensitive beneficial use would probably be salmonid fish spawning, for which the critical criteria would be temperature and dissolved oxygen. For the upper reaches of the Middle Fork of the North Fork of the Trask River subwatershed, the most sensitive beneficial use is public and private domestic water supply. An additional important water quality consideration for the Trask River is bacteria concentration, because bacterial contamination in the Trask River influences resident aquatic life, including oysters cultivated in Tillamook Bay.

The Clean Water Act regulates discharge of waste to surface water. In order to discharge any waste, a facility must first obtain a permit from the State. ODEQ issues two primary types of

[1]With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards.

discharge permit. Dischargers with Water Pollution Control Facility (WPCF) permits are not allowed to discharge to a water body. Most WPCF permits are issued for on-site sewage disposal systems. Holders of National Pollutant Discharge Elimination System (NPDES) permits are allowed to discharge wastes to waters of the state, directly or indirectly, but their discharge must meet certain quality standards as specified in their permits. Permits set limits on pollutants from industrial and municipal dischargers based on the ability of the receiving stream to absorb and dissipate the pollutants. Industries, municipal wastewater treatment facilities, fish hatcheries, and similar facilities typically have NPDES permits. General permits (GEN) are issued to certain categories of discharger rather than to individual facilities. The current discharge permits for the Trask River watershed are listed in Table 3.9.

Table 3.9. U.S. EPA water discharge permits in the Trask River watershed.

ID #	Common Name	Address	River Mi.	Type
1	ODF – Tillamook District H.Q.	4907 E. Third St.	2.24	GEN12C
2	Tillamook Lumber Company (ABN)	3111 Third St.	0.72	GEN12Z
3	Tillamook STP		1.90	NPDES-DOM-C2a
4	Five Rivers Assisted Living & Retirement	3500 12th St.	1.05	GEN12C
5	Treesource Industries, Inc.	5900 Moffett Rd.	4.50	GEN05
6	Peal Point Oyster Company	1802 1st St.	4.00	GEN09
7	S-C Paving Company – Trask River	9575 Trask River Rd.	8.27	GEN12A
8	ODFW – Trask River Hatchery	15020 Chance Rd.	9.70	GEN03
9	Tillamook Industrial Park STP	4000 Blimp Blvd.	5.20	NPDES-DOM-Db
10	Tillamook Industrial Park STP	4000 Blimp Blvd.	1.96	GEN12Z
11	ODFW – Trask Rearing Pond	26915 Trask River Rd.	0.50 on S.F. Trask	GEN03

Water quality limited water bodies found in the Trask River watershed are listed in Table 3.10. This table includes more stream segments than are on the current 303(d) list. This is because once a TMDL has been approved, a water body is removed from the 303(d) list, even though it may still not meet water quality criteria.

3.1.5.2 Water Quality Data and Evaluation Criteria

Water quality data were collected from 100 sites in the Trask River watershed between October 25, 1960 and September 17, 2002 and are available from ODEQ. However, many of those sites were visited only once or twice. Table 3.11 lists the 33 sites that have been sampled more than two times during the period of record. As can be seen from the table, water quality sampling has been concentrated on a relatively few sites, with only 15 locations sampled more than 10 times during the period of record in the ODEQ database.

Table 3.10. Water quality-limited water bodies in the Trask River watershed prior to approval of the TMDL. (Source: ODEQ)					
Waterbody Name	River Mile	Parameter	Season	Criteria	Listing Status
Dougherty Slough	0 to 4.9	Dissolved Oxygen	Year Round	Estuarine: 6.5 mg/l	303(d) List
Hoquarten Slough	0 to 3.1	Dissolved Oxygen	Year Round	Estuarine: 6.5 mg/l	303(d) List
Mill Creek	0 to 3	Dissolved Oxygen	Sept. 15 - May 31	Spawning: 11 mg/L or 95% saturation	303(d) List
Mill Creek	0 to 3	Iron	Year Round	Table 20	303(d) List
Trask River	0 to 10.2	Dissolved Oxygen	Sept. 15 - May 31	Spawning: 11 mg/L or 95% saturation	303(d) List
Dougherty Slough	0 to 4.9	Chlorophyll *a*	Year Round	0.01 mg/l	Potential Concern
Hoquarten Slough	0 to 3.1	pH	Year Round	pH: 6.5 to 8.5	Potential Concern
Mill Creek	0 to 4.1	Biological Criteria		Waters of the state shall be of sufficient quality…	Potential Concern
Dougherty Slough	0 to 4.9	Fecal Coliform	Summer	Geometric Mean of 200, No more than 10%>400	TMDL Approved
Dougherty Slough	0 to 4.9	Fecal Coliform	Winter/Spring/Fall	Geometric Mean of 200, No more than 10%>400	TMDL Approved
Hoquarten Slough	0 to 3.1	Fecal Coliform	Summer	Geometric Mean of 200, No more than 10%>400	TMDL Approved
Hoquarten Slough	0 to 3.1	Fecal Coliform	Winter/Spring/Fall	Geometric Mean of 200, No more than 10%>400	TMDL Approved
Mill Creek	0 to 3	Fecal Coliform	Summer		TMDL Approved
Mill Creek	0 to 3	Fecal Coliform	Winter/Spring/Fall		TMDL Approved
Mill Creek	0 to 4.1	Temperature	Summer	Rearing: 17.8^{o} C	TMDL Approved
Mills Creek	0 to 1.2	Fecal Coliform	Summer		TMDL Approved
Mills Creek	0 to 1.2	Fecal Coliform	Winter/Spring/Fall		TMDL Approved
N Fk of N Fk Trask R.	0 to 7.1	Fecal Coliform			TMDL Approved
N Fk of N Fk Trask R.	0 to 7.1	Temperature	Summer	Rearing: 17.8^{o} C	TMDL Approved
North Fork Trask R.	0 to 4.4	Temperature	Summer	Rearing: 17.8^{o} C	TMDL Approved
Simmons Creek	0 to 0.9	Fecal Coliform	Winter/Spring/Fall		TMDL Approved
Trask River	0 to 18.6	Temperature	Summer	Rearing: 17.8^{o} C	TMDL Approved
E Fk of S Fk Trask R.	0 to 12.3	Flow Modification		The creation of tastes or odors or toxic or other condition	Water Quality Limited; No TMDL
North Fork Trask R.	0 to 11.4	Flow Modification		The creation of tastes or odors or toxic or other conditions	Water Quality Limited; No TMDL
Trask River	0 to 10.2	Habitat Modification		The creation of tastes or odors or toxic or other conditions	Water Quality Limited; No TMDL
Trask River	10.1 to 18.5	Flow Modification		The creation of tastes or odors or toxic or other conditions	Water Quality Limited; No TMDL

Table 3.11 Sites in the Trask River watershed sampled for water quality on more than two occasions, 1960 through 2002.

Station Key	Location[a]	Latitude	Longitude	No. Days	No. Tests
13433	Trask River at Hwy 101	45.42986	-123.82278	165	2914
13430	Hoquarten Slough at Hwy 101 (Tillamook)	45.45917	-123.84444	92	903
13431	Trask River at Netarts Road	45.45639	-123.86000	55	870
13428	Dougherty Slough at Hwy 101	45.46528	-123.84389	40	617
13432	Trask River @ Tillamook Loop Road	45.44664	-123.84272	33	464
13429	Dougherty Slough at Wilson R Loop Rd	45.47083	-123.80917	28	402
13435	Trask River at Panther Creek	45.44467	-123.71261	28	320
13434	Trask River at Trask River Loop Road	45.42692	-123.79417	25	253
13484	Holden Creek at Evergreen Street	45.44944	-123.82778	18	88
13485	Holden Creek at Miller Street	45.44972	-123.83750	17	134
13483	Holden Creek at McCormack Loop Road	45.45417	-123.80000	12	160
13537	Trask River at Sp&S Railroad Bridge	45.42978	-123.80097	12	165
12342	Mill Creek at Rm 1.0	45.42525	-123.79253	11	284
13479	North Fork Trask River at Bridge	45.44028	-123.60806	11	82
13506	Hoquarten Slough at Wilson R Loop Rd	45.46500	-123.80917	10	320
13514	Mill Creek at Magnolia Drive	45.41028	-123.78083	9	42
12841	City Of Tillamook STP Final Effluent	45.45694	-123.85536	8	191
13478	Trask River U/S of Milepost 11	45.44417	-123.61444	8	46
13507	Hoquarten Slough at Headwaters	45.45944	-123.78250	6	39
12829	Trask River @ Tillamook Boat Ramp	45.45408	-123.85669	5	154
13535	South Fork Trask River U/S of Trask R Rd	45.43750	-123.60667	5	16
13536	Green Creek at Trask River Road	45.44111	-123.76000	5	23
13538	Elk Creek at Brickyard Road	45.42000	-123.78000	5	30
11936	Trask River 45 Yds D/S of STP Outfall	45.42969	-123.80147	4	103
13480	Edwards Creek Near Hollywood Camp	45.40972	-123.61333	4	13
13481	East Fork Trask River D/S of Fish Hatchery	45.41611	-123.60167	4	13
13482	East Fork Trask River U/S of Fish Hatchery	45.41583	-123.59889	4	16
13504	Mill Creek at Long Prairie Road	45.41556	-123.76583	4	27
13513	Mill Creek at Brickyard Road	45.41667	-123.77750	4	31
12515	M.F./N.F. Trask River at RM 3.0	45.46508	-123.43572	3	244
12835	Hoquarten Slough @ Mouth	45.46444	-123.86383	3	87
13144	Hoquarten Slough at RR Br (0.7 Mi U/S of Hwy 101)	45.46219	-123.83258	3	32
13146	Dougherty Slough at RR Br (O.9 Mi U/S of Hwy 101)	45.46517	-123.83308	3	32

[a] D/S - downstream; U/S - upstream

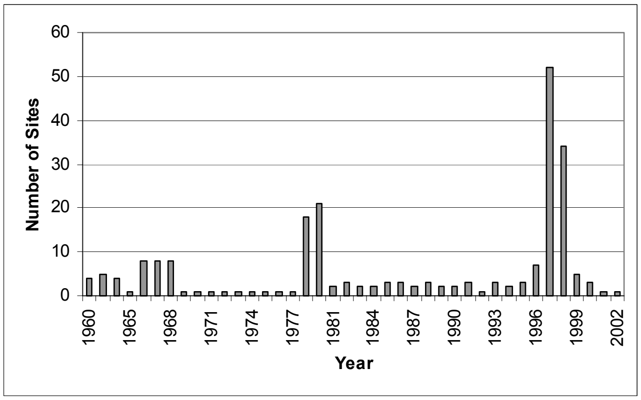

Figure 3.2. Number of sites sampled each year in the Trask River watershed from 1960 to 2002. (Source: ODEQ LASAR database)

Figure 3.2 shows the number of sites from which samples were collected in the Trask River watershed each year between 1960 and 2002, and for which data are available from ODEQ. Sampling intensity has varied considerably from year to year, with many more samples collected in some years than in others. Recently, the number of samples collected (and for which data are available from ODEQ) per year from the watershed has ranged between five and ten. More samples were collected in 1997 and 1998 in conjunction with TMDL development by ODEQ (Figure 3.3).

Table 3.12 shows the percent of samples that exceeded the relevant water quality criteria for the parameters and seasons included on the current 303(d) list of water quality limited water bodies, based on data available from ODEQ.

For stream segments listed with respect to narrative criteria, such a percent calculation is not possible because the criteria are not quantitative. High percent sample exceedences are mainly confined to the lower portions of the watershed, especially Mill Creek and Hoquarten and Dougherty Sloughs. These involve DO, FCB, and pH (Table 3.12). Temperature exceedences are more broadly distributed throughout upland portions of the watershed, mainly along mainstem reaches.

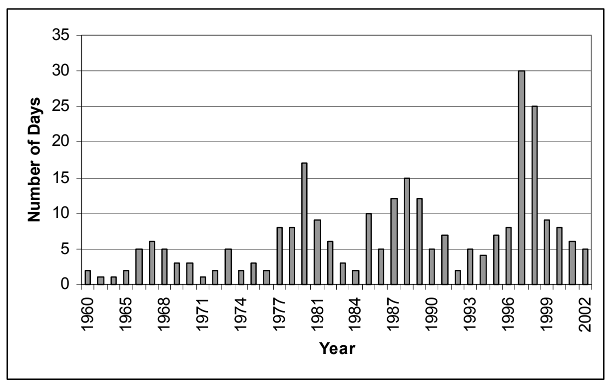

Figure 3.3. Number of days water quality data were collected each year in the Trask River watershed between 1960 and 2002.

The evaluation criteria used for this assessment are based on the Oregon Water Quality Standards for the North Coast Basin (ORS 340-41-205) and on literature values where there are no applicable standards, as for example, for nutrients (WPN 1999). They are not identical to the 303(d) water quality standards in that not all seasonal variations are included. The evaluation criteria listed in Table 3.13 are used as indicators that a possible problem may exist.

The water quality evaluation criteria were applied to the available data by noting how many, if any, of the water quality data exceeded the criteria. If sufficient data were available, a judgment was made based on the percent exceedence of the criteria as shown in Table 3.14. If insufficient, or no, data were available, this was noted as a data gap to be filled by future monitoring. If any water quality parameter was rated as “moderately impaired” or “impaired” using these criteria, water quality in the stream reach in question is considered impaired for purposes of the

Table 3.12. Percent of samples (based on ODEQ data) from water quality limited stream segments that exceeded the relevant water quality criteria.

Waterbody Name	River Mile	Parameter	Season	Criteria	No. sites	No. samples	Percent exceed
Mill Creek	0 to 4.1	Biological Criteria		Waters of the state shall be of sufficient quality……	na	na	na
Dougherty Slough	0 to 4.9	Chlorophyll *a*	Year Round	>0.01 mg/l	2	10	60
Dougherty Slough	0 to 4.9	Dissolved Oxygen	Year Round	Estuarine: <6.5 mg/l	3	95	42
Hoquarten Slough	0 to 3.1	Dissolved Oxygen	Year Round	Estuarine: <6.5 mg/l	5	78	36
Mill Creek	0 to 3	Dissolved Oxygen	Sept. 15 - May 31	Spawning: <11 mg/L or 95% saturation	2	17	29
Trask River	0 to 10.2	Dissolved Oxygen	Sept. 15 - May 31	Spawning: <11 mg/L or 95% saturation	26	427	28
Dougherty Slough	0 to 4.9	Fecal Coliform	All year	> 200 cfu/100 mL	2	86	67
				> 400 cfu/100 mL	2	86	59
Hoquarten Slough	0 to 3.1	Fecal Coliform	All year	> 200 cfu/100 mL	5	203	65
				> 400 cfu/100 mL	5	203	51
Mill Creek	0 to 3	Fecal Coliform	All year	> 200 cfu/100 mL	5	26	58
				> 400 cfu/100 mL	5	26	50
N Fk of N Fk Trask R.[a]	0 to 7.1	Fecal Coliform		> 200 cfu/100 mL	1	2	0
				> 400 cfu/100 mL	1	2	0
E Fk of S Fk Trask R.[a]	0 to 12.3	Flow Modification		The creation of tastes or odors or toxic or other conditions	na	na	na
N Fork Trask R.	0 to 11.4	Flow Modification		The creation of tastes or odors or toxic or other conditions	na	na	na
Trask River	10.1 to 18.5	Flow Modification		The creation of tastes or odors or toxic or other conditions	na	na	na
Trask River	0 to 10.2	Habitat Modification		The creation of tastes or odors or toxic or other conditions	na	na	na
Mill Creek	0 to 3	Iron	Year Round		1	4	50
Hoquarten Slough	0 to 3.1	pH	Year Round	pH: 6.5 to 8.5	6	122	32
Mill Creek	0 to 4.1	Temperature	Summer	Rearing: 17.8 C	5	10	20
N Fk of N Fk Trask R.[a]	0 to 7.1	Temperature	Summer	Rearing: 17.8 C	1	2	0
North Fork Trask R.	0 to 4.4	Temperature	Summer	Rearing: 17.8 C	1	3	67
Trask River	0 to 18.6	Temperature	Summer	Rearing: 17.8 C	9	113	31

[a] The data used to classify this site as water quality limited were not available for this analysis.

Table 3.13. Water quality criteria and evaluation indicators (WPN 1999).	
Water Quality Attribute	Evaluation Criteria
Temperature	Daily maximum of 64° F (17.8° C) (7-day moving average)
Dissolved Oxygen	8.0 mg/L salmonid rearing, 6.5 mg/L estuarine
pH	Between 6.5 and 8.5
Nutrients[a]	
Total Phosphorus	8.75 μg/L
Total Nitrogen	0.10 mg/L
Chlorophyll *a*	1.9 μg/L[a] 15 μg/L[b]
Bacteria	Water-contact recreation 126 E. coli/100 mL (30-day log mean, 5 sample minimum) 406 E. coli/100 mL (single sample maximum)
	Marine water and shellfish areas 14 fecal coliform/100 mL (median) 43 fecal coliform/100 mL (not more than 10% of samples)
Turbidity	50 NTU maximum (fish feeding impaired) 10 NTU adverse aesthetic effect
Organic Contaminants	Any detectable amount
Metal Contaminants	
Arsenic	190 μg/L
Cadmium	0.4 μg/L
Chromium (hex)	11.0 μg/L
Copper	3.6 μg/L
Lead	0.5 μg/L
Mercury	0.012 μg/L
Zinc	32.7 μg/L

[a] Based on current U.S. EPA guidance for nutrients and chlorophyll for Ecoregion II (U.S. EPA 2002).
[b] Based on Oregon DEQ action levels (ORS 340-41-0150).

Table 3.14. Criteria for evaluating water quality impairment (WPN 1999).	
Percent of Data Exceeding the Criterion	Impairment Category
Less than 15%	No impairment
15 to 50%	Moderately impaired
More than 50%	Impaired
Insufficient data	Unknown

assessment. The condition that caused the impairment should be addressed through watershed management or stream restoration activities.

In addition to the ODEQ data, there are data for some water quality parameters available for sites that were sampled in the lower watershed in conjunction with efforts by the TBNEP. From December 1996 to January 2002, E&S Environmental Chemistry, Inc. conducted a river water quality characterization and monitoring effort that included the Trask River. Water samples were collected periodically at the 5th St. dock[2] at RM 1.5, and occasionally at other sites. The monitoring program focused on storm sampling for FCB and TSS, and approximately bimonthly sampling for nitrogen (NO_3^-, NH_4^+, TKN) and total phosphorus. A total of 27 storms were sampled, with typically six to eight samples (plus QA samples) collected and analyzed for FCB and TSS at the primary monitoring site during each storm.

3.1.5.3 Water Quality Parameters

Temperature

The Trask River has been recognized as water quality limited for temperature, and a TMDL has been established through the Tillamook Bay Watershed TMDL (ODEQ 2001). There have been 964 temperature measurements on discrete samples reported from the Trask River watershed since 1960. Of these, 12% exceeded the evaluation criterion of 17.8°C (64°F) for salmonid rearing, and 36% exceeded the evaluation criterion of 12.8°C (55°F) for salmonid spawning (Figure 3.4). The sites with samples that exceeded the evaluation criterion are shown on Figure 3.5.

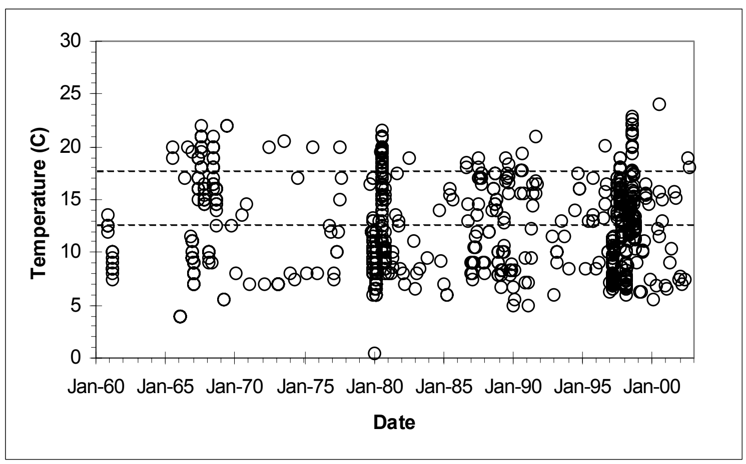

Figure 3.4. Water temperature data measured at various sites in the Trask River watershed between 1960 and 2002. The dashed lines indicate the evaluation criteria of 17.8° and 12.8°C (64° and 55°F, respectively).

Prior to TMDL establishment, the Trask River was 303(d) listed for water temperature from the mouth to the South Fork of the Trask River (19.2 miles). In addition, the North Fork was listed from its mouth to Bark Shanty Creek (4.4 miles), and the North Fork of the North Fork was listed from the mouth to the headwaters.

[2]Initially, the sampling site was the Tillamook Toll Road bridge, but it was moved to 5th St. in 1998 when construction work limited access to the bridge.

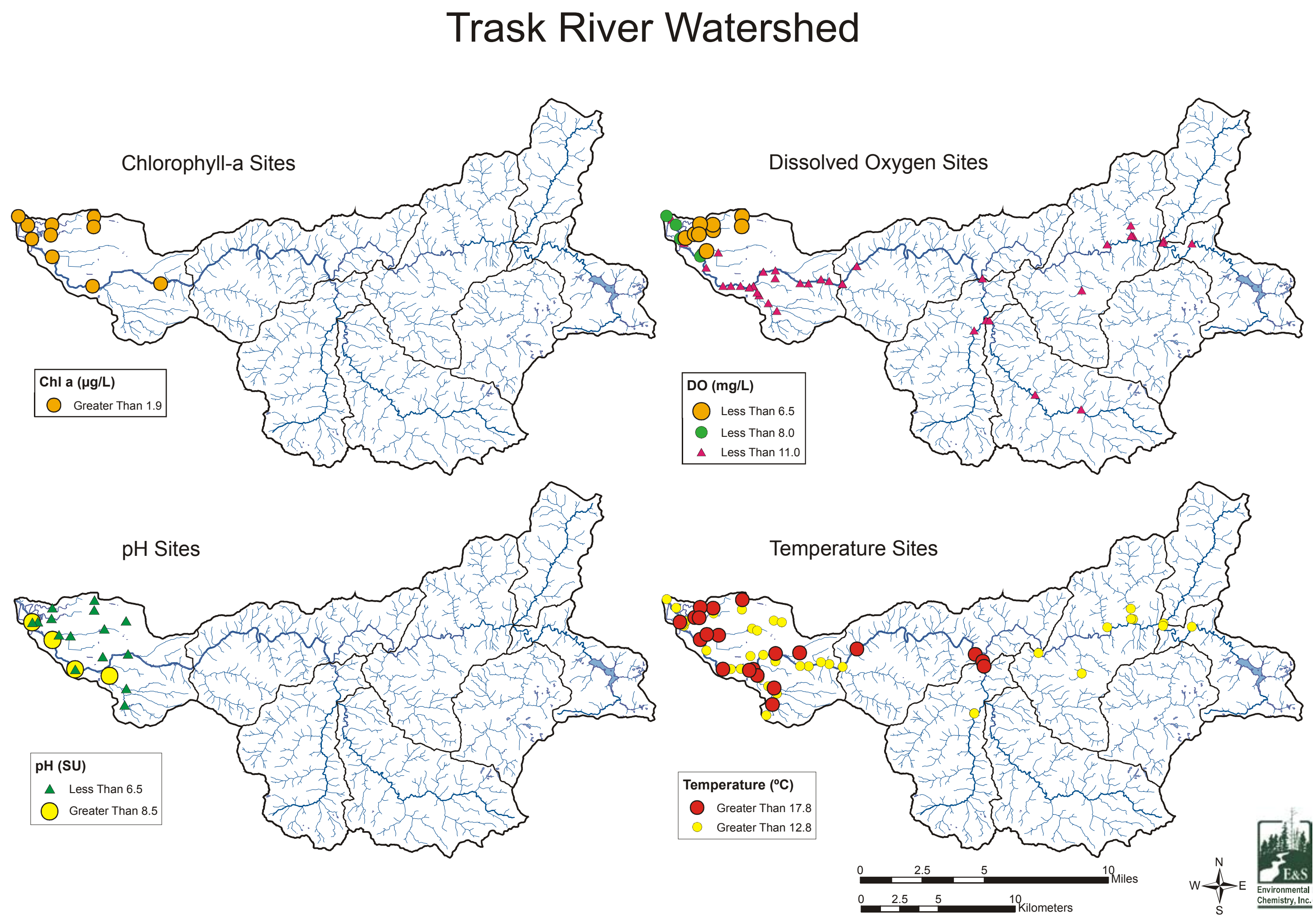

Figure 3.5. Location of sampling sites for which one or more measured value exceeded the criterion for chlorophyll *a*, dissolved oxygen, pH, and temperature.

Continuous temperature monitoring (30 minute intervals) was conducted by ODEQ in 1998 as part of the TMDL process. Figure 3.6 shows the number of days the 7-day mean maximum daily temperature exceeded the relevant criteria at the continuous monitoring sites. All but two of the monitored sites on mainstem reaches of the Trask River and its major tributaries exceeded the 7-day mean maximum daily temperature criterion of 64°F for part of the summer. Highest temperatures are reached in late July and August. Adult migration and holding occurs in the Trask River system during July and/or August for spring and fall chinook, summer steelhead, and cutthroat trout (both resident and sea-run). Rearing occurs in both July and August for all of the salmonid species that are present within the Trask River system, except chum salmon, which do not rear in fresh water (ODEQ 2001).

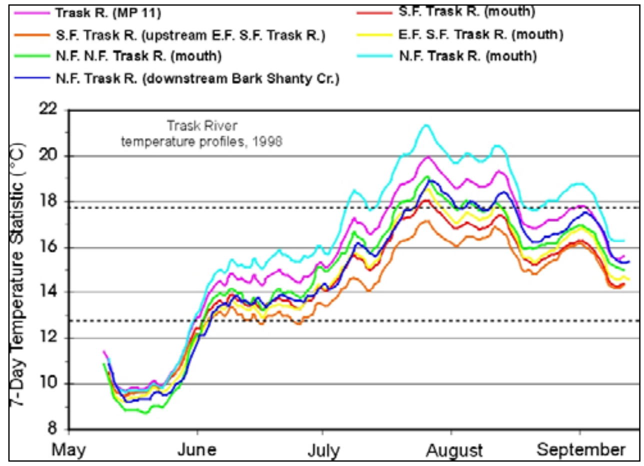

Figure 3.6. Continuous temperature data from the Trask River watershed: 7-day mean maximum daily temperature in 1998. (Source: ODEQ 2001)

Warm point source discharges into the Trask River can be a source of stream heating, but such an effect is not expected to be substantial. Discharge temperature for the Tillamook STP is restricted under the NPDES permit to 71°F, and the flow rate is low (1.64 cfs).

Dissolved Oxygen

Of 417 measurements of DO concentration taken at various sites between 1960 and 2002, 62% were less than the 11 mg/L criterion for salmonid spawning, 20% were below the 8 mg/L criterion for salmonid rearing, and 11% were below the 6.5 mg/L criterion for estuaries (Figure 3.7). However, at the lowland sites that may experience tidal influence, 40% of values were below the 6.5 mg/L criterion. Sites not meeting the evaluation criteria are shown in Figure 3.5. Based on these DO data, the Trask River watershed might be considered impaired with respect to salmonid spawning, and moderately impaired with respect to salmonid rearing. Additional site-specific studies and studies focused on the times of salmonid utilization of the stream system may be required to determine the seasonal and spatial extent of any potential DO limitations.

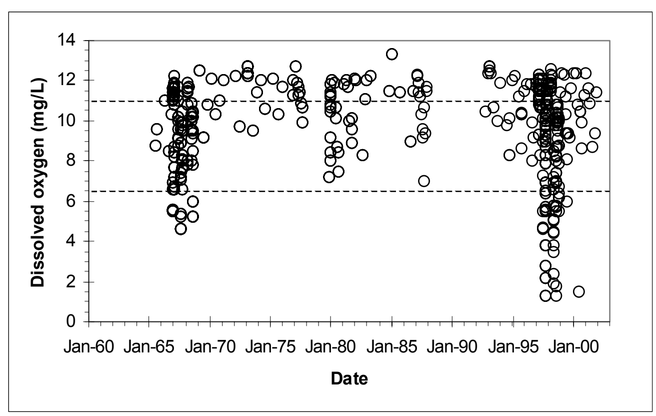

Figure 3.7. Dissolved oxygen measured at various sites in the Trask River watershed between 1960 and 2002. The dashed lines indicate the evaluation criteria of 11.0 and 6.5 mg/L.

pH

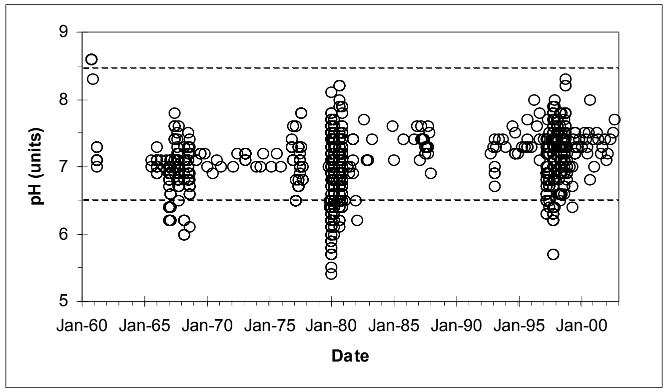

Figure 3.8. pH measured at various sites in the Trask River watershed from 1960 through 2002. The dashed lines indicate the evaluation criteria of 8.5 and 6.5 pH units.

There are 843 measurements of pH available from the Trask River watershed between 1960 and 2002. Of these, 10% were below the evaluation criterion of 6.5, but only 0.5% were greater than the upper limit of 8.5 (Figure 3.8). Tributaries of the lower Trask River exhibited a relatively high number of low pH values, but this is not unexpected because of the abundant rainfall received. The natural pH of rainwater can be as low as 5.7, and this is reflected in the low pH found on occasion in some of the smaller tributary streams. Figure 3.5 shows the sites that had pH values outside the range of the evaluation criterion. All were located in the lower watershed. There is no reason to suspect that water quality is impaired with respect to pH.

Chlorophyll *a*

The ODEQ established an action level of 0.015 mg/L for chlorophyll *a* in rivers and streams. EPA proposed a guideline value of 0.0019 mg/L for chlorophyll in the Western Forested Mountains ecoregion. Chlorophyll *a* has been measured on 69 samples from the Trask River watershed since 1960 (Figure 3.9). Of these values, 7% exceeded 0.015 mg/L and 43% exceeded 0.0019 mg/L. The Trask River watershed would not be considered impaired with respect to chlorophyll. Figure 3.5 shows sites with chlorophyll *a* values that exceeded the Oregon action level.

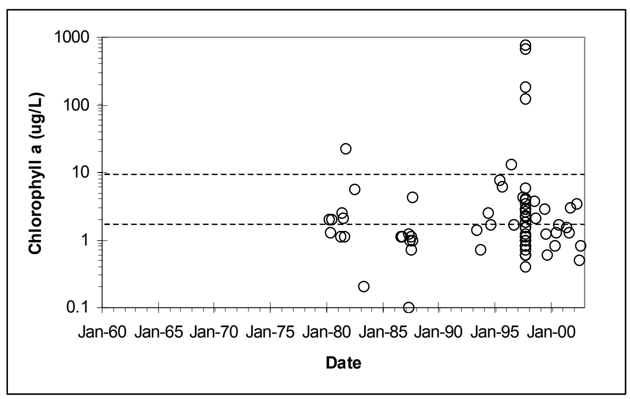

Figure 3.9. Chlorophyll *a* values measured in water samples from the Trask River watershed from 1960 to 2002. Dashed lines represent the Oregon action level (10 μg/L) and the EPA guidance value (1.9 μg/L).

Nutrients

There are currently no State of Oregon standards for nitrogen or phosphorus. The evaluation criteria are based on current (2002) U.S. EPA guidance for nutrients and chlorophyll *a* for Ecoregion II (Western Forested Mountains). The nitrogen criterion is based on total nitrogen, whereas the available data from the Trask River watershed are reported as nitrate-nitrogen. This may cause an underestimate in the number of samples that exceed the criterion, but this bias is expected to be small.

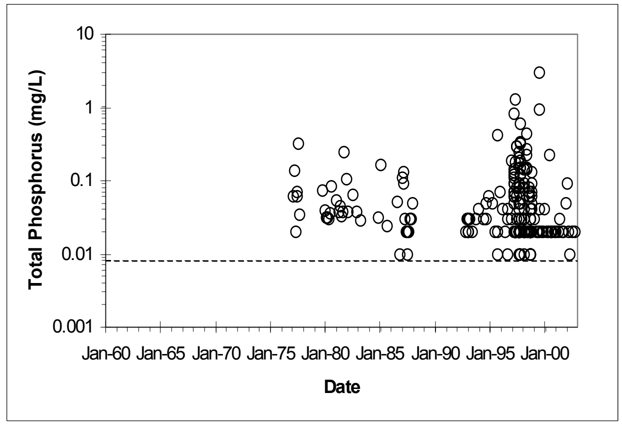

Figure 3.10. Total phosphorus values measured in water samples from the Trask River watershed in 1960 through 2002. The dashed line marks the EPA guidance value of 0.00875 mg/L.

Total phosphorus (TP) was measured on 230 samples from the Trask River watershed from 1960 to 2002. All of these samples exceeded the U.S. EPA guidance value for TP (Figure 3.10). In fact, the guidance level for TP is lower than the reporting limit for the analytical method used to measure TP. This suggests that the Trask River watershed streams are impaired with respect to P or that the guidance level is too low. Studies in neighboring watersheds have reported naturally high P content in some sedimentary bedrock types, although not all sedimentary rock types appear to be high in P (Dave Degenhardt, ODF, pers. comm., 2003). It may require further study to determine the principal source of the P in the Trask River watershed.

Nitrate-nitrogen (NO_3-N) was measured on 286 water samples from the Trask River watershed from 1960 to 2002. Of these samples, 92% exceeded the U.S, EPA guidance value for total N (Figure 3.11). This suggests that the streams in the watershed are impaired with respect to N. However, there are potential natural sources of N in the basin. Bacteria associated with alder trees are capable of fixing atmospheric N, and can be a source of dissolved N in streams draining forested areas. Figure 3.11 suggests that there has been a general increase in nitrate-nitrogen in basin streams between about 1967 and 1977, and perhaps thereafter. This could be consistent with an increased input of nitrogen to the streams from a growing alder forest. It may require further study to determine the source of nitrogen in the Trask River watershed.

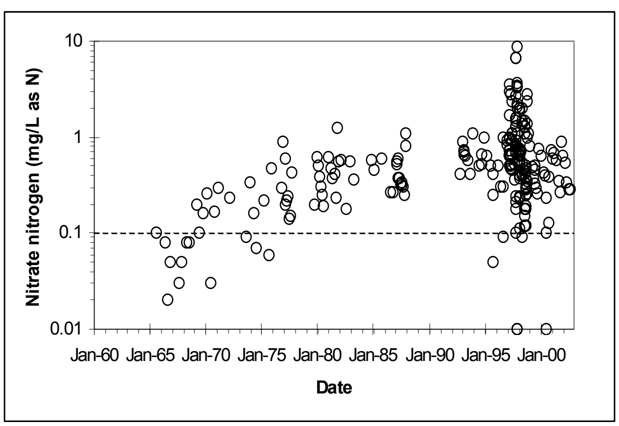

Figure 3.11. Nitrate-nitrogen (as N) values measured in water samples from the Trask River watershed from 1960 to 2002. The dashed line represents the EPA guidance value for total nitrogen.

Bacteria

Two wastewater treatment plants discharge to the Trask River downstream from public lands, although under proper operations and most flow conditions they should not be a source of bacteria to the stream. The Port of Tillamook Bay wastewater treatment plant discharges to the river during the fall-spring period at RM 5.2 and the City of Tillamook discharges year round at RM 1.9 (DEQ 2001).

The indicator bacterium used by ODEQ for evaluating bacterial contamination of recreational waters changed in 1996 from FCB to *E. coli*, a species commonly associated with the digestive tract microflora of mammals and birds. In general, *E. coli* is a subset of FCB, although for measurement purposes both are somewhat operationally defined. In other words, the measurement techniques do not precisely discriminate among bacterial types or species. The change was made because *E. coli* is believed to more directly reflect contamination from sources that also carry pathogens harmful to humans. FCB is still used as the standard for assessing water quality in commercial shellfish harvesting areas, such as in Tillamook Bay. Because there are two standards, both applicable to the Trask River System, that utilize different indicators, ODEQ samples for both. Most data currently available for the Trask River are for FCB. The previous FCB standard for recreation contact in freshwater was:

- geometric mean of 5 samples not to exceed FCB > 200 cfu/100 ml, and
- no more than 10% of samples to exceed FCB = 400 cfu/100 ml.

It has been replaced by the *E. coli* standards for fresh and estuarine waters given in Table 3.13.

The Trask River is not on the 303(d) list for bacteria. However, examination of the available historical data (mostly for the lower river) reveals frequent violations of the applicable criteria. In the lower river, the FCB criterion (no more than 10% of the samples can be greater than 400 counts/100 mL) is exceeded on occasion throughout the year.

Concentration of bacteria in the river and in Tillamook Bay are often too high to allow safe use of these waters for recreational swimming/ wading and shellfish harvesting, respectively. Examination of the available ODEQ data shows that 50% of the 836 measurements taken from 1960 to 2002 exceeded 126 counts/100 mL, and 28% exceed 406 counts/100 mL (Figure 3.12). Sites that exceeded 406 counts/ 100 mL are shown in Figure 3.13.

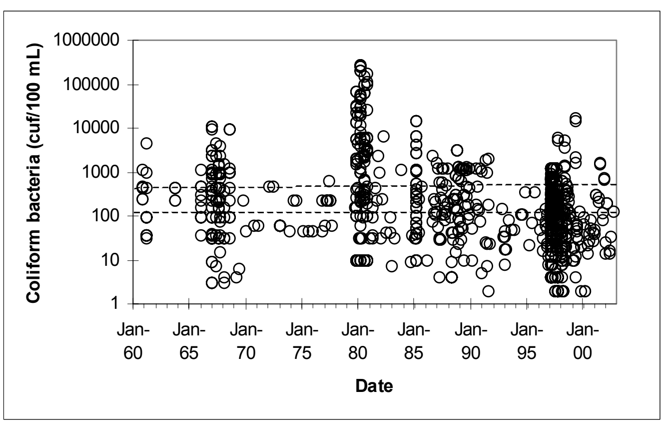

Figure 3.12. Coliform bacteria measured at various sites in the Trask River watershed between 1960 and 2002. Dashed lines indicate the evaluation criteria of 126 and 406 cfu/100 mL.

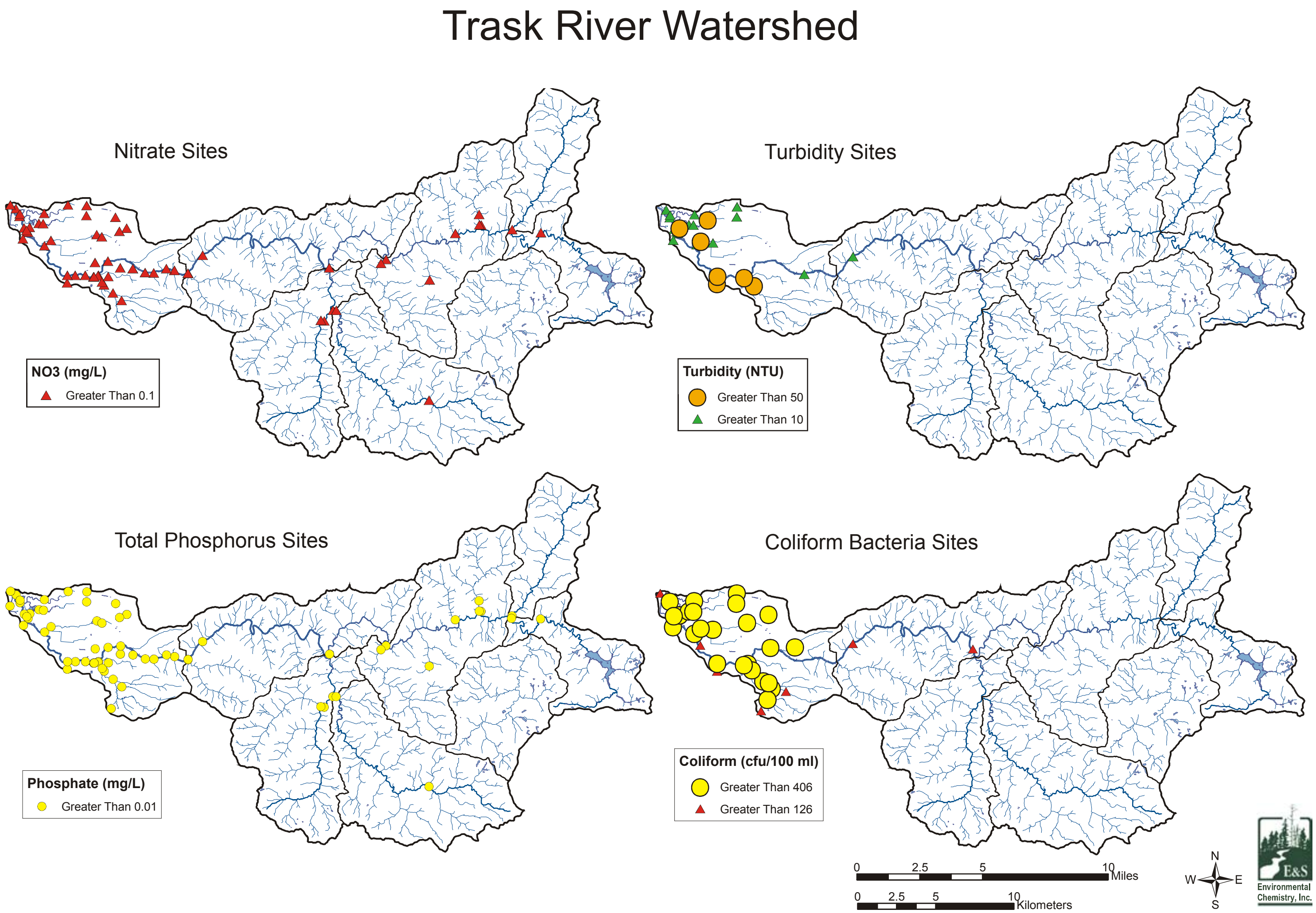

Figure 3.13. Location of sampling sites for which one or more measured value exceeded the criterion for nitrate, turbidity, total phospohrus and fecal coliform bacteria.

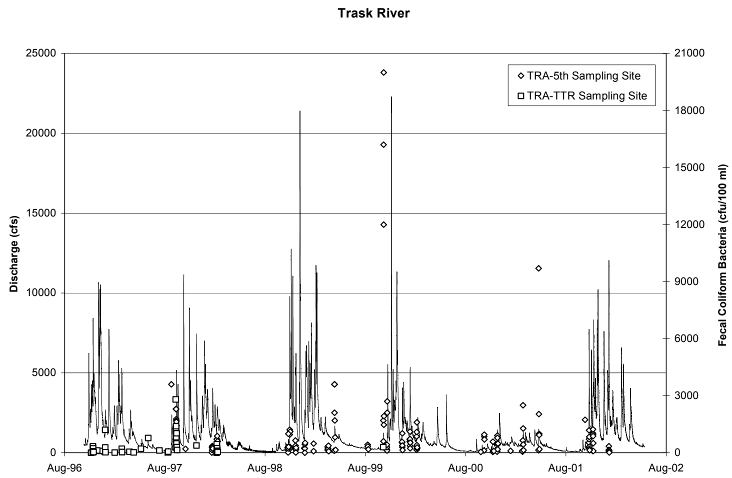

Figure 3.14. Discharge and measured values of fecal coliform bacteria in the lower Trask River throughout the period of monitoring from 1996 to 2002 (Sullivan et al. 2002).

Fecal coliform bacteria concentrations in the lower Trask River mainstem reported from the TBNEP storm sampling project varied annually, seasonally, and episodically, with values ranging from near 0 to over 20,000 cfu/100 ml (Sullivan et al. 2002, Figure 3.14). Concentrations in excess of 500 cfu/100 ml were frequently observed during fall storms. During most years studied, the majority of monitored storms showed storm median and geomean values in the lower river higher than 200 cfu/100 ml (Table 3.15), the previous FCB threshold criterion for human contact recreation. The median measured value in storms in the fall season, during the period December 1996 to January 2002, was more than twice as high as the median measured values during winter or spring. More than 75% of the fall samples (n=87) showed values higher in the lower Trask River than the 200 cfu/100 ml health criterion value. Concentrations were lower during winter and spring, but more than half of the samples during those seasons also exceeded the 200 cfu/100 ml criterion (Table 3.16).

Table 3.15. Percent of monitored storms having median or geomean FCB concentration in the lower Trask River higher than 200 cfu/100 ml. (Source: Sullivan et al. 2002)

Water Year	n[a]	Median	Geomean
1997	2	0	0
1998	5	80	60
1999	6	100	33
2000	5	100	100
2001	5	80	80
2002	3	67	67

[a] number of storms sampled.

Table 3.16. FCB and TSS concentrations by season[a] in the lower Trask River, based on data collected during rainstorms between 1996 and 2002. (Source: Sullivan et al. 2002)						
	FCB (cfu/100 ml)			TSS (mg/L)		
	Fall	Winter	Spring	Fall	Winter	Spring
Number of samples	87	65	58	54	72	36
1st Quartile	205	93	111	5	18	3
Median	560	234	245	15	54	4
3rd Quartile	1153	440	788	51	152	10

[a] Fall was defined as Sept. 1 to Nov. 30, winter as Dec. 1 to Feb. 15, and spring as Feb. 16 to May 31

Turbidity

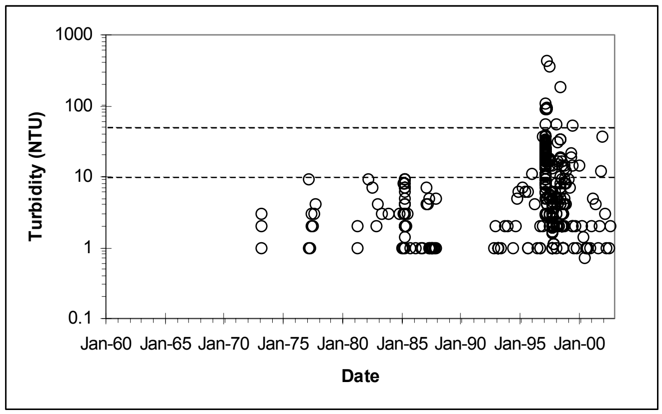

Figure 3.15. Turbidity measurements made on water samples from the Trask River watershed from 1960 to 2002. Dashed lines represent evaluation criteria of 10 and 50 NTU.

The Oregon water quality standard for turbidity does not provide a numerical value, but rather defines a limit of not more than 10% increase as a result of any activity. The evaluation criteria have been set at 50 NTU, a level at which fish feeding might be affected by poor visibility, and 10 NTU, a level that might cause adverse aesthetic effects. Of 360 turbidity measurements, 29% exceeded 10 NTU, and 2.7% exceeded 50 NTU (Figure 3.15). Streams in the Trask River watershed do not appear to be seriously impaired with respect to turbidity.

Organic Contaminants

Ten sites were tested for 57 organic contaminants in 1998 as part of the Tillamook groundwater study. No organic contaminant was present above the method detection limit at any of the sites.

3.1.5.4 Summary of Water Quality Concerns

The major water quality concerns in the Trask River watershed appear to be temperature, FCB, and DO. The migration, rearing, and spawning of salmonid fish may be put at risk throughout mainstem reaches in portions of the watershed by high water temperatures (those that exceed

64˚F for migration or 55˚F for spawning). The most important factor contributing to elevated water temperature, at least along mainstem reaches, is likely reduction in the extent of riparian shade in response to past logging, fires, and land-clearing activities (ODEQ 2001). The widening of stream channels subsequent to removal of riparian vegetation is also believed to be important in this regard, but conclusive evidence is lacking. It is unclear whether mainstem river temperatures were naturally below criteria values, even under reference conditions. Fecal coliform bacteria, including *E. coli*, are contributed to the Trask River from dairy farming and other agricultural activities, urban land use, rural residential housing, and sewer treatment systems (Jackson and Glendening 1982, Sullivan et al. 1998 a, b). Shellfish (especially oyster) harvest in the bay is dependant on water having very low FCB concentrations. Commericial harvesting is now restricted whenever flow in the adjacent Wilson River exceeds 2500 cfs, due to the increased risk of bacterial contamination. Dissolved oxygen impairment is focused largely on the lowland areas, especially the sloughs. Organic contaminants associated with industrial, agricultural, and urban sources of pollution likely contribute to low DO in these areas, especially those having poor river and tidal flushing. Nitrogen and phosphorus concentrations in the Trask River, including at the transition between forest and agricultural lands, are also high relative to guidance criteria values, most likely due to the abundance of alder in the riparian zone and erosional inputs, respectively.

3.1.5.5 Water Quality Trends

It is difficult to detect trends in water quality data, including the data available for this report, for a number of reasons. Most of the data were not gathered under a statistical framework designed to detect trends; the data may vary seasonally and may be autocorrelated; changes in sampling or analytical methods may have introduced spurious shifts in values; there may be an uneven distribution of data through time, with long gaps having little data interspersed with periods of intense data collection; and so on. We have, however, been able to find trends in such data through a three-step analytical process. The long-term time series data were plotted against day of the year. A curve that minimizes the overall residual was then fit to the data, and residuals (the difference between the calculated value and the actual value) were calculated. The residuals were plotted against the actual collection date, and a linear regression line generated. The slope of this line indicates the direction and magnitude of any long-term trend that may exist in the data after removing any bias associated with sampling seasonality. This process is outlined in Figure 3.16, using stream temperature as an example.

The resulting residual plots for primary variables other than temperature are shown in Figure 3.17. Over the period of record, since about 1960 to 1977 (depending on variable), stream temperature, FCB, ortho-phosphate, and total phosphorus data all suggest declining trends. Nitrate-nitrogen, DO, and turbidity data suggest increasing trends. All of the residual trends were statistically significant at $p \leq 0.05$. The highest r^2 values were for nitrate-nitrogen (0.48) and temperature (0.14). The statistical significance of the DO and turbidity residual plots appear to be attributable to a relatively small number of low DO values measured in the mid 1960s and high turbidity values measured in 1997, respectively. Other water quality trends suggest that temperature, FCB, and phosphorus (total phosphorus and ortho-PO_4) conditions may be

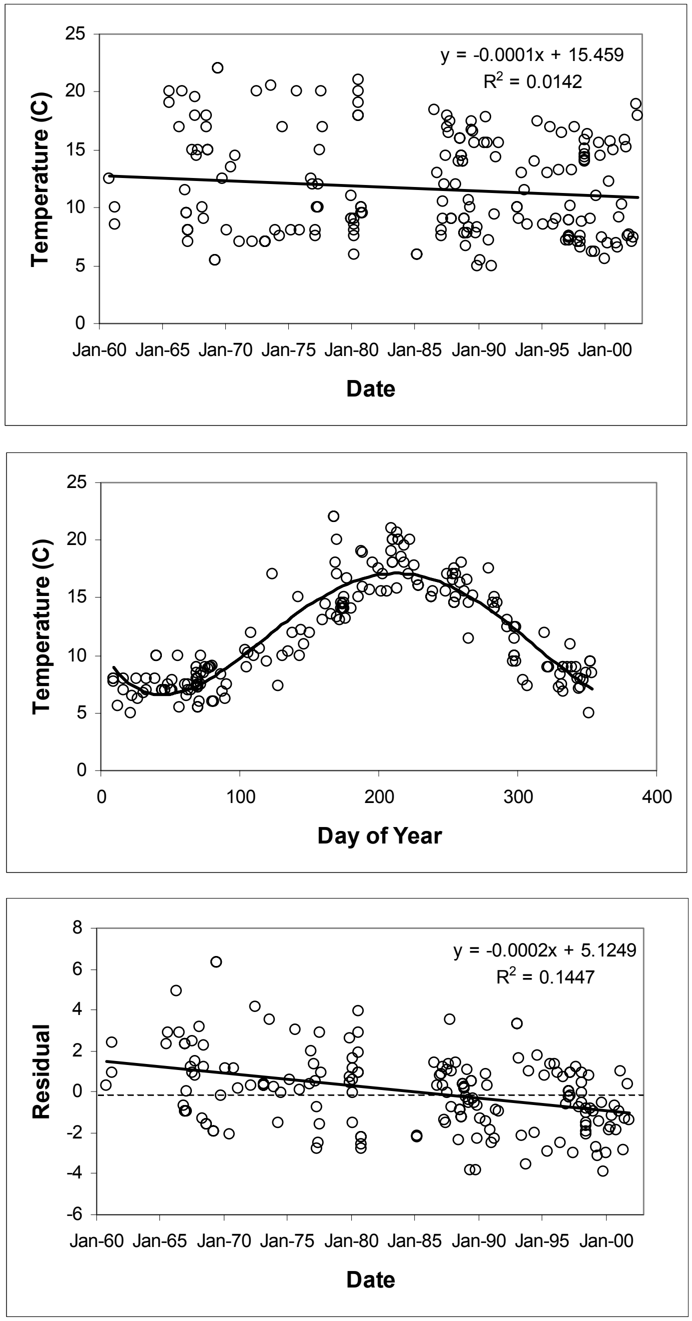

Figure 3.16. Temperature trends analysis for available Trask River temperature data at all measured locations within the watershed, based on ODEQ data. Raw data are given in the top panel; stream temperature versus day of year is given in the middle panel; the residual plot is given in the bottom panel. To account for the possibility of seasonal variation in the data, a three-step process was used to evaluate water quality trends. Available data were plotted against day of the year and a curve was fitted through the data. The calculated residuals were then plotted against date and a linear regression line plotted. The slope (and its statistical significance) of the regression line indicates any trend in the data.

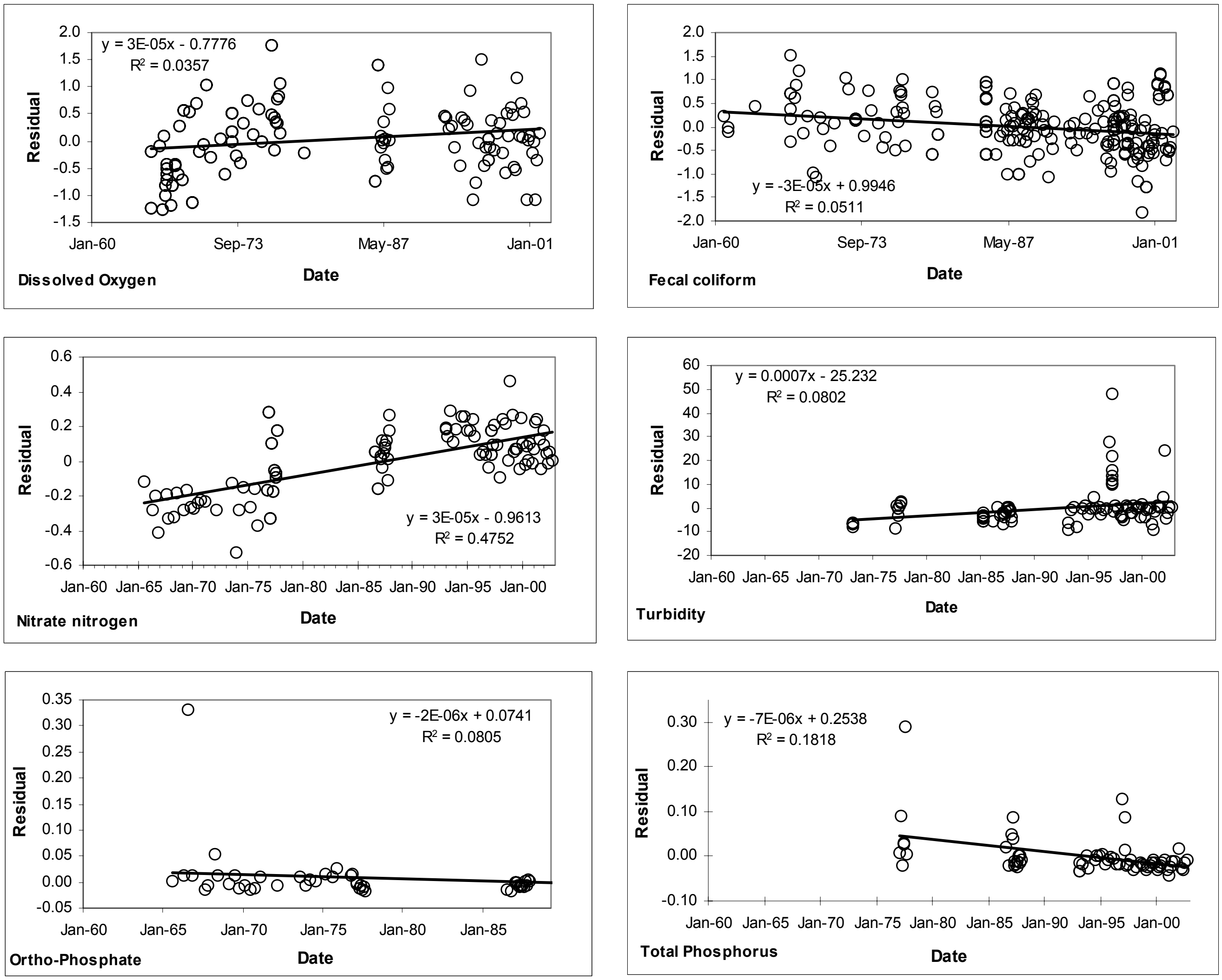

Figure 3.17. Residual plots for dissolved oxygen, fecal coliform bacteria, nitrate-nitrogen, ortho phosphate-phosphorus, total phosphorus, and turbidity. All trends lines shown are statistically significant at $p \leq 0.05$.

improving, whereas nitrate-nitrogen conditions are deteriorating (concentrations are increasing) in the Trask River watershed.

3.1.6 AQUATIC SPECIES AND HABITAT

3.1.6.1 Fish and Fish Habitat

Anadromous salmonid species known to occur in the Trask River watershed include chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), chum salmon (*O. keta*), steelhead trout (*O. mykiss*), and sea-run cutthroat trout (*O. clarkii*). Although details of their life histories and habitat requirements differ substantially, all spawn in fresh water, migrate through the estuary, and rear for varying lengths of time in the ocean before returning to their natal streams to complete their life cycle. Resident cutthroat trout are also present throughout the Trask River watershed.

The National Oceanic and Atmospheric Administration (NOAA) fisheries division, has listed coho salmon as Threatened along the Oregon Coast. Coastal cutthroat and steelhead are candidates for listing. Listing for chum and chinook was not warranted as determined by NOAA, although chum is listed as Threatened under the State of Oregon's Endangered Species Act. Coastal cutthroat and Pacific lamprey (*Lampetra tridentate*) are listed as State Species of Concern (Table 3.17). Pacific lamprey, together with three other lamprey species, have recently been included in a petition for T&E listing with the U.S. Fish and Wildlife Service (USFWS).

Table 3.17. Listing status of fish species.

Fish Species in the Trask River watershed	Federal Status	ODFW Status
Chinook Salmon	--	--
Coho Salmon	Threatened	Critical
Chum Salmon	--	Critical
Steelhead	Candidate	Vulnerable
Coastal Cutthroat Trout	Species of Concern	Vulnerable
Pacific Lamprey	Species of Concern	Vulnerable
River Lamprey	Species of Concern	Vulnerable
Sculpin	--	--
Stickleback	--	--

Coho Salmon

Juvenile coho salmon normally spend one summer and one winter in fresh water. They migrate to the ocean in the spring, generally one year after emergence. Most adults mature at 3 years of age (ODFW 1995).

Coho salmon populations along the entire Oregon coast are considered by ODFW to be depressed. The record of coho abundance over the past 52 years shows a trend of decline (Jacobs et al. 2002). Historically, the Trask River was an important producer of coho salmon (TBNEP 1998a), contributing significantly to the Tillamook Bay population. The annual commercial catch for the Tillamook Bay during the 1930s ranged from 25,000 to 74,000. By the late 1980s, the total combined harvest of naturally-produced Tillamook Bay coho was estimated to average 3,500 annually (Bodenmiller 1995). The recreational catch of coho in Tillamook Bay and its tributaries has been estimated since 1975, based on angler salmon/steelhead reporting tag returns. Harvest rates averaged 1,785 fish annually and have shown wide interannual variation (TBNEP 1998a).

The distribution of coho salmon within the Trask River watershed is shown in Plate 6. Recently, there have been signs of improvement in coho population abundance. The number of returning adult spawners has increased in recent years from the historically low levels observed in 1997 and 1998. The number of adult spawners observed in peak counts in the Trask River watershed in 2001 averaged 4.6 per mile, and in 2002 averaged 18.0 per mile. Although an estimate of the

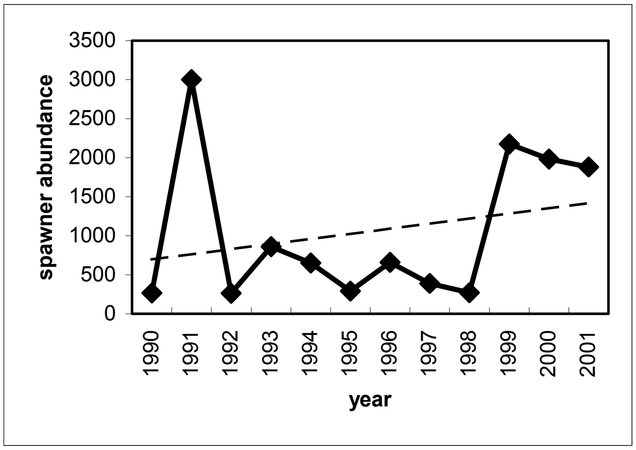

Figure 3.18. Wild coho spawner abundance in the Tillamook Basin, 1990-2001 (Jacobs et al. 2002).

size of the overall wild coho spawner population has not been determined for the Trask River separately from other Tillamook Bay runs, preliminary data for combined Tillamook Bay runs estimated an adult spawner population of 1,956 in 2001 and 2,158 in 2002, in contrast to the record low of 271 in 1998 (Jacobs et al 2002; Figure 3.18).

Medium and large streams throughout the Trask River watershed, including all subwatersheds, provide habitat for coho. Spawning and rearing occur primarily in the mainstem streams in the South Fork, East Fork of the South Fork, and the North Fork subwatersheds.

Chinook Salmon

Both fall and spring chinook salmon are present in the Trask River watershed. Chinook salmon populations exhibit a wider range of life history strategies than coho or chum salmon (Nicholas and Hankin 1989). Generally, subyearling juveniles rear in coastal streams from three to six months and rear in estuaries from one week to five months. Chinook salmon usually enter the ocean during their first summer or fall (ODFW 1995). Mature fall chinook (2 to 6 years of age) return to the Trask River from early September through mid-February. Peak entry into the watershed occurs in mid-October, and spawning from October to January. Spring chinook enter the Trask River from April through June, peaking in May (Nicholas and Hankin 1988). Spawning begins as early as the first week in September and peaks during the last week of September or first week of October (TBNEP 1998a).

In the Tillamook Basin, there has been a declining trend for fall chinook over the past 16 years, in contrast to the increasing or stable trends for populations elsewhere along the Oregon coast. Peak counts for the basin have declined from over 100 spawners per mile to less than 50 per mile from 1986 to 2001 (Jacobs et al. 2002).

Chinook use the mainstem Trask River from the Lower Trask subwatershed high into the upper watershed (Plate 7). Fall chinook are found extensively in the large tributary streams throughout the watershed, spawning and rearing in every subwatershed of the Trask River watershed. Spring chinook are also widespread, spawning and rearing in all subwatersheds except Elkhorn Creek (Plate 7).

Chum Salmon

The chum salmon rears in the Pacific and Arctic oceans. Chum salmon in Oregon require typical low gradient, gravel-rich, barrier-free freshwater habitats and productive estuaries. Most of the chum salmon life span is spent in a marine environment. Adults are strong swimmers, but poor jumpers, and are restricted to spawning areas below barriers, including minor barriers that are easily passed by other anadromous species. Juveniles are intolerant of prolonged exposure to freshwater and migrate to estuarine waters promptly after emergence. A brief residence in an estuarine environment appears to be important for smoltification and for early feeding and growth. Chum salmon mature at 2 to 6 years of age and may reach sizes over 40 pounds (ODFW 1995).

Chum have not been monitored in the Trask River watershed, so population abundance and trend information is not available specific to the Trask. However, ODFW has collected peak counts of spawning chum salmon since 1948 in the Kilchis, Miami, and Wilson River watersheds (Figure 3.19). Despite high interannual variability, the chum population has been declining since 1954, reaching a low of 30 fish per mile in 1996. In 2001, peak counts jumped up to 303 per mile, the highest density in 15 years (Jacobs et al. 2002).

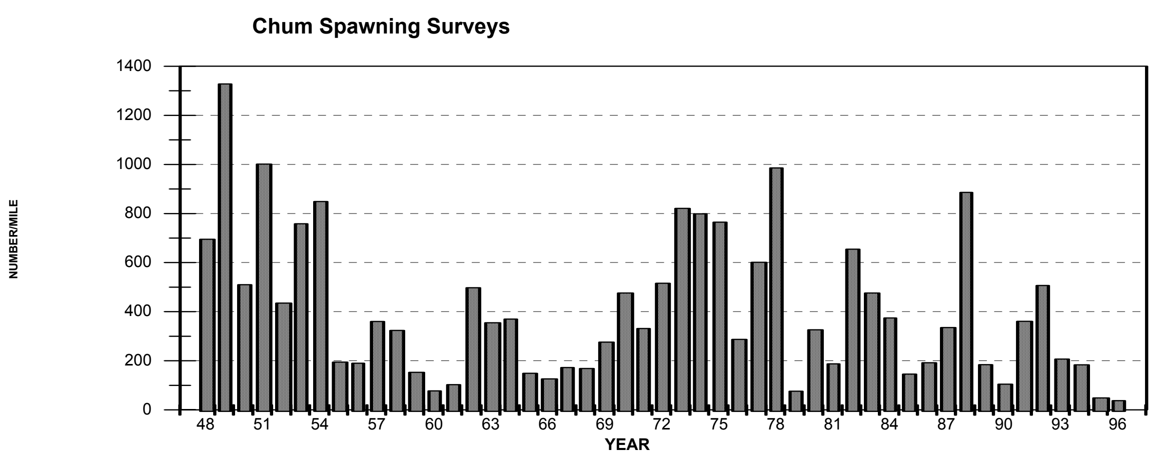

Figure 3.19. Results from chum salmon spawning surveys in the Tillamook Basin. (Source: TBNEP 1998a)

Chum salmon use only the lowest portions of the Trask River watershed, never extending upstream above the Lower Trask subwatershed (Plate 6). Most of the spawning occurs in the lower reaches of the main river channels or in small floodplain streams tributary to the lower river channels (TBNEP 1998a). Recent habitat trend information for these areas is not available.

Coastal Cutthroat Trout

Coastal cutthroat trout exhibit diverse patterns in life history and migration behavior. Populations of coastal cutthroat trout show marked differences in their preferred rearing environment (river, lake, estuary, or ocean); size and age at migration; timing of migrations; age at maturity; and frequency of repeat spawning. Anadromous populations migrate to the ocean (or estuary) for usually less than a year before returning to freshwater. Anadromous cutthroat trout either spawn during the first winter or spring after their return or undergo a second ocean migration before maturing and spawning in freshwater. Anadromous cutthroat are present in most coastal rivers. Resident forms of coastal cutthroat trout occur in small headwater streams and may migrate within the fresh waters of the river network (i.e. potadromous migration). They generally are smaller, become sexually mature at a younger age, and may have a shorter life span than many anadromous cutthroat trout populations. Resident cutthroat trout populations are often isolated and restricted above waterfall barriers, but may also coexist with other life history types.

Less is known about the present status of sea-run cutthroat trout than the other anadromous salmonid species in the Trask River watershed. The smallest of the anadromous salmonids present in the watershed, they have not been fished commercially. Although sea-run cutthroat trout are harvested in the recreational fishery, their numbers are not recorded on salmon/steelhead report tags. Therefore, determination of trends in abundance cannot be made on the basis of catch data. Beginning in 1997, sea-run cutthroat trout angling regulations were changed to “catch and release” only (TBNEP 1998a); in 2003, regulations were changed to “limited catch” only. They spawn in small headwater tributaries in late winter and early spring when water conditions are generally poor for viewing. Age at spawning is highly variable (2 to 10 years) and individual adults may spawn more than once during their lifetime (Emmett et al. 1991).

The only attempt to routinely count sea-run cutthroat has been resting pool counts made by ODFW staff since 1965 in conjunction with summer steelhead counts in the Wilson and Trask Rivers (Figure 3.20). Note that holding pool surveys were not conducted on the Wilson River in 1975 or 1978 or on the Trask River in 1975, 1977, or 1978. The resting hole count results are presented as average number of fish per hole to allow comparison from year to year despite

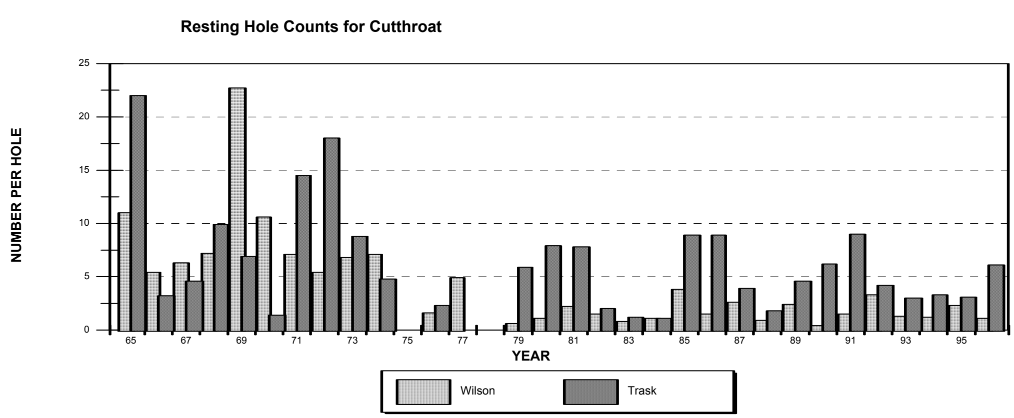

Figure 3.20. Resting hole counts for cutthroat trout (Source: TBNEP 1998a)

differences in the number of holes surveyed. These data suggest that numbers of sea-run cutthroat trout in resting holes may have been somewhat higher before the mid-1970s than they have been since.

Steelhead Trout

Steelhead trout include a resident phenotype (rainbow trout) and an anadromous phenotype (coastal steelhead). Steelhead express a further array of life histories, including various freshwater and saltwater rearing strategies and various adult spawning and migration strategies. Juvenile steelhead may rear one to four years in fresh water prior to their first migration to saltwater. Saltwater residency may last one to three years. Adult steelhead may enter freshwater on spawning migrations year round if habitat is available for them, but generally spawn in the winter and spring. Both rainbow and steelhead may spawn more than once. Steelhead return to saltwater between spawning runs.

Winter steelhead are native to, and are widely distributed throughout, the Trask River watershed. Winter steelhead generally enter streams from November through March and spawn soon after entering freshwater. Age at the time of spawning ranges from 2 to 7 years, with the majority returning at ages 4 and 5 (Emmett et al. 1991). Summer steelhead were introduced in the early 1960s and were supported entirely by hatchery production (TBNEP 1998a).

The only information available for assessing trends in the abundance of steelhead runs in Tillamook Bay streams is angler salmon/steelhead report tags and holding pool counts for summer steelhead. The combined recreational catch of winter steelhead for all five subbasins and Tillamook Bay shows a declining trend since the early 1970s. The recreational catch declined from a high of more than 20,000 in 1970 to fewer than 2,000 in 1993. The trend in the combined catch reflects the trends seen in each of the individual subbasins. However, counts of summer steelhead in resting pools in the Wilson and Trask Rivers since 1965 (Figure 3.21) suggest that numbers of fish in resting pools were at least as high in the late 1980s as they were during much of the 1970s (TBNEP 1998a).

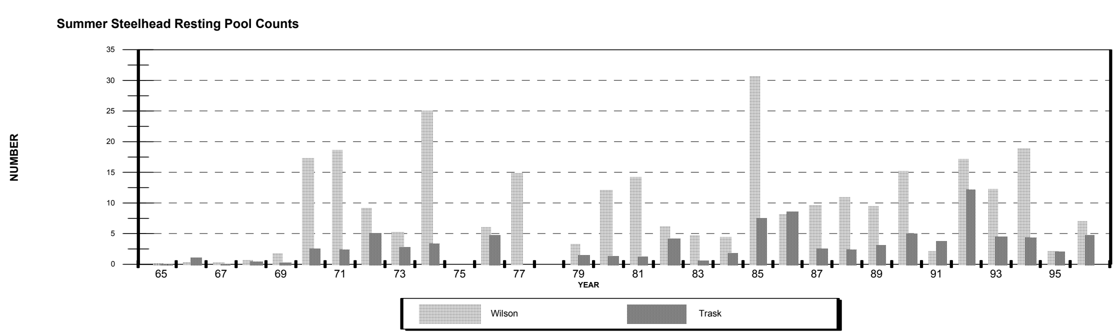

Figure 3.21. Resting pool counts of summer steelhead trout in the Wilson and Trask Rivers. (Source: TBNEP 1998a).

Both winter and summer steelhead use the entire Trask River watershed (Plate 8). Winter steelhead are found in more of the smaller tributaries than summer steelhead, including small tributaries in the upper subwatersheds. Both summer and winter steelhead benefit from structurally complex streams with large in-stream wood, floodplains, beaver ponds, braided channels, and coastal marshes and bogs.

Other Fish Species

Other fish in the watershed include Pacific lamprey, sculpins (*Cottus* sp.), and stickleback (*Gasterosteus aculeatus*). Some sturgeon (*Acipencer sp.*) may enter in tidewater for short periods of time (Keith Braun, ODFW, pers. comm., 2003). There are almost no data regarding population abundance, extent, and distribution of these species in the Trask River watershed. No fish species are known to have been extirpated (Keith Braun and Steve Jacobs, ODFW, pers. comm., 2003).

Hazards and Limiting Factors

Fish that occur within the Trask River watershed face a number of hazards and limiting factors. Particularly important in this regard are likely impediments to fish passage at road crossings, high water temperature, and habitat degradation. There are few documented impediments to fish passage, but there exist many road-stream crossings where poorly designed culverts may constitute barriers, especially to juvenile fish. High temperatures appear to be a problem in mainstem reaches throughout much of the watershed, although summer maximum water temperatures are somewhat cooler in the South Fork mainstem than elsewhere within the watershed. Habitat degradation has occurred basin-wide. In particular, in-stream LWD and future recruitment potential are limited due to past logging and fires and the scarcity of riparian conifers, and the frequency and depth of pools have been reduced. In addition, off-channel refugia and wetland areas, which provide important shelter from high-flow conditions and rearing habitat, have been substantially reduced and/or disconnected from the river system, especially in the lower watershed.

Hatcheries and Fish Stocking

Hatchery coho were stocked in the Tillamook Basin, almost without interruption, from 1902 to the early 1990s. Returns of hatchery fish to the Trask River hatchery for the period 1985 to 1992 ranged from 1,245 to 10,174, with an average of 5,231 (TBNEP 1998a). In 1998, hatcheries began marking all hatchery-raised fish with an adipose fin-clip, making it possible to accurately distinguish returning wild fish from hatchery fish. Results from the past four years for the northern Oregon Coast have shown that wild fish were the dominant component of naturally spawning populations of coho (Jacobs et al 2002).

Fall and spring chinook are also stocked in the Trask River. The Trask River chinook broodstock has been used to stock the Kilchis, Wilson, and Nestucca Rivers, as well. Adipose fin-clips have also shown a low proportion of hatchery chinook on the spawning grounds.

Summer steelhead were introduced to the Trask River watershed, but have not been stocked for approximately 50 years. The present summer steelhead population is composed entirely of hatchery strays from the neighboring Wilson River (Keith Braun, pers. comm., 2003).

Oregon has never had a large chum salmon hatchery program, and there are currently no state hatchery programs for the species. Chum salmon probably have been impacted by coho salmon hatchery programs releasing large numbers of hatchery smolts into estuaries that are used by rearing juvenile chum. Coho salmon juveniles have been shown to be a major predator on chum juveniles in the Northwest (Hargreaves and LeBrasseur 1986). Juvenile chum salmon may also be affected by large releases of fall chinook salmon hatchery fish, particularly pre-smolts, since fall chinook juveniles also rear in estuaries and may compete with chum juveniles (ODFW 1995). Hatchery coho may also have contributed to the decline of wild coho salmon, through competition for food, outbreeding depression, and introduction of disease (Hemmingston et al. 1986, Ryman and Laikre 1991, Nickelson et al. 1986).

Aquatic Habitat Conditions

To assess current in-stream habitat conditions within the Trask River watershed, we have compiled fish habitat survey data collected according to the ODFW protocols (Moore et al. 1997). To interpret the habitat survey data, ODFW has established statewide benchmark values as guidelines for an initial evaluation of habitat quality (Table 3.18). The benchmarks rate conditions as “desirable”, “moderate”, or “undesirable” in relation to the assumed natural regime of these streams. These values depend upon climate, geology, vegetation and disturbance history, and can help to identify patterns in habitat features that are affected by watershed processes.

Table 3.18. Stream channel habitat benchmarks. (Source: WPN 1999)

Parameter	Subfactor	Units	Good	Fair	Poor
Area		% of channel area	>35	>10 and <35	<10
Pool frequency		# of channel widths	>8	> 8 and <20	<20
Pool depth	gradient <3% or <7m (23 ft) wide	meters	>0.5	>0.2 and <0.5	<0.2
	gradient >3% or >7m (23 ft) wide	meters	>1.0	>0.5 and <1.0	<0.5
Gravel available		% of area	>35	>15 and <35	<15
LWD density[a]		# pieces/100m (328 ft)	>20	>10 and <20	<10
LWD volume		cubic m/100m (328 ft)	>30	>20 and <30	<20
Key LWD[b] density		# pieces/100m (328 ft)	>3	>1 and <3	<1

[a] LWD is defined as >50 cm (20 in) diameter and longer than the width of the ‘active’ channel.
[b] Pieces that are at least 0.6 m (2 ft) in. diameter and 10 m (32.8 ft) long.

Since 1996, 23 creeks and rivers have been surveyed in the Trask River watershed, totaling approximately 109 miles of the stream network (Plate 9). The large flood event of 1996 altered LWD conditions in the watershed and probably introduced some new LWD to the stream network. High-velocity peak flows in 1998 and 1999 further altered LWD conditions. Stream channels still lack LWD in general, although this problem has recently been partially alleviated through operation stump drop, which has added LWD, especially to the East Fork of the South Fork. The condition of LWD in the system is dynamic, and while watershed-scale assessments can provide information useful for prioritizing restoration activities, all sites should be field-verified before specific restoration actions are planned.

Figure 3.22 summarizes important measures of stream habitat, following OWEB guidelines and ODFW benchmarks. For each subwatershed, the miles of "desirable", "moderate", and "undesirable" stream conditions are shown for each of the summarized stream habitat characteristics. The percentage of total stream length is displayed at the bottom of each figure.

Overall, pool and gravel conditions are most desirable in the North Fork of the North Fork, the Middle Fork of the North Fork, and the Upper Trask subwatersheds, although LWD conditions are almost completely undesirable in these subwatersheds. The North Fork and South Fork subwatersheds show the greatest proportions of moderate and desirable conditions overall, although approximately a third of the pool depths are undesirable, and undesirable LWD conditions are common. The East Fork of the South Fork is unusual, having far worse pool area and frequency conditions than the other subwatersheds, although LWD volume and density are predominantly desirable and moderate.

In general, LWD conditions are undesirable throughout the Trask River watershed, although there is a high proportion of desirable and moderate LWD volume and density conditions in the Elkhorn and East Fork of the South Fork subwatersheds. The density of key LWD pieces (LWD that is currently providing functional habitat) is predominantly undesirable in every subwatershed in the Trask, even in those which have high proportions of LWD volume and density.

Stream shade conditions throughout the Trask River watershed are desirable overall, with all subwatersheds except the Lower Trask reporting a predominance of high shade conditions. However, the length of the Trask River mainstem from Tillamook Bay to the Upper Trask subwatershed has undesirable shade conditions, ranging from 20 to 44% shaded. Near the Bay, the width of the river limits the potential for stream shading by vegetation, and it is possible that stream shading in the lower reaches of the mainstem did not meet the ODFW "desirable" benchmark in historical times. However, it is also likely that the channel is substantially wider in some places now than it was previously, especially in the lower reaches (U.S. EPA 2001), and this can influence the effectiveness of riparian shade.

In addition to the ODFW data on stream shading, a graduate student was contracted by ODF in 2002 to conduct a study of riparian conditions on ODF lands in the watershed (Falcy 2002). In this study, OWEB procedures were followed to analyze stream shading (or more accurately stream cover) by examination of aerial photographs. OWEB guidelines specify that if streambanks are visible throughout the photos, then the amount of shading is low; if the water surface is visible, but not the banks, then shading is medium; and if the water surface is only

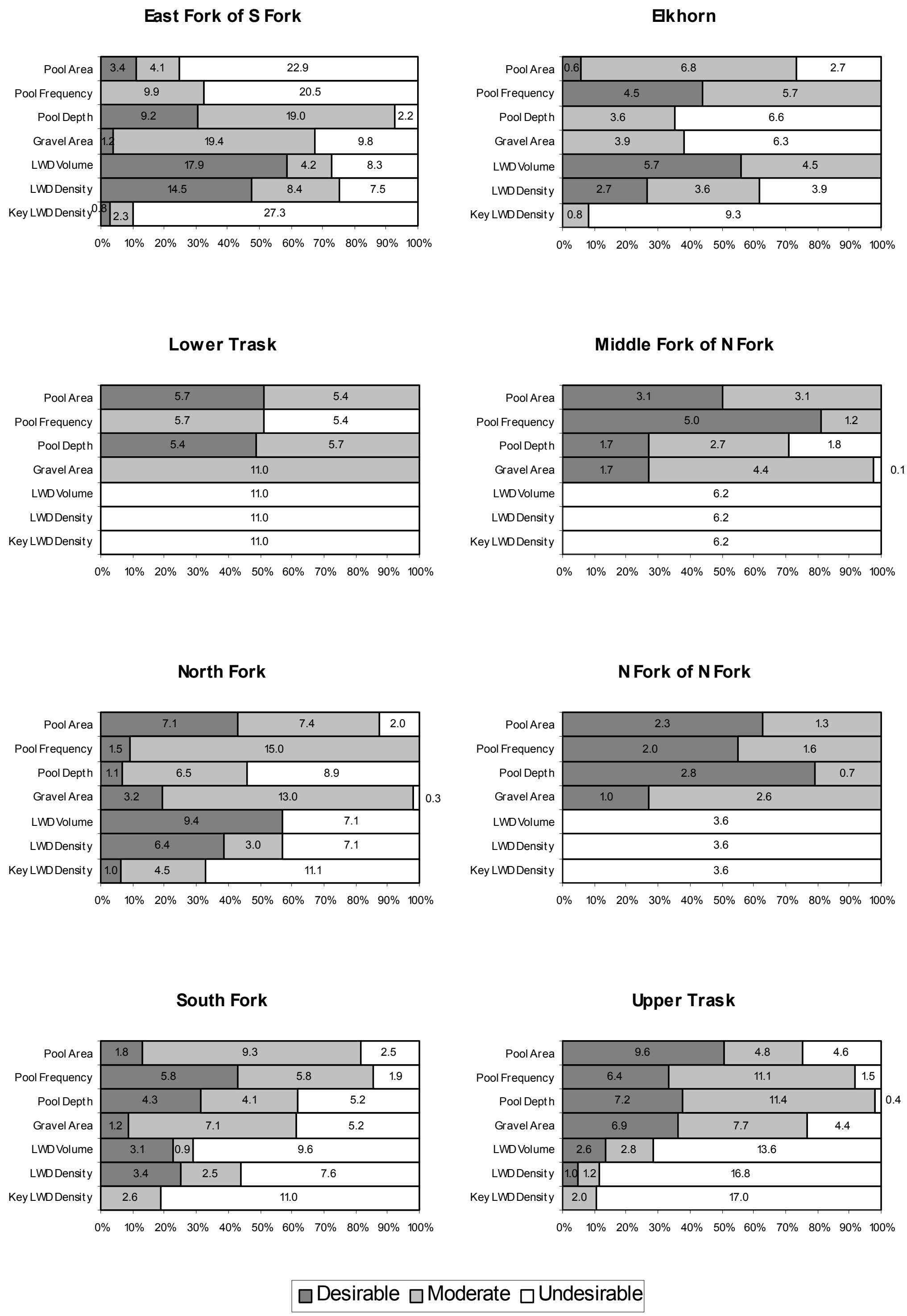

Figure 3.22. Stream habitat conditions, by subwatershed. The numbers within the bars are given in miles of stream length. The numbers along the x-axis reflect percentages of the stream length surveyed.

partially visible, then shading is high (Falcy 2002, WPN 1999). This analysis provided essentially the same result as the ODFW surveys: stream shading was estimated to range from 86 to 98% everywhere except in the Lower Trask subwatershed, where estimated stream shading was 43%.

Large woody debris recruitment potential was rated as undesirable throughout the Trask River watershed, based on ODFW data. The density of large trees was undesirable in all subwatersheds, for both ODFW benchmarks (conifers larger than 20 in. dbh per 1,000 ft of stream, and conifers larger than 36 in. dbh per 1,000 ft of stream). For most surveyed stream reaches, there were no conifers in either of those ODFW size classes.

Large woody debris recruitment was also analyzed by Falcy (2002) for ODF, following the OWEB guidelines (WPN 1999). Riparian vegetation in two parallel zones on each side of the streams was classified by tree size class (dbh), vegetation type (conifer, hardwood, or mixed), tree stand density (dense or sparse), and stream channel constraint (unconstrained, semi-constrained, and constrained). The first riparian zone (RA1) was variable in width, depending on channel constraint and stream size, ranging from 25 ft to 75 ft from the edge of the active channel. The second riparian zone (RA2) extended from 100 ft from the edge of the active channel, regardless of the width of RA1, to the edge of RA1 (e.g., if RA1 is 75 ft, then RA2 is only 25 ft wide; but if RA1 is 50 ft wide, RA2 is also 50 ft wide; Falcy 2002, WPN 1999). Vegetation conditions were then compared with OWEB benchmarks for conditions necessary to provide 'adequate' LWD recruitment (i.e. the ability of the riparian zone to keep the stream channel supplied with LWD). The OWEB benchmark for the "adequate" classification for RA1 was dense, medium-sized (12 to 24 in. dbh) hardwoods. Larger trees, especially conifers, are considered to provide higher quality LWD. The OWEB benchmark for RA2 was dense, large (>24 in. dbh) conifers, except along unconstrained reaches, where dense, large mixed conifers and hardwoods are considered adequate (Falcy 2002, WPN 1999).

In general, LWD recruitment potential was adequate in RA1, and inadequate in RA2, according to OWEB methods (Table 3.19). Adequate LWD recruitment potential accounted for over 90% of the RA1 riparian zones in all of the upland subwatersheds, except for the Upper Trask subwatershed, for which it was 69%. LWD recruitment potential in the Lower Trask subwatershed, on the other hand, was adequate in only 58% of the RA1 riparian zone. Adequate LWD recruitment potential conditions in RA2 ranged from 4% in the Upper Trask subwatershed to 31% in the Middle Fork of the North Fork subwatershed. The Elkhorn Creek subwatershed had the second-highest proportion of adequate LWD recruitment potential in RA2, at 29%. Overall, LWD recruitment potential is probably least in the Lower Trask and Upper Trask subwatersheds (Table 3.19).

Although recruitment potential is considered "adequate" for RA1 based on the OWEB benchmark (medium-sized hardwoods), the lack of large conifers in RA2 indicates a potential overall worsening in LWD conditions in the future, because RA1 contains mainly hardwoods. Large conifers will not be available any time soon from RA2 to provide LWD to the stream channel (Falcy 2002).

Table 3.19. Area and percentage of "adequate" LWD recruitment potential for two riparian zones (RA1 and RA2), based on analyses by Falcy (2002).				
	RA1		RA2	
Subwatershed	Acres	%	Acres	%
East Fork of South Fork of Trask River	1468	96	523	17
Elkhorn Creek	509	93	315	29
Lower Trask River	11	58	4	9
Middle Fork of North Fork of Trask River	447	91	286	31
North Fork of North Fork of Trask River	347	91	130	17
North Fork of Trask River	1552	95	222	6
South Fork of Trask River	1034	95	207	9
Upper Trask River	583	69	80	4
Total	5953	91	1766	13

There are relatively few known barriers to fish passage in the Trask River watershed, other than the Trask River hatchery on Gold Creek and the Barney Reservoir Dam. Several waterfalls are also known passage barriers: two in Bark Shanty Creek, and one in Rock Creek. However, based on the number of road-stream crossings, there may be many culverts that are inhibiting fish passage (Plate 10).

3.1.6.2 Amphibians

Several species of amphibian occur in the Trask River watershed, although no amphibian surveys have been conducted and their distribution is not known. Amphibians are particularly sensitive to environmental change, in part because their complex life cycles expose them to hazards in both the aquatic and terrestrial environments. Most amphibians require cool, moist conditions to maintain respiratory function. Many are highly specialized and have specific habitat requirements, such as association with headwater streams or LWD. The following species (and perhaps others) appear to have suitable habitat, and may occur, within the watershed:

Northern red-legged frog (*Rana aurora aurora*)

This species requires emergent riparian vegetation near deep, still or slow-moving ponds or intermittent streams. These well-vegetated areas are needed for escaping from predators, for providing shade to maintain cool water temperatures, and as shelter, especially during the winter. Red-legged frogs move out of riparian zones into nearby upland forest during non-breeding seasons.

Tailed frog (*Ascaphus truei*)

Tailed frogs are stream dwellers that do not inhabit ponds or lakes. Tadpoles are often numerous and easily found by turning over rocks in streams. At night the frogs emerge and feed upon insects found along the stream and in the moist woods near the stream.

Columbia torrent salamander (*Rhyacotriton kezeri*)

These salamanders live at the edges of clear, cold mountain streams; they can be abundant under gravel at stream edges and in the spray zones of waterfalls. During rainy seasons, they are occasionally found on land away from streams. The Columbia torrent salamander is the only BLM Special Status Species amphibian in the Trask River watershed.

3.1.6.3 Reptiles

No reptile species of concern have been identified in the Trask River watershed. The western pond turtle (*Clemmys marmorata*) has been known to occur in small ponds and marshes in the Coast Range, but there is no documentation of its existence within the Trask River watershed. For a list of other sensitive species, see Table 1.3.

3.1.6.4 Wetland Species and Habitat

Wetland habitats constitute critical sources of biological diversity. The National Wetlands Inventory (NWI) has mapped wetlands within the Lower Trask River subwatershed. While wetlands also exist in the upper areas of the Trask River watershed, they are rare and poorly documented. The FMP provides guidance for the management of wetlands on state lands. Within the Lower Trask River subwatershed, 6.7% of the area has been designated as wetland by NWI. Of the wetland area, the majority (80%) is of palustrine type with most designated as emergent and forested. Other types of wetlands surveyed by NWI are riverine (18%) and estuarine (2%; Table 3.20).

Salmonid species within the Trask River watershed depend on wetland habitat for rearing. In particular, chum salmon spawn primarily in portions of the lower Trask River watershed and may depend heavily on estuarine wetlands. Riparian and wetland areas also provide habitat for many bird species. Seasonal flooding of fields in the lower watershed provides temporary habitat for species such as Aleutian and dusky Canada goose (*Branta canadensis leucopareia; Branta canadensis occidentalis*) and many other species of waterfowl.

Table 3.20. Wetlands from NWI maps. All wetlands are located in the Lower Trask River subwatershed.

System	Subsystem	Class	Water Regime	Other	Acres	Percent
Estuarine	Subtidal	Unconsolidated Bottom	Subtidal	N/A	15	1.6
	Intertidal	Emergent	Regularly Flooded	N/A	4.1	0.4
		Unconsolidated Shore		N/A	0.3	0.03
Palustrine		Aquatic Bed	Permanently Flooded	N/A	0.3	0.03
				Excavated	0.4	0.05
			Permanent-Tidal	N/A	10	1.0
		Emergent	Saturated	N/A	7.5	0.8
			Seasonally Flooded	N/A	107	11
				Partially Drained/Ditched	330	34
				Diked/Impounded	1.4	0.1
			Semipermanently Flooded	Excavated	2.0	0.2
			Seasonal-Tidal	N/A	1.3	0.1
		Forested	Temporarily Flooded	N/A	200	21
			Seasonally Flooded	N/A	51	5.3
			Seasonal-Tidal	N/A	1.4	0.1
		Scrub/Shrub	Seasonally Flooded	N/A	45	4.7
				Excavated	3.5	0.4
		Unconsolidated Bottom	Semipermanently Flooded	N/A	1.4	0.1
				Excavated	0.8	0.1
			Permanently Flooded	N/A	3.6	0.4
				Diked/Impounded	0.5	0.1
				Excavated	4.5	0.5
Riverine	Tidal	Unconsolidated Bottom	Permanent-Tidal	N/A	37	3.8
	Lower Perennial		Permanently Flooded	N/A	118	12
		Unconsolidated Shore	Seasonally Flooded	N/A	16	1.6
Total					962	100

3.2 TERRESTRIAL ECOSYSTEMS

3.2.1 ROADS

3.2.1.1 Road Density and Hillslope Position

In order to provide a general sense of the density of roads throughout the watershed, we calculated the miles of road, by subwatershed. The BLM general transportation GIS layer was used for this analysis, because it includes all ownerships in the watershed, and has a similar density to the ODF roads layer. Based on the GIS analysis, road density ranges from 2.8 mi/sq mi in the Middle Fork of the North Fork subwatershed to 5.6 mi/sq mi in the Lower Trask subwatershed. The average road density in the watershed is 3.7 mi/sq mi (Table 3.21). It should be noted, however, that there are many undocumented legacy roads in the watershed, and therefore the road density might actually have been considerably higher if those roads had been included in the analysis.

Table 3.21. Road density in the Trask River watershed, based on BLM GIS data.

Subwatershed	Area (mi^2)	Road Density mi/mi^2
East Fork of South Fork of Trask River	29	3.6
Elkhorn Creek	17	3.8
Lower Trask River	22	5.6
Middle Fork of North Fork of Trask River	13	2.8
North Fork of North Fork of Trask River	13	5.6
North Fork of Trask River	29	3.0
South Fork of Trask River	23	2.8
Upper Trask River	28	3.2
Total	175	3.7

The road density statistic does not incorporate important characteristics of roads, such as the topographic position of roads in the landscape. A more useful measure of roads from the perspective of sediment and water quality is road slope position. Road slope position information was not available for roads on BLM lands, but was available from the ODF road inventory. Three road slope positions were recorded: valley, midslope and ridge (Table 3.22). For inventoried ODF roads in the Trask River watershed, the majority were midslope roads. The proportion of midslope roads ranged from 47% in the Lower Trask to 77% in the Elkhorn Creek subwatershed. The North Fork had the greatest length of midslope roads (35 mi). Ridge roads were the next prevalent, ranging from 20% in Elkhorn Creek to 53% in the Lower Trask, with an average of 27% for the watershed overall. Valley roads were the least common, ranging from 3% in Elkhorn Creek to 13% in the South Fork of the Trask subwatershed.

3.2.1.2 Condition of Roads

In the Trask River watershed, approximately 148 miles of ODF roads were inventoried, following the guidelines provided in the ODF Forest Roads Manual. Information was gathered in the field, including the condition and location of road fill material and culverts. Since the

Table 3.22. Miles and percent of roads within each subwatershed that were classified as midslope, ridge, or valley topographic position. (Source: ODF road inventory)

Subwatershed	Miles (%) of Road			
	Midslope	Ridge	Valley	Total
East Fork of South Fork of Trask River	29 (65)	12 (27)	4 (8)	45 (100)
Elkhorn Creek	17 (77)	4 (20)	0.7 (3)	22 (100)
Lower Trask River	0.4 (47)	1 (53)	-	1 (100)
Middle Fork of North Fork of Trask River	0.01 (100)	-	-	0 (100)
North Fork of Trask River	35 (67)	15 (29)	2 (4)	52 (100)
South Fork of Trask River	19 (58)	10 (30)	4 (13)	33 (100)
Upper Trask River	19 (64)	8 (27)	3 (9)	30 (100)
Total	120 (65)	50 (27)	13 (7)	183 (100)

majority of ODF roads in the watershed (and virtually all of the roads on steep slopes) occur within the Tillamook District, and the GIS routing of the road inventory was not complete at the time of this analysis, Forest Grove District roads were not examined here. It should be noted that road maintenance is an ongoing process, and many of the issues recorded in the Road Inventory may have already been addressed.

The Tillamook District Road Inventory provided information regarding the condition of road fill in the watershed (Table 3.23, Plate 12). Fill condition was rated as good or conforming (i.e. fillslope was not excessively steep) for two-thirds of the surveyed road (97.4 mi). Steep fillslopes (i.e., steeper than the natural slope) were by far the most common road fill concern, recorded for 30% of the surveyed road length (44.8 mi). The North Fork, Upper Trask, and South Fork subwatersheds had the most miles of road with steep fillslopes (13.4, 11.1, and 10.0 mi, respectively). The Lower Trask and Middle Fork of the North Fork subwatersheds recorded no steep road fill conditions (Table 3.23).

Approximately 5% of the surveyed road length (5.7 mi) showed indication of water seeping or flowing through the fill. Most of the road found to have water emerging from the fill was in the East Fork of the South Fork subwatershed (5.4 mi). The remaining 0.4 mi was identified in the South Fork of the Trask subwatershed. In one location in the North Fork of the Trask subwatershed, the road fill was recorded as “gone”, which presumably indicates a slide, slump, or gullying.

Road surface drainage conditions were not provided as part of the Road Inventory, so we were unable to assess the conditions of ditches, cutslopes and road surface, or the probability of sediment delivery from surface drainage (c.f., ODF Forest Roads Manual Appendix 1: Protocol for Road Hazard Inventories).

Table 3.23. Surveyed road condition length (miles) by subwatershed								
	Miles of Road Reported in Category							
Designated Category	EF of SF Trask	Elkhorn	Lower Trask	MF of NF Trask	NF Trask	SF Trask	Upper Trask	Grand Total
Fill Condition								
Steep	6.5	3.7			13.4	10.0	11.1	44.8
Water	5.4					0.4		5.7
Gone					0.1			0.1
Conforms	5.8	2.1	0.8		17.2	9.5	8.8	44.2
Good	27.1	0.2			18.8	5.1	2.0	53.2
Downslope Risk								
High	13.7	5.1			12.1	0.8	0.4	32.1
Moderate	20.7	0.6			19.3	16.0	9.4	66.1
Low	10.4	0.2	0.8		18.1	8.2	12.2	49.9
Movement Indicators								
Cracks						3.8	1.5	5.3
Cracks/Drop	0.1				0.6	0.1		0.8
Cracks/Slide							1.4	1.4
Drop	0.5	0.2			9.9		4.7	15.2
Drop/Slide	1.5							1.5
Slide Activity	13.7				20.7	3.3	6.2	43.9
Slide/Crack						3.4		3.4
None	29.0	5.7	0.8		18.5	14.4	8.1	76.6
Total Length	44.8	5.9	0.8	0.0	49.6	25.1	22.0	148.1

3.2.1.3 High Risk Areas for Road-related Slope Failures

The locations of road fill movement indicators, including cracks in the roadbed, drops (sunken grade), slide activity (fillslope sliding or slumping), and various combinations of these indicators were recorded in the Road Inventory (Table 3.23). Almost one-third (32%) of the surveyed roads showed indications of slide activity, drop/slide activity, or slide/crack activity (48.8 mi), with nearly half of these road segments located in the North Fork subwatershed (20.7 mi). The East Fork of the South Fork had the second highest length of fillslope sliding (drop/slide and slide activity, Table 3.23; Plate 12) at 15.2 mi.

Drops in the roadbed were the second most commonly recorded road fill movement indicator, accounting for 10% of the surveyed road length of Trask roads in the Tillamook District (15.2 mi). The majority of the drops in the roadbed (9.9 mi) were in the North Fork subwatershed. Approximately 3.5% of the surveyed road showed cracks in the roadbed (5.3 mi), of which 3.8 mi were in the South Fork subwatershed, and 1.5 mi were in the Upper Trask subwatershed (Table 3.23; Plate 12).

On a percentage basis by subwatershed, the North Fork subwatershed had the greatest number of identified road issues (all movement indicators combined), at 63% (31.2 mi). The Upper Trask subwatershed was second highest, with 50% of the roads showing indications of movement (10.9 mi), and the South Fork third at 42% (10.6 mi). Although the East Fork of the South Fork had the second highest surveyed road mileage (44.8 mi), it had proportionally the least amount of road with indications of movement (35%; 15.8 mi).

A qualitative evaluation of the likelihood that fill material will reach a stream in the event of a road fill failure (referred to as downslope risk) was also provided in the Road Inventory (Table 3.23). Of the 148.1 miles of surveyed road, 22% (32.1 mi) were considered to pose a high risk of contributing sediment to a stream in the event of a fill failure. Moderate downslope risk accounted for 45% (66.1 mi) of the surveyed roads. The remaining third of the roads were estimated to pose a low downslope risk for sediment contribution (49.9 mi). On a percentage basis by subwatershed, the most road in the high downslope risk category was recorded in Elkhorn Creek (86%), although only 5.9 miles of road were surveyed in the subwatershed. Second highest was the East Fork of the South Fork (31%), with 13.7 miles of high downslope risk. Nearly one quarter (24%) of the roads in the North Fork subwatershed were in the high downslope risk category. In the other subwatersheds, the percentage of high downslope risk was small (i.e. < 4%).

3.2.1.4 Stream Crossings

The Tillamook District Road Inventory recorded 676 culverts in the Trask River watershed, of which 224 (33%) were stream crossings and 375 (55%) were cross drain culverts (Table 3.24). Spring crossings, bridges and log puncheons made up the remaining 77 (12%) culverts (Table 3.24). There were 22 (3%) collapsed or blown out culverts recorded. Culverts showing signs of mechanical damage, rust, sediment blockage, and other types of damage were also recorded. Rusted culverts were the most common (105 culverts; 16%), followed by sediment blockage (72 culverts; 11%). On ODF land, the Upper Trask had the most damaged (mechanical, rust, and sediment) stream crossing culverts in the watershed (21), whereas the fewest were recorded in the Lower Trask subwatershed (3).

Log puncheons were uncommon, except in the North Fork subwatershed, which had 21. All other subwatersheds had fewer than five log puncheons. Bridges were also relatively uncommon. One collapsed/blown out bridge was recorded in the East Fork of the South Fork subwatershed.

3.2.1.5 Access

Private non-commercial ownership in the Trask River watershed is concentrated along the mainstem river, and makes up a small proportion of the watershed. Private commercial ownership is apparent mostly at the edges of the watershed, such as in the upper portions of the North Fork of the North Fork and Elkhorn Creek subwatersheds. The majority of the forested uplands are comprised of large, contiguous blocks of public land. Consequently, road access issues are minimal. Easements allow passage through private lands where necessary for access.

Table 3.24. Number of surveyed culverts and stream crossings and existing condition per subwatershed[a]. (Source: ODF Tillamook District Road Survey)

Sub watershed	Structure/Crossing	Condition of Culvert Structure/Crossing							
		Good	Collapsed/ Blowout	Mechanical	Rusted	Sediment	Other	Unknown	Grand Total
EF of SF Trask	Stream Crossing	12	2	4	6	2	6		32
	Cross Drain	71		12	21	22	1		127
	Spring Crossing	8		3	9	1		2	23
	Log Puncheon		1						1
	Bridge		1				1		2
Total EF of SF Trask		91	4	19	36	25	8	2	185
Elkhorn	Stream Crossing	12		2	13	1	3	4	35
	Cross Drain	7	2	1	4	2		1	17
	Spring Crossing	1							1
	Log Puncheon	3	1				1		5
	Bridge	1							1
Total Elkhorn		24	3	3	17	3	4	5	59
Lower Trask	Stream Crossing				3				3
	Cross Drain				1	2			3
	Spring Crossing			1					1
	Log Puncheon								0
	Bridge								0
Total Lower Trask				1	4	2			7
NF Trask	Stream Crossing	31	5		4	4	8		52
	Cross Drain	50		5	1	9		4	69
	Spring Crossing	3							3
	Log Puncheon	9	9			1	1	1	21
	Bridge	2							2
Total NF Trask		95	14	5	5	14	9	5	147
SF Trask	Stream Crossing	21	4	6	11	2	7		51
	Cross Drain	45		7	15	5			72
	Spring Crossing			1					1
	Log Puncheon	2	2						4
	Bridge	2					1		3
Total SF Trask		70	6	14	26	7	8		131
Upper Trask	Stream Crossing	28		9	10	2	2		51
	Cross Drain	48	2	8	5	18		6	87
	Spring Crossing	3			2			1	6
	Log Puncheon		1			1			2
	Bridge	1							1
Total Upper Trask		80	3	17	17	21	2	7	147
Grand Total		360	30	59	105	72	31	19	676

[a] Not all of the Trask River watershed roads were surveyed

3.2.2 TERRESTRIAL WILDLIFE SPECIES AND HABITAT

The Trask River watershed contains a diversity of wildlife species, although abundance, distribution, and habitat information is lacking for most species. The focus of this section is on species whose populations are uncommon or at risk of being unviable. Terrestrial species in the Trask River watershed that have been federally listed as Threatened and Endangered (T&E) include the northern spotted owl (*Strix occidentalis caurina*), marbled murrelet (*Brachyramphus marmoratusus*), and bald eagle (*Haliaeetus leucocephalus*). Several other species are listed as state T&E species, Survey and Manage Species, BLM Special Status Species, and Species of Concern by the Oregon Natural Heritage Program (ONHP). A list of species of concern is presented in Chapter 1 (Table 1.3). Here we provide descriptions and available population and habitat condition information for key species believed to have suitable habitat in the watershed. In addition, black-tailed deer (*Odocoileus hemionus*) and Roosevelt elk (*Cervus elaphus roosevelti*), two common inhabitants of forest lands in the Trask River watershed, represent a valuable resource for hunting and wildlife viewing.

3.2.2.1 Mammals

<u>Voles</u>

Red Tree Vole

The red tree vole (*Arborimus longicaudus*), a small rodent found primarily in old-growth Douglas-fir stands, is an important food source of the northern spotted owl. Red tree voles are nocturnal and live in the canopy of large coniferous trees. They build nests using fir needles and feed primarily on the needles of Douglas-fir trees.

Red tree voles are considered an indicator species and have been designated as a Survey and Manage species by the Northwest Forest Plan (NWFP) ROD. They require large blocks of contiguous habitat or corridors connecting areas of suitable habitat. In the Oregon Coast Range, the average stand size utilized by this species is 475 acres (75 acre minimum; Maser 1981, Huff et al. 1992). Although found in stands as young as 40 years old, it is thought that stands less than 100 years old are unable to maintain viable populations (Carey 1991).

Habitat suitable for red tree voles is very rare in the Trask River watershed. A few patches of old-growth forest are present, such as on the northwestern edge of the Upper Trask subwatershed, although the presence of red tree voles has not been confirmed.

White-footed Vole

Found in mature, coastal forests, the white-footed vole (*Arborimus albipes*) usually inhabits the vicinity of small streams with dense alder and other deciduous trees and shrubs. This species occupies habitat from ground surface to canopy, feeding in all layers. The primary food sources of white-footed voles include the leaves of trees, shrubs, and forbs. Red alder leaves constitute a major food source. Nests are built on the ground or under stumps, logs, or rocks. They prefer the cover provided by dense vegetation near streams, and generally are found near water.

Bats

All forest dwelling bats in the Pacific Northwest are insectivores, and serve an important role as predators of forest pest species. Bats that concentrate their foraging in riparian areas and fly to upland forests to roost may serve as dispersers of nutrients. Bat populations have been declining, largely due to a lack of sites for roosting and hibernation. The deeply fissured bark of old-growth conifers and loose blankets of bark found on large, decaying logs provide roosting habitat for some sensitive bat species, but such habitat has become very uncommon in the Trask River watershed. Suitable nesting, roosting, and hibernation sites require a narrow range of temperature and moisture conditions.

Silver-haired bat

The silver-haired bat (*Lasionycteris noctivagans*) feeds mainly on moths and other soft-bodied insects and, to a lesser extent, beetles and other hard-shelled insects. They feed very close to (i.e., within 20 ft) forest streams and ponds, and in open brushy areas, using echolocation to locate prey. Roosts are found in hollow trees, snags, buildings, rock crevices, caves, and under bark.

Long-eared myotis

Long-eared myotis (*Myotis evotis*) bats are found predominantly in coniferous forests. They roost in tree cavities and beneath exfoliating bark in both living trees and snags. Pregnant long-eared myotis females often roost at ground level in rock crevices, fallen logs, and even in the crevices of sawed-off stumps, but they generally cannot rear young in such vulnerable locations. Long-eared myotis capture prey in flight, but also glean stationary insects from foliage or the ground. Their main diet consists of moths.

Fringed myotis

Beetles are the primary food for fringed myotis bats (*Myotis thysanodes*), although they also eat moths and arachnids. Foraging flight is slow and maneuverable, and they sometimes utilize wing and tail membranes to capture their prey. They are capable of hovering, and occasionally may land on the ground. Feeding occurs over water and open habitats, and by gleaning from foliage. The fringed myotis roosts in caves, mines, buildings, and crevices.

Long-legged myotis

Long-legged myotis bats are dependent on coniferous forest habitats. Radio-tracking studies have identified maternity roosts beneath bark and in other cavities. Most nursery colonies live in older trees (≥ 100 years) that provide crevices or exfoliating bark. These typically are located in openings or along forest edges where they receive a large amount of sun. Though maternity colonies are most often formed in tree cavities or under loose bark, they also are found in rock crevices, cliffs, and buildings. Long-legged myotis forage over ponds, streams, water tanks, and in forest clearings. Their primary food is moths.

3.2.2.2 Birds

Several federally threatened bird species are known to inhabit, or have been observed in the vicinity of, the Trask River watershed. Although suitable conditions for most of these rare species is very limited in the Trask River watershed, a few patches of adequate forest habitat are present for some species, including the northern spotted owl. Life history information for key sensitive bird species follows.

Marbled Murrelet

The marbled murrelet is a seabird that often uses mature or old-growth coniferous forests within 50 miles of the ocean for nesting. Most inland activity occurs between April and September. Preferred nesting habitat includes trees with large, moss-covered limbs.

No known marbled murrelet nesting sites exist within the Trask River watershed, although suitable habitat exists in a fringe of older timber in the lower watershed. Areas of the watershed impacted by the Tillamook Burn generally do not currently provide suitable habitat, but some stands of young hemlock may provide adequate murrelet habitat (Steve Bahe, BLM, pers. comm. 2003).

Murrelets are usually detected by vocalizations. Sightings are rare, making accurate counts difficult. When surveys detect an occupied area on ODF land, a marbled murrelet management area (MMMA) is established. There are no designated MMMAs on ODF land in the Trask River watershed, but there are some in adjacent watersheds.

Northern Spotted Owl

The northern spotted owl generally requires cool, moist, undisturbed late-successional forests, characterized by multiple canopy layers, fallen trees, trees with broken tops, and mature and over-mature trees. Northern spotted owls nest in cavities and on various types of platforms including abandoned raptor nests, squirrel nests, and debris accumulations.

The spotted owl population within the Oregon Coast Range is extremely low and in significant decline. Between 1994 and 1999 there was a 60% decline in the number of spotted owl pairs in the northern Coast Range. Researchers cite a number of reasons why spotted owl populations in the north Coast Range are especially at risk. High levels of habitat fragmentation have forced spotted owls to forage over broader territories, making them more vulnerable to predators. Competition with barred owls (*Strix varia*) may have increased. The lack of dispersal habitat has contributed to localized isolation and high rates of mortality; young spotted owls have a 1-in-10 chance of surviving beyond two years. The absence of suitable habitat on surrounding private timberlands serves to further isolate spotted owl populations, and few new spotted owls immigrate into state forests. Consequently, female spotted owls have produced fewer young than in other regions, and in some years have not reproduced at all.

Reserve Pair Areas (RPAs) protect habitat for spotted owls equal to their mean home range area. In the Trask River watershed, all BLM lands within the Upper Trask River subwatershed are in the RPAs of two spotted owl pairs.

Bald Eagle

Bald eagle nest selection varies widely between deciduous, coniferous, and mixed-forest stands. They frequently use snags for roosting and nesting. Bald eagles primarily nest in dominant or co-dominant trees, often located near a break in the forest such as a burn, clearcut, field edge, or water edge. They prefer riparian habitat in close proximity to water to ensure food availability. Habitat occurs primarily in underdeveloped areas with little human activity. Over 95% of Oregon's bald eagle nesting sites fall within five areas, including Tillamook County. Bald eagles are known to be present within the Trask River watershed, although relative abundance is not known (David Nuzum, ODFW, pers. comm., 2003).

Pileated Woodpecker

Pileated woodpeckers (*Dryocopus pileatus*) are year-round residents in the Trask River watershed. They require large snags for nesting and roosting and downed wood for foraging. One study in western Oregon found the highest densities of pileated woodpecker nests in stands 70 years of age and older. Approximately three-quarters of the nests were found in Douglas-fir (*Pseudotsuga menziesii*) snags. Douglas-fir, red alder (*Alnus rubra*), western red cedar (*Thuja plicata*), and big leaf maple (*Acer macrophyllum*) were used for roosting (Mellen 1987). They feed primarily on carpenter ants and other wood boring insects, although they will eat fruits when available. Although pileated woodpeckers are dependent on some components of older forests, they have been observed foraging in riparian areas and young stands or clearcuts when large snags, stumps, or down wood are present. No information is available regarding their distribution and abundance in the vicinity of the Trask River watershed.

Peregrine Falcon

No peregrine falcon (*Falco peregrinus anatum*) active nest sites are currently known on state forest lands. However, preliminary surveys indicate that potential nesting habitat is present in the Tillamook District. Peregrines currently nest in close proximity to state forest lands and forage in coastal areas. The peregrine falcon is a BLM Special Status species. Populations have been recovering throughout the West. In 1999 the species was removed from the federal Threatened and Endangered species list.

Other Bird Species

The Aleutian Canada goose and dusky Canada goose may use the lower agricultural fields of the Trask River watershed for wintering. Band-tailed pigeons (*Columba fasciata*) are summer breeding residents in the Trask River watershed. The watershed also contains suitable habitat for other species of concern such as purple martin (*Progne subis*), mountain quail (*Oreortyx pictus*), little willow flycatcher (*Empidonax traillii brewsteri*), and western bluebird (*Sialia mexicana*).

3.2.2.3 Abundance and Condition of Habitat

Historically, the forest of the Trask River watershed was characterized by a broad mosaic of conditions. Natural disturbances, such as fires, floods, landslides, windstorms, and insect outbreaks, created a patchwork of stands of different ages, including regenerating stands, young stands, mature forest, and old growth (Spies et al. 2002). Large fires, especially the Tillamook Burn fires, burned most of the forest, and many remaining trees (live and dead) were salvage logged and replanted with Douglas-fir. Consequently, the forest of today is very homogeneous, with little species or age-class diversity. Old-growth forest is currently present at much lower levels than would be expected in the natural range of variability (Spies et al. 2002). Older forest stands in the Trask River watershed are very rare, small, and discontinuous. Consequently, many animal species of concern in the watershed are species that require or prosper in late-successional forest. Habitat characteristics such as snag and LWD abundance, vertical forest structure, and roosting and nesting habitat for sensitive species of bats, birds, and rodents are in short supply in the Trask River watershed. The current predominance of young, even-aged, closed-canopy stands means that habitat conditions provided by other age, structure, and species composition classes are currently less available than during historic times.

Nonetheless, some habitat characteristics for sensitive species may be improved through active management. Measures to improve habitat quality are currently being developed, implemented, and incorporated into management plans. Increases in late-successional forest characteristics, such as tree species diversity, snag and woody debris abundance, and vertical forest structure, may be hastened through management actions. The ODF IPs for the Tillamook and Forest Grove districts and the FMP utilized a structure-based management approach which sets targets for the future distribution of each forest structure class in the landscape. For more on this topic, see section 3.2.3.2 Forest Management, below.

3.2.2.4 ODF Management of Sensitive Species

Threatened and Endangered species on ODF land are currently managed under interim policies until the HCP is completed in 2005. The proposed HCP details specific strategies for managing T&E species, and other species of concern. Detailed information regarding management policies for terrestrial wildlife and bird species and habitats on ODF land is provided in the Tillamook District IP, the Forest Grove IP, and in the Northwest Oregon State FMP.

The FMP outlined a strategy to retain and improve habitat conditions for species of concern using the concept of "anchor habitats", which is expected to be incorporated into the HCP. Anchor habitat areas are intended to allow species of low mobility, limited dispersal ability, or high site fidelity to recolonize new habitat as it is being created. Stationary central blocks of habitat, or "anchors," ensure that newly developed habitat will be readily colonized by species of concern.

3.2.2.5 BLM Management of Sensitive Species

BLM lands are managed according to the standards and guidelines of the NFP. "Survey and Manage" is a component of the NFP, designed as mitigation for the protection of lesser known species thought to remain at risk of loss of population viability despite implementation of the NFP. Survey and Manage requires the BLM (and USDA Forest Service) to survey for certain species whose habitat may be disturbed, prior to the implementation of a project, and to manage known sites of those species found. A list of over 400 species of plants and animals was originally included in the NFP document, of which a portion occur in northwest Oregon. In January 2001, the BLM and Forest Service published the *Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines Environmental Impact Statement* (Survey and Manage EIS), which amended the Survey and Manage provisions by removing many species from the original list and implementing provisions for annually reviewing the list. The BLM has surveyed over 2,400 acres in the Trask River watershed (primarily in the Elkhorn Creek subwatershed) for Survey and Manage plant species and found none. Two Survey and Manage lichen species, *Platismatia lacunosa* and *Peltigera pacifica*, are known to occur immediately adjacent to the Trask River watershed and most likely also occur within the watershed.

Currently, the BLM and USDA Forest Service are in the process of amending the Survey and Manage EIS to include alternatives to modify the Survey and Manage provisions or to possibly remove the provisions from the NFP Standards and Guidelines completely. If the provisions are removed, the habitat needs of affected rare or little-known species would rely on other elements of the NFP and existing Forest Service Sensitive Species and BLM Special Status Species programs.

The Trask River watershed contains habitat for four terrestrial wildlife species that are covered by the Survey and Manage provisions, three mollusks and one mammal:

- Red tree vole (*Arborimus longicaudus*)
- Oregon megomphix (*Megomphix hemphilli*)
- Puget Oregonian (*Cryptomastix devia*)
- Evening field slug (*Deroceras hesperium*)

In addition to the protections required by the Survey and Manage Species guidelines of the NFP, the BLM has a Special Status Species program to protect sensitive species that do not meet the requirements of the federal and state endangered species acts, and to provide an "early warning" for species likely to be listed in the future (BLM 1990). The Special Status Species program requires "For those species where lands administered by BLM or actions have a significant effect on their status, manage the habitat to conserve the species" (BLM 1990).

Two of the Survey and Manage species, the Oregon megomphix (*Megomyphix hemphelli*) and the evening field slug (*Deroceras hesperium*), are also Special Status Species. Other terrestrial species included in the BLM's Special Status Species program, and for which habitat may be found in the Trask River watershed, include:

- Peregrine falcon (*Falco peregrinus anatum*)
- Common nighthawk (*Chordeiles minor*)
- Purple martin (*Progna subis*)
- Columbia torrent salamander (*Rhyacotriton kezeri*).

3.2.3 VEGETATION SPECIES AND HABITAT

3.2.3.1 Landscape Pattern of Vegetation

We have examined forest vegetation from three primary sources: the ODF Summary Stand Inventory (SSI), the BLM Forest Operations Inventory (FOI), and the Coastal Landscape Analysis and Modeling Study (CLAMS) vegetation map. The SSI and FOI data sets provide detailed information, but only for each respective agency's land holdings, and the data were gathered using different methods and objectives. The CLAMS data set is based on satellite-imagery and field plots, and covers all of the Trask River watershed, making it possible to summarize across land ownerships. However, the CLAMS data are coarse, and species and age information is absent.

The distribution of conifer, hardwood, and mixed conifer-hardwood stands, by size class, is presented in Table 3.25 and Plate 3, based on CLAMS data. Over half of the forest in the Trask River watershed is dominated by conifers (51.5%) of which 91.8% are in the small (< 10 in) and medium (10 to 20 in) size classes. Mixed conifer-hardwood stands of all sizes account for 22.4% of forest in the watershed, half of which is in the small size class. Hardwood stands of all sizes account for 13.4% of the watershed. Other land cover categories (including water, open forest, open non-forest, woodlands and other vegetation types) collectively constitute 12.7% of the Trask River watershed.

Table 3.25. Vegetation type based on DBH (diameter at breast height) and basal area of trees. Numbers represent square miles and percent by subwatershed. Data derived from CLAMS (Coastal Landscape Analysis and Modeling Study) GIS coverages.

Vegetation Type	Size Category (DBH)	EF of SF of Trask mi²	EF of SF of Trask %	Elkhorn mi²	Elkhorn %	Lower Trask mi²	Lower Trask %	MF of NF of Trask mi²	MF of NF of Trask %	NF of NF of Trask mi²	NF of NF of Trask %	NF of Trask mi²	NF of Trask %	SF of Trask mi²	SF of Trask %	Upper Trask mi²	Upper Trask %	Grand Total mi²	Grand Total %
Hardwood (>65%)	> 65% Hardwood presence (all sizes)	2.2	7.5	0.7	3.8	3.4	15.3	0.3	2.6	0.4	2.9	4.7	15.9	4.8	20.5	7.0	25.4	23.4	13.4
Mixed (20-65% hardwood)	Small (<10 in)	4.7	16.3	0.4	2.0	0.4	2.0	0.1	1.0	0.3	2.7	2.4	8.1	4.3	18.3	2.3	8.5	15.0	8.6
	Medium (10-20 in)	3.0	10.4	1.3	7.8	0.4	1.6	1.4	10.5	1.0	7.7	4.4	14.9	3.1	13.5	3.1	11.2	17.7	10.1
	Large (20-30 in)	0.5	1.8	0.3	1.9	0.1	0.5	0.3	1.9	0.2	1.2	1.0	3.4	0.6	2.5	1.2	4.3	4.1	2.3
	Very Large (>30 in)	0.3	1.1	0.0	0.2	0.1	0.5	0.0	0.2	0.1	0.6	0.3	0.9	0.4	1.8	1.2	4.4	2.5	1.4
Conifer (>80%)	Small (<10 in)	5.1	17.5	6.7	38.6	1.5	6.8	2.3	17.2	6.6	52.1	6.1	20.8	4.0	17.2	3.7	13.3	35.9	20.6
	Medium (10-20 in)	10.9	37.4	7.0	40.4	0.6	2.9	7.4	56.3	3.5	27.7	8.8	30.0	4.9	20.9	3.4	12.4	46.5	26.7
	Large (20-30 in)	1.9	6.5	0.5	2.8	0.1	0.5	0.6	4.3	0.3	2.4	0.8	2.8	0.9	3.7	0.9	3.2	6.0	3.4
	Very Large (>30 in)	0.1	0.4	0.1	0.3	0.0	0.0	0.1	0.5	0.1	0.4	0.2	0.6	0.1	0.3	0.9	3.3	1.5	0.8
Other[a]		0.3	1.0	0.4	2.3	15.7	70.0	0.7	5.5	0.3	2.3	0.7	2.5	0.3	1.4	3.9	14.0	22.0	12.7
	Grand Total	29.0		17.3		22.4		13.2		12.6		29.2		23.3		27.6		174.4	

[a] Water, open, non-forest vegetation

The CLAMS data show the highest proportion of medium-sized conifers in the Middle Fork of the North Fork subwatershed (56.3%), and the highest proportion of hardwoods in the Upper Trask subwatershed (25.4%). Medium-sized mixed conifer-hardwood stands are fairly evenly distributed throughout most of the watershed, ranging from 7.7% (North Fork of the North Fork subwatershed) to 14.9% (North Fork subwatershed); the Lower Trask subwatershed, which has only 1.6% of the mixed forest type, is the exception.

The distributions of forest stands by dominant tree species and age class on Tillamook District ODF land (SSI data) and BLM land (FOI data) are presented in Table 3.26. Three age class categories were created, based on stand age information present in both of the respective data sets ("age" in SSI and "DK" in FOI). Dominant tree species (Douglas-fir, western hemlock [*Tsuga heterophylla*], red alder, and Sitka spruce [*Picea sitchensis*] was shown from information in each data set, by subwatershed. Both the area and the percentage of each forest type category were calculated.

ODF lands are dominated by Douglas-fir stands 26 to 50 years old (84% of all Tillamook District ODF land within the Trask River watershed). Douglas-fir dominated stands also make up the greatest percentage of BLM lands within the Trask River watershed (65%), but there is a higher diversity of stands dominated by other tree species, such as red alder (23%), western hemlock (5.6%), and Sitka spruce (0.7%). Sitka spruce dominated stands on both ODF and BLM lands exist only within the Lower and Upper Trask River subwatersheds, probably because fog is more prevalent at the lower elevations found in these two subwatersheds.

3.2.3.2 Forest Management

ODF identifies three primary stand types within the Trask River watershed, each requiring different management activities (Tillamook and Forest Grove District Implementation Plans), as follows:

Regeneration Stands result from clearcuts and patch cuts. They are reforested within two years and vegetation management activities are undertaken to ensure sapling release. Pre-commercial thinning or pruning may take place. Larger green trees will be left at harvest, scattered or in clumps, to provide future snags and downed wood. Hemlock, cedar, noble fir, spruce, and Douglas-fir are planted to create species diversity.

Closed Single Canopy stands are a result of reforestation of the Tillamook Burn. Most are dense stands of Douglas-fir, but some are stands naturally regenerated with hemlock as the dominant species. Light to heavy partial cutting will be used in these stand types to promote understory, layering, and older forest structure. Partial cuts will mostly remove non-dominant trees and at times will be used to treat areas of Swiss needle cast (SNC; *Phaeocryptus gaumanni*). Snags will be left or created and down wood will be recruited by leaving cull logs and logging slash.

Understory, Layered, and Older Forest Structure Stands make up a small percentage of the Trask River watershed at this time. The goal of management will be to develop and maintain

Table 3.26. Distribution of forest stands by dominant tree species. Only ODF lands within the Tillamook District are included. Areas expressed as square miles and as a percent of total ODF or BLM land within a subwatershed. Data sources included SSI from ODF and FOI from BLM.

Subwatershed	Age Class (yr)	Dominant Tree Species																All Species			
		Douglas-fir				Western Hemlock				Red Alder				Sitka Spruce							
		ODF		BLM		ODF		BLM		ODF		BLM		ODF		BLM		ODF		BLM	
		mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%	mi^2	%
Lower Trask River	0-25	0.2	56															0.2	56		
	26-50	0.05	10															0.05	10		
	> 50			0.001	26	0.04	8.7							0.03	5.7	0.004	74	0.1	14	0.01	100
	All	0.3	66	0.001	26	0.04	8.7							0.03	5.7	0.004	74	0.4	80	0.01	100
Middle Fork of North Fork of Trask River	0-25																				
	26-50	0.02	100	1.6	80							0.2	8.8					0.02	100	1.7	88
	> 50			0.2	8.7															0.2	8.7
	All	0.02	100	1.7	88							0.2	8.8					0.02	100	1.9	97
North Fork of North Fork of Trask River	0-25																				
	26-50	0.1	100															0.1	100		
	> 50																				
	All	0.1	100															0.1	100		
North Fork of Trask River	0-25	0.7	2.9															0.7	2.9		
	26-50	21	85	1.5	50	1.2	4.7	0.01	0.4	1.7	6.9	0.4	12					24	97	1.9	62
	> 50	0.001	0.003	0.2	7.0							0.6	20					0.001		0.8	27
	All	22	88	1.7	57	1.2	4.7	0.01	0.4	1.7	6.9	1.0	32					25	100	2.7	89
South Fork of Trask River	0-25	0.1	0.5			0.001	0.01											0.1	0.5		
	26-50	17	94	0.5	67			0.03	3.5	0.8	4.4	0.1	12					18	98	0.6	82
	> 50	0.3	1.4	0.1	13													0.3	1.4	0.1	13
	All	18	96	0.6	80	0.001	0.01	0.03	3.5	0.8	4.4	0.1	12					18	100	0.7	95
Upper Trask River	0-25	0.9	6.7	0.04	1.0	0.1	0.6	0.02	0.6									1.0	7.3	0.1	1.6
	26-50	7.3	54	0.1	2.0	0.3	2.2			1.8	13	0.1	3.8					9.5	69	0.2	5.8
	> 50	1.6	12	0.6	17	1.2	8.9	0.6	18	0.1	1.0	1.7	47	0.02	0.1	0.1	2.5	3.0	22	3.0	85
	All	9.9	73	0.7	20	1.6	12	0.6	18	1.9	14	1.8	51	0.02	0.1	0.1	2.5	13	99	3.3	92
All Subwatersheds	0-25	2.6	2.9	0.04	0.3	0.1	0.1	0.02	0.2									2.7	3.0	0.1	0.4
	26-50	74	84	7.3	54	1.5	1.7	0.04	0.3	4.3	4.9	0.8	6.2					80	91	8.2	61
	> 50	3.9	4.4	1.5	11	1.2	1.4	0.7	5.2	0.1	0.1	2.3	17	0.04	0.05	0.1	0.7	5.3	6.1	4.5	33
	All	81	91	8.8	65	2.8	3.2	0.8	5.6	4.4	5.0	3.1	23	0.04	0.05	0.1	0.7	88	100	13	94

complex stand structure, such as by creating small openings or reducing tree density to facilitate improved growth of understory species. Light or moderate partial cutting and/or group selection cutting, as well as underplanting of conifers, is planned.

Forest management on ODF lands in the Trask River watershed for the current planning period (2003 to 2011) will be largely focused on addressing SNC infections, which are severe in approximately 40% of the Tillamook District forest in the Trask River watershed. According to the IP, severely impacted SNC stands will be harvested during the next two decades, and replanted with a diversity of tree species, including hemlock, cedar and spruce. Regeneration (REG) stands in the Tillamook District in the Trask will increase in proportion from <1% to approximately 25% during the planning period. Closed Single Canopy (CSC) will be reduced from 82% to approximately 53%. The desired future condition (DFC) for REG will be 10%, and 15% for CSC. Layered (LYR) and old forest stands (OFS), which currently constitute approximately 1% of the forest each, will be monitored over time, with partial cutting being prescribed if stand densities develop to a point where structure or function becomes limited. The DFC for LYR is 30% and for OFS is 20%.

The BLM utilizes land use allocations (LUA) and the Aquatic Conservation Strategy (ACS) to determine the types of management activities practiced on their land. LUAs provide guidance for the uplands, while the ACS designates Riparian Reserves (RR) for special management near streams and waterbodies. In the Trask River watershed, two LUAs are represented, adaptive management areas (AMA), and adaptive management reserves (AMR). AMAs are areas where new management approaches that integrate ecological and economic health, and restore late successional forest habitat may be developed and tested. AMRs combine late seral reserve (LSR) and AMA guidelines.

The ACS emphasizes management for the protection and restoration of aquatic and riparian habitat. According to the ACS, Riparian Reserves, which are streamsize zones of variable width, are to be managed according to special Standards and Guidelines. For more information on LUAs and the ACS, refer to the NFP and the Salem District Resource Management Plan (RMP).

3.2.3.3 Exotic/Noxious Plants

Exotic weed species exist within both forested and agricultural portions of the Trask River watershed. Such weed species tend to out-compete native plants, diminishing their population size and resulting in reduced plant species diversity. They are typically aggressive colonizers of disturbed soils, and are often found along roadside ditches, on recently harvested forest lands, and in agricultural fields. On both BLM and ODF lands within the Trask River watershed, noxious and other exotic weed species do not currently pose a significant problem, possibly due in part to the extensive canopy cover found on most forested lands (Kurt Heckeroth, BLM, and Susan Nicholas, ODF, pers. comm., 2003). Common exotic plant pest species within the Trask River watershed include Scotch broom (*Cytisus scoparius)*, Himalayan blackberry (*Rubus discolor*), Canadian thistle (*Cirsium arvense*) and bull thistle (*C. vulgare*). Tansy ragwort (*Senecio jacobaea*) is also present along roadsides within the watershed. Another wetland invader, policeman's helmet (*Impatiens glandulifera*), has been observed within the watershed, but its extent and population size are unknown (Susan Nicholas, ODF pers. comm., 2003).

In agricultural areas, certain weed species can be toxic to livestock, or otherwise damaging to agricultural operations. The ODA designates such plants as noxious weeds. Noxious weeds of concern within the Trask River watershed are Scotch broom, tansy ragwort, Japanese knotweed (*Polygonum cuspidatum*) and giant knotweed (*Reynoutria sachalinensis*).

3.2.3.4 Rare Plants

Four categories of rare plants are managed by ODF are as follows:

1. Federal Threatened & Endangered plants – Plants designated on a federal level by the USFWS through a formal process. These species are protected by federal statute.
2. State Threatened & Endangered plants – Plants designated at the state level by the ODA through a formal process, and protected by state statute.
3. State Candidate plants – Plants designated by a formal process by the ODA. These species are not protected by statute, but ODF policy pledges special consideration.
4. Special Concern plants – Plants designated by ODF for special consideration.

Based on reviews of the Oregon Natural Heritage Program's database of plant locations, consultations with the Oregon Department of Agriculture's Rare Plant Program, and ODF's own work in the basin, the known or potential rare plants in the Trask River watershed on ODF land are listed in Table 3.27.

Table 3.27. Endangered, Threatened, Candidate, and Special Concern plant species on ODF land in the Trask River watershed.

Species	Common Name	Status[a]	Record Exists[b]	Potential to be Present
Threatened and Endangered Plants				
Sidalcea nelsoniana	Nelson's checkermallow	ST, FT		✔
Erythronium elegans	Coast Range fawn-lily	ST		✔
Plants of Special Concern				
Dodecatheon austrofrigidum	Frigid shootingstar	SP	✔	
Candidate Plants				
Sidalcea hirtipes	Bristly-stemmed sidalcea	SC	✔	
Filipendula occidentalis	Queen-of-the-forest	SC	✔	

[a] Status: FT = Federally Threatened; ST = State Threatened; SC = State Candidate; SP = Special Concern
[b] Plants have been observed on or in close proximity to state forestlands.

The BLM's Special Status Species policy includes a number of species in addition to those designated as Survey and Manage (see BLM website for description of the policy). The following is a list of Special Status Species that are known to occur on BLM land in the Trask River watershed:

Frigid shooting star (Bureau Sensitive) - *Dodecatheon austrofrigidum*

Western wahoo (Tracking Species) - *Euonymus occidentalis*

Tall bugbane (Bureau Sensitive) - *Cimicifuga elata*

Weak bluegrass (Tracking Species) - *Poa marcida*

Bog anemone (Assessment Species) - *Anemone organa*

3.2.3.5 Riparian Vegetation

Riparian vegetation was analyzed in the Trask River watershed for ODF by Falcy (2002). Following OWEB riparian assessment guidelines, riparian vegetation was classified by size, density, and vegetation type (i.e. conifer, hardwood, or a mixture of the two) using 1 m digital orthophotos (WPN 1999). Only streams on ODF lands were analyzed.

Ninety percent of the riparian vegetation on surveyed streams was composed of dense, medium-sized (12 to 24 in dbh) trees, of which conifer-dominated stands accounted for 22%, 40% were hardwood-dominated stands, and 38% were stands composed of a mixture of conifers and hardwoods (Table 3.28; Plate 11). The remaining 10% of the surveyed riparian zones were composed of sparse medium-sized conifers, small trees (4 to 12 in dbh), regeneration (<4 in dbh), and non-forest vegetation. Overstory vegetation was predominantly very dense. Large trees (>24 in dbh) were not common (Falcy 2002).

Table 3.28. Percent of conifers, hardwoods, and mixed forest in the riparian zone on ODF lands. (Source: Falcy 2002)

Subwatershed	Conifers	Hardwoods	Mixed
EF of SF Trask	28	39	34
Elkhorn	49	28	24
Lower Trask	12	6	82
MF of NF Trask	53	30	18
NF of NF Trask	28	33	40
NF Trask	9	40	52
SF Trask	16	47	37
Upper Trask	8	53	39
Total	22	40	38

Riparian reserves have been delineated on BLM lands, and are managed to protect and enhance riparian resources, as specified in the NFP and the Salem District ROD and RMP. Riparian reserves occupy 51% of BLM land in the Trask River watershed (6.9 sq mi). The riparian reserve width depends on the presence of fish and duration of flow. Fish-bearing streams have RR widths that are equal to two site-potential tree heights, and nonfish-bearing streams have RR widths equal to one site-potential tree height. In riparian reserves, timber harvest is permitted to acquire desired vegetation characteristics needed to attain ACS objectives, or following a catastrophic natural event, or for salvage, if LWD is abundant. For detailed information on BLM riparian reserve management guidelines, refer to the RMP.

On ODF lands, riparian areas are managed with variable guidelines from the FMP for the Stream Bank Zone (0 to 25 ft from stream), the Inner RMA Zone (25 to 100 ft from stream), and Outer RMA Zone (100 to 170 ft from stream). Important characteristics include stream size, flow pattern, and fish use. For details of the ODF riparian management policy, refer to the Northwest Oregon State FMP.

3.3 SOCIAL

3.3.1 RECREATIONAL OPPORTUNITIES

Recreational opportunities throughout the Trask River watershed include a wide range of activities. Nonconsumptive activities such as camping, hiking, mountain biking, kayaking, and wildlife viewing generally have low potential for wildlife disturbance, soil compaction, or erosion. These activities are enjoyed on public lands within the Trask River watershed. Trails are prevalent on state lands within the Trask River watershed. Off-Highway Vehicle (OHV) use, a nonconsumptive use with much greater potential to disturb wildlife and result in soil disturbance and erosion, is very popular within the Trask River watershed. Based on the 1993 Tillamook Forest Recreation Plan, Forest Grove and Tillamook Districts have zoned areas that are open to OHV (designated trails only).

Consumptive recreational uses within the watershed include hunting, fishing, and mushrooming. Hunting and mushrooming occur throughout the watershed, from the valley bottoms up into the uplands. Impacts on natural resources are limited to the populations of animal or plant species being extracted, and the small amount of ground and vegetation disturbance resulting from human activity in the woods, which is generally minimal. Fishing from the streambank or from boats can impact fish populations, but has very little impact on other aspects of the watershed.

An additional impact of both consumptive and non-consumptive recreational activities can include the use of roads to access areas within the watershed, increasing traffic, and potentially erosion from road surfaces and the spread of exotic plants.

3.3.2 TIMBER HARVEST

Forest management objectives for both the ODF and BLM include timber harvest methods designed to improve wildlife habitat, forest health, forest structure, and tree species diversity. On ODF lands, desired future conditions, as presented in the Implementation Plan for the Trask Basin in the Tillamook District, include reduction of CSC forest from 82% to 15%. For the ODF Forest Grove District, CSC in the Sunday Creek Basin (the western portion of which is in the Trask River watershed) is targeted to be reduced from 56% to 10%. In the Tillamook District, many of the CSC stands are affected by SNC (40% of the Tillamook District land in the Trask River watershed), so management options for LYR and OFS are limited in the short term.

During the current planning period (2003 to 2011), approximately 320 to 455 acres of partial cut and 10,160 to 14,515 acres of clearcut are anticipated in Tillamook District lands. Thinning has occurred or will occur on many acres, although the IP does not provide an estimate of the number of acres. The predominance of CSC in the watershed, much of which is affected by SNC, will make it difficult to plan for OFS and LYR stand types. Desired future conditions, which include 30% OFS and 20% LYR, are estimated to be at least 50 to 80 years away. In the Sunday Creek Basin of the Forest Grove District, approximately 350 to 700 acres will be clearcut, to increase the proportion of REG from <1% to 6%, approaching the DFC of 9%. Pre-commercial thinning will also be conducted on 50 to 100 acres.

BLM forest management activities are focused in the Elkhorn Activity Planning Unit (APU). In the Blind Barney lands, 320 acres of commercial thinning and 85 acres of small conifer release in riparian stands are planned. The Flora and Fauna lands include 118 areas designated for coarse woody debris creation, 880 acres of thinning, and a 5 acre botany survey. Finally, the Cruiserhorn lands include 673 acres of thinning, as well as projects identified for botany inventories, CWD treatments, pre-commercial thinning, and riparian release.

CHAPTER 4. DISCUSSION

4.1 AQUATIC

4.1.1 HYDROLOGY AND WATER QUANTITY ISSUES

Changes in forest age and species composition from reference conditions have probably resulted in changes to the hydrologic regime, although the magnitudes of such changes are unknown. Typically, peak flows are increased for the first 10 to 15 years following vegetation removal, after which time flows gradually return to prior levels. Impervious road surfaces and ditches may also increase flows by hastening the delivery of runoff to streams, resulting in a “flashier” peak discharge. However, increases in peak flows associated with human activities today are probably relatively minor. If harvesting increases substantially in response to Swiss needle cast (SNC) infection, impacts on peak flows will become more pronounced in the short term. We do not have a strong basis for predicting the magnitude of such impacts. Since most of the watershed occurs below the rain-on-snow zone, snowmelt from rainstorms would typically not be expected to contribute much to runoff.

Peak flows are of concern because of frequent flooding in Tillamook and other lowland areas and because of the influence of peak flows on erosion and channel stability. Twenty-nine percent of the Lower Trask River subwatershed occurs within the 100-year floodplain. A primary function of this floodplain is to reduce the severity of peak flows. Much of this function has been compromised by hydrological modifications in lowland areas. As a consequence, it is likely that flooding will continue to be an important concern in and around Tillamook.

Low-flow conditions are also of concern, because of associated effects on water quality, water temperature, and habitat suitability for aquatic biota. The monthly average Trask River low flow for August, the driest month, is about 108 cfs, based on 40 years of data. The 7-day average low flow that occurs on average only once every 10 years, or the 7Q10, is 54 cfs. We are not aware of any studies of the extent of perennial streamflow in relation to watershed area in the vicinity of the Trask watershed. However, we expect that most streams in the Trask watershed are perennial, except for the smallest headwater streams, although in late summer flows may become very low.

4.1.1.1 Management Effects on Hydrology

ODF and BLM management actions have the potential to alter water quantity and quality throughout much of the Trask River watershed. More than two-thirds of the watershed, and more than 90% of the East Fork of the South Fork and North Fork Trask subwatersheds, is in public ownership (Table 4.1).

Past and current anthropogenic changes in the hydrological regime in the uplands are attributable to accelerated runoff from road surfaces and residual effects of past logging operations and fires on runoff and stream channel morphology. We expect that the magnitude of such impacts has been decreasing steadily since completion of the salvage logging that followed the Tillamook

Table 4.1. Land ownership by subwatershed.				
	Stream Length	Percent Stream Length		
Subwatershed	(mi)	ODF	BLM	Private
East Fork of South Fork Of Trask River	177	89	1	10
Elkhorn Creek	105	53	22	25
Lower Trask River	89	1.8	-	96
Middle Fork of North Fork of Trask River	81	44	16	30
North Fork of North Fork of Trask River	77	47	-	53
North Fork of Trask River	193	81	10	8.9
South Fork of Trask River	151	81	2	17
Upper Trask River	197	49	13	38
Total	1070	62	8	30

Burn fires. Ongoing hydrologic changes associated with forestry operations are expected to be minor and of short duration. Effects of future management on hydrology of ODF and BLM lands will primarily concern the planned increases in harvesting and the associated construction, maintenance, and decommissioning of roads. Reduction of roaded area, especially roads on steep slopes and in close proximity to streams, will reduce the impacts of roads on peak flows and associated erosional processes. At present, however, roads probably exert a relatively minor influence on watershed hydrology. This is because road density is not high, newer roads have been better constructed and situated, and poorly-constructed roads have had ample time in which to fail.

Hydrological changes in the lowlands have been more extensive than those in the uplands, and are probably associated with more significant ecological consequences. Conversion of forests and wetlands to agriculture during the late 19th and early 20th centuries was accompanied by extensive diking, channelization, installation of tidegates, tile draining, and ditching of lowland areas. As a consequence, the mainstem Trask River has largely been disconnected from its floodplains and wetlands. Most of these changes are probably permanent. The ability of the floodplains and associated wetlands to store water and moderate flows has been diminished, resulting in higher peak flows and reduced low flows. Peak flow velocities have increased, contributing to enhanced erosion, and low flow velocities have decreased, contributing to reduced water quality. These hydrological changes have also dramatically reduced the quantity and quality of off-stream salmonid rearing habitat.

The importance of flooding in the Lower Trask River subwatershed and the sensitivity of valley flooding to upstream watershed conditions indicates the need for a management focus on restoring natural watershed functions throughout the watershed. Flood management efforts in the lowland floodplains may be affected by the management of upland watershed conditions that influence the flow rate and volume of floodwaters. However, altered upland processes can be difficult and take a long time to restore, and we do not know to what extent there may be residual effects from the significant disturbance that was associated with the Tillamook Burns. Floodplain and wetland restoration and protection throughout the watershed could be helpful to improve flood attenuation and storage.

Water diversions have also affected hydrology, especially during summer and early fall. Some of the water has been used for irrigation, a portion of which might be expected to return to the stream system as runoff. However, such agricultural runoff is often characterized by higher temperature, reduced dissolved oxygen, and higher contaminant concentrations.

Portions of the Lower Trask subwatershed are now covered by impervious surfaces. Such surfaces increase surface runoff and decrease groundwater recharge. Because only 1% of this subwatershed is urban, however, such impacts are expected to be very small.

4.1.1.2 Water Rights Allocations

Water rights in the Trask River are over-allocated during dry months. Most existing water rights are in the Lower Trask River subwatershed, but the largest potential diversion is at Barney Reservoir, in the Middle Fork of the North Fork subwatershed. Typically, the only significant water use between November and July is municipal use; irrigation is important between July and October. The greatest cumulative effects of over-allocation occur in the lower portions of the watershed. Actual demand on water from the Trask River system varies by season and from year to year. It is likely, however, that agricultural demand is highest precisely at the times when flows would be lowest, irrespective of water use.

The mainstem Trask River and the North Fork system exhibit relatively high potential for dewatering. Summer flows are not adequate to meet consumptive and in-stream allocations, although the consumptive portion is less than one-third of the in-stream portion of the water rights. This problem further exacerbates the temperature and other water quality concerns in these areas. There is little that can be done on ODF or BLM lands to improve the low-flow situation, other than to work towards mitigation of the closely-linked water temperature problem.

4.1.2 STREAM CHANNEL ISSUES

The conditions of the stream channels have changed from reference conditions, and these changes have been most pronounced in the lower watershed. The mainstem river has been channelized and confined, and has lost its natural meandering pattern and much of its connection with estuarine and off-channel wetlands. The reduction in riparian vegetation and increased sediment load, attributable to past logging, agricultural activities, and fires, have likely made the channels wider and shallower.

The most important change in stream morphology, from a functionality standpoint, has been the loss of large woody debris (LWD). This change has occurred throughout the watershed. Under reference conditions, mature forests contained a substantial component of large-diameter coniferous trees. These trees provided LWD from blowdown in the riparian zone and from debris flows that reached the stream channel, and they created hydrologic characteristics that were conducive to pool formation, hydraulic diversity, and the retention of gravel, small woody debris, and organic material. Past timber harvest and fire removed large wood, especially coniferous trees, from the riparian zone. Furthermore, management practices encouraged LWD removal prior to the 1980s. The result of these past activities has been the development of a system that is currently deficient in structural elements necessary to generate pool formation and habitat complexity.

LWD recruitment potential is generally poor throughout the watershed. Where there are moderate to large size trees present in the riparian zone, they tend to be deciduous, mainly red alder (*Alnus rubra*). Deciduous logs decay rapidly within the stream, typically lasting less than about five years. Conifer logs, in contrast, provide beneficial effects over much longer periods of time. The historic riparian zone probably contained greater diversity of tree species and age classes, and included more large conifers than it does today. Recent changes in forest management practices will provide improved recruitment conditions in the future, but such changes will not have any appreciable beneficial impact for many decades. Interim measures, such as artificial placement of large wood, appear to have been at least partly successful within the watershed, especially in the South Fork Trask River. Planting of conifers in the riparian zone, partial cuts, and thinning in selected areas may further improve future prospects.

Channel widening results in increased stream surface area exposure to radiant energy and greater energy exchange between the stream and its environment (Boyd 1996). In addition, wider channels typically have less shading from the riparian vegetation that is present. Riparian vegetation often has a substantial impact on the width-to-depth ratio of the stream, which in turn influences water temperature and in-stream habitat characteristics. Analyses of ODFW stream survey data by ODEQ (2001) showed interquartile range (25^{th} to 75^{th} percentile values) of the width:depth ratios of 7 to 57 for annual vegetation (grasses), 18 to 38 for young forest stands, and 17 to 22 for mature forest stands. The mature stands were associated with the lowest overall width-to-depth ratios and the least variability in width to depth ratios. ODEQ did not determine whether young forest stands differed appreciably from older stands.

ODEQ (2001) estimated from digital orthophotos and field measurements the near-stream disturbance zone (NSDZ) width, as the distance between shade-producing near-stream vegetation. The NSDZ width can be considered an estimate of the bankfull width. Widths were highly variable along the Trask River mainstem, although the width generally increased with distance downstream. Because the NSDZ was frequently narrower at some downstream locations, as compared with unusually wide places further upstream, ODEQ concluded that these narrow places were, in fact, sufficiently wide to accommodate high discharge. This implies that the wider NSDZ upstream might be the result of disturbance. Management decisions concerning channel width reductions should logically target an upper limit of NSDZ as a function of distance along the mainstem. Such targets were selected by ODEQ (2001) using a moving median width value, calculated sequentially from 10 measurements along 1,000-ft stream segments. The best fit line (Figure 4.1) was used to determine an upper limit on the NSDZ width at various locations along the mainstem:

$$\text{Potential NSDZ width} = -2.84 \times RM + 143.98$$

where NSDZ is given in feet and RM is river miles from the mouth.

Areas where the estimated NSDZ width exceeded the potential NSDZ width are shown in Figure 4.1. Most areas having the largest discrepancy are located off ODF and BLM land. Other than a small section near RM12, ODF and BLM do not own much mainstem riparian area downstream from RM18.

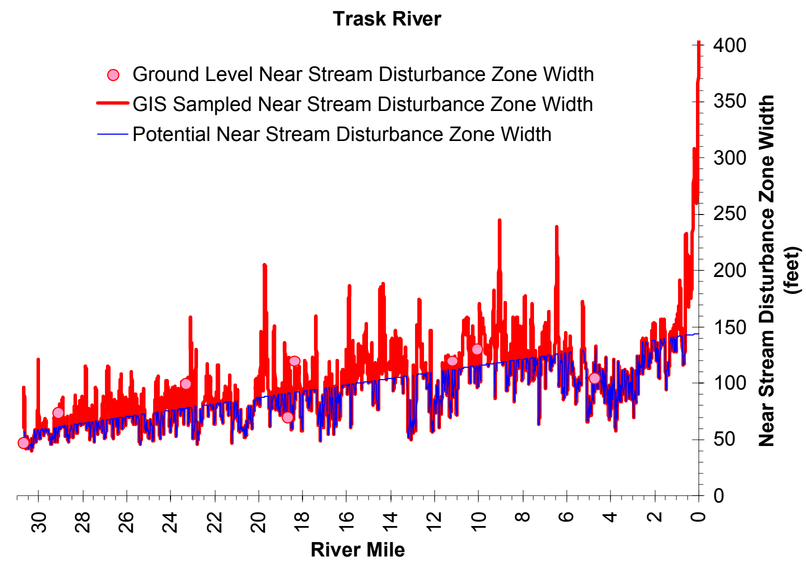

Figure 4.1. Near stream disturbance zone (NSDZ) width for the lower 30 miles of the Trask River, as determined by ODEQ based on ground measurements and aerial photo interpretation. The potential NSDZ width was calculated as: potential NSDZ width = -2.84 x (River Mile) + 143.98.

Channel morphology downstream of ODF and BLM land in the Lower Trask River subwatershed has been dramatically altered by channelization and flood control efforts. Early dredging, logging, and log transport activities removed roughness elements from the channel and also removed most of the natural mix of riparian vegetation. Subsequent channel straightening, diking, and ditching have contributed to channel incision in some places and disconnection of the river from most of its floodplain. Current land uses limit the prospects for restoration of the functionality of the lower river and its associated wetlands and floodplain. However, the Tillamook Estuaries Partnership has recently been involved in land purchase and restoration actions to restore some of the estuarine wetland functionality.

ODEQ (2001) estimates of potential channel width for the mainstem Trask River from the mouth to RM30, based on estimates of current median width, gradually increased from headwaters towards mouth (Figure 4.1). The analysis suggested that the channel width has increased in many areas above RM6, but decreased between RM2 and 6 (the latter effect was probably attributable to diking). The estimated changes in channel width above RM6 were simulated by ODEQ to impact stream temperature, along with changes in riparian vegetation. The increased current near-stream disturbance zone and wetted widths, compared with simulated potential conditions, are believed to result in increased stream surface area and decreased shading of the mainstem Trask River, both of which would contribute to increased stream temperature.

The steep narrow valley (SV) and very steep headwaters (VH) channel habitat types (CHTs) predominate within all subwatersheds except the Lower Trask River. These CHTs have probably not been modified as dramatically by human activities since European settlement, in part because they are often very inaccessible. LWD in these CHTs cycle through phases of accumulation and release by debris flows. Overall, LWD abundance in SV and VH channels was probably greater prior to the Tillamook Burn.

Moderate gradient moderately confined (MC) and moderately steep narrow valley (MV) CHTs account for 20% to 30% of the stream channels in the upper watershed (Table 3.6). MV streams, in particular, probably contained a moderate amount of LWD prior to European settlement. It is possible that areas of extensive in-channel exposed bedrock, for example in the North Fork of the North Fork subwatershed, may have lost some of their former soil and sediment cover from erosion subsequent to past logging and fires. Such a change may have contributed to increased stream heating. The less common (4% to 7% of the uplands) moderate gradient moderately confined (MM) CHT probably historically contained abundant LWD, and is considered most responsive to restoration activities such as LWD emplacement (Table 3.6).

4.1.3 EROSION ISSUES

4.1.3.1 Changes in Erosional Processes

Erosional processes are believed to be different now, in both rate and timing, than they were under reference conditions. Historically, erosion rates were probably generally lower than they are currently, but they increased dramatically in association with periodic fires and large storm events. Such increases in erosion were generally short-lived. Erosional events were always largely episodic in nature, but it is likely that high stream flows elicit more erosion today, as compared with historic times, because of additional sediment contribution by roads. We would expect that rates of erosion throughout the watershed reached their peak shortly after the Tillamook Burn fires and associated salvage logging, and then decreased substantially after revegetation.

Debris flows constitute the principal erosional process in the Trask River watershed. They generally occur in response to large storm events, and often are associated with roads and, to a lesser extent, clearcut harvests. To some extent, debris flows are beneficial, providing sediment and LWD to the stream system. Throughout the Oregon Coast Range, past road-building, logging, and fires increased the frequency of debris flow occurrence, contributing to increased sedimentation in the lower rivers and bays. Although there is a lack of Trask-specific data, we would expect the same to have been true in the Trask watershed, since geological, disturbance, and vegetation conditions have been similar to neighboring watersheds. Improved road construction and logging practices have reduced this impact throughout the Coast Range.

Bank erosion is also important throughout the watershed. Based on results obtained in ODFW stream surveys (109 miles on 23 streams), approximately 14% of the stream banks in the Trask River watershed are actively eroding. Bank erosion in mature riparian stands would be expected to be very low (Table 4.2). The highest levels of bank erosion were recorded in the East Fork of the South Fork (30%), Elkhorn Creek (30%), and Lower Trask (23%) subwatersheds.

Established and mature woody riparian vegetation adds the greatest rooting strength to the streambank and the greatest flood plain/streambank roughness; annual riparian vegetation (e.g., grasses) adds the least. Streambank erosion rates for Tillamook Basin rivers, analyzed by ODEQ, are given in Table 4.2, showing dramatically lower median percent of streambank actively eroding for banks dominated by mature forest, as opposed to young forest stands or annual vegetation. Efforts to increase the extent to which riparian areas are occupied by mature forest types would be expected to decrease bank erosion.

Table 4.2. Relationship between riparian vegetation type and percent of stream bank actively eroding, based on ODFW survey data in the Tillamook Basin. (Source: ODEQ 2001)

Riparian Vegetation Type	Median Percent of Stream Bank Actively Eroding
Annual (grass-dominated)	37
Young Hardwood	18
Young Conifer	16
Mature Hardwood	3
Mature Conifer	0

The type of material delivered to the stream and estuary systems has also changed. During historic times, landslides and, to a lesser extent, blowdown provided abundant LWD to the stream system. This LWD was relatively stable in some portions of the stream channel because of its large size, the abundance of large trees along the stream bank which served to anchor the LWD, and the generally narrower channels that prevailed at that time. This LWD contributed structure to the channel, altered flow patterns, dissipated stream energy, reduced bank erosion, retained gravel, and promoted pool formation. It also contributed some LWD to the estuary, which would have provided increased estuarine habitat complexity.

There is little input of large wood to the stream system today because the forests, and especially the riparian areas, are dominated by smaller trees. The smaller wood contributed by landslides today is more easily transported downstream during high flow periods and provides little structural complexity to the channel system.

4.1.3.2 Management Impacts on Erosion

Changes in erosional processes have occurred as a result of land use practices since Euro-American settlement and the Tillamook Burn fires. The principal historic land use activities that have contributed to increased current erosion rates were road building and logging in the uplands and practices associated with agriculture and flood control in the lowlands (especially vegetation removal, channel straightening, diking, and wetland draining).

The legacy of land use within the watershed probably continues to cause accelerated erosion today, but the magnitude of effect is not known. In the uplands, human-caused erosion is probably most strongly associated with the presence of roads, especially those in closest proximity to stream channels and on steep slopes (Plate 12). In the lowlands, the absence of intact riparian vegetation and the continuation of land disturbing activities along stream channels contribute to accelerated bank erosion.

Logging practices improved substantially subsequent to passage of the Oregon Forest Practices Act in 1973. Practices are now mandated, including riparian buffers and cable yarding on steep slopes, to reduce soil disturbance and retain riparian vegetation during logging operations. More recent forestry operations cause less erosion than previously, but effects from past practices probably persist to some extent.

Conversion of lowland forest and wetland areas to agriculture during the 19th and early 20th centuries contributed substantially to bank and surface erosion. In addition, many sediment deposition areas were bypassed or eliminated and the lower river was channelized, thereby contributing to enhanced sediment transport from the river to Tillamook Bay. Such impacts continue to the present. The increased peak stream velocity that has resulted from channelization and diking has increased the erosion capability of the Trask River. In addition, the clearing of vegetation along the lower riverbanks has reduced bank resistance to erosion. Some of these changes are probably irreversible. Erosion due to agricultural practices has been reduced to some extent by implementation of Best Management Practices (BMPs), although such changes do not appear to have been dramatic or widespread in recent years. Riparian restoration and planting efforts should continue to make modest improvements in bank stability. Greater reductions in erosion on agricultural lands might be achieved by bringing more farms under Voluntary Farm Water Quality Management Plans.

4.1.3.3 Potential Future Sources of Sediment

It is likely that future sources of sediment to the stream system will continue to include legacy effects of past road construction, fire, and logging operations. In general, however, such erosional sources will probably continue to diminish in importance over time as problem culverts are replaced, roads are upgraded or decommissioned, and forest and riparian vegetation continue to develop. Future logging and associated road building may contribute new sources of erosion, but proper road design, maintenance practices, and careful adherence to current management practices should minimize such impacts. It will be important to carefully consider management actions, especially those associated with roads in landslide hazard locations, in consultation with geotechnical specialists.

4.1.3.4 Priority Locations for Projects to Address Erosion Issues

Steep lands within the watershed are susceptible to landslides and debris flows, even with no disturbance. Much of the watershed is on steep terrain, especially in the South Fork, Upper Trask, and North Fork subwatersheds, and in proximity to the mainstem within the North Fork of the North Fork and the Elkhorn Creek subwatersheds. Management decisions regarding steep lands should be carefully considered, possibly avoiding land-disturbing activities in such areas.

Current management-related erosional impacts in the Trask River watershed uplands are largely attributable to roads, which are subject to erosion of fillslopes, cutslopes, road surface (of unpaved roads), and ditches. In steep areas subject to shallow, rapidly-moving landslides, roads increase the risk of slope failure on both the underlying slope (oversteepened and low strength) and the slope above the road (oversteepened). Drainage ditches associated with roads route surface runoff, thereby contributing increased sediment delivery if the ditches are hydrologically connected to streams.

Erosion control efforts in upland portions of the watershed should be especially focused on areas subject to recent or ongoing land-disturbing activities. Particular attention should be paid to midslope roads in steep areas with high debris flow hazard, especially such areas that include many road/stream crossings (Table 4.3) and those that have high road densities (Table 4.4). The presence of roads within 200 ft of a stream on steep terrain is a particular cause for concern. Such roads are not common within the watershed, but are most prevalent in the North Fork Trask and North Fork of the North Fork subwatersheds (Table 4.5, Plate 12). For more information on roads and erosion, see section 4.2.1.

Areas that are experiencing high bank erosion, including the East Fork of the South Fork, Elkhorn Creek, and the Lower Trask River subwatersheds, should also be considered good candidates for erosion control actions where it is determined that the bank erosion is partly attributable to human activities. These could include such actions as riparian planting, LWD emplacement (in appropriate CHTs), culvert replacement, and road repair and decommissioning.

4.1.4 WATER QUALITY ISSUES

Water quality in the Trask River, especially above the forest/agriculture interface, is generally good for most parameters of interest. Some water quality degradation has occurred, however, since Euro-American settlement, mostly involving increases in water temperature and fecal coliform bacteria (FCB) concentration in some areas. High temperature has been found to occur during late summer and early fall, especially in the Trask River mainstem and North Fork Trask River mainstem areas. Bacterial problems are primarily confined to areas downstream from the forest/agriculture transition. Localized lowland areas (primarily the sloughs) exhibit low dissolved oxygen and may be at least periodically inhospitable for biota. Nitrogen (N) concentrations have increased over the last four decades, probably due to the increased prevalence of N-fixing alder stands in riparian areas. Phosphorus (P) concentrations during stormflow are probably higher than under reference conditions due to erosional inputs of geologic material that has naturally high P content.

Among the five rivers that flow into Tillamook Bay, the estimated annual loading rate for FCB (cfu per unit time) was highest for the Trask River (2,000 to 3,200 x 10^{12} cfu/year). Similarly, the estimated total suspended solids (TSS) loading (mass per unit time) for the Trask River (185 x 10^6 kg/yr) was second only to the estimate for the Wilson River (314 x 10^6 kg/yr), and the estimated total inorganic nitrogen loading (which can contribute to eutrophication of the bay) was highest for the Trask River (1.1 x 10^6 kg/yr; Sullivan et al. 1998b). Thus, the Trask River watershed accounts for proportionately more pollution (bacteria, sediment, nitrogen) loading to

Table 4.3. Available data regarding condition of culverts and roads on ODF lands by subwatershed. (Source: ODF roads database).

				Culverts (Stream Crossings)			Roads (mi)		
Subwatershed	Subwatershed Area (sq mi)	Road Length (mi)	Road/ Stream Crossing	Collapsed/ Blowout Culverts	Damaged Culverts[a]	Total Culverts Surveyed	Fill Condition (Steep/Water)	Slide Activity (Drop/ Slide/Crack)	Downslope Risk (High)
EF of SF Trask	29.0	87.9	155	2	12	32	11.9	15.2	13.7
Elkhorn	17.3	35.6	70	0	16	35	3.7		5.1
Lower Trask	22.5	1.9	1	0	3	3			
MF of NF Trask	13.2	18.9							
NF of NF Trask	12.7	22.5							
NF Trask	29.3	70.1	182	5	8	52	13.4	20.7	12.1
SF Trask	23.3	49.4	99	4	19	51	10.4	6.7	0.8
Upper Trask	27.6	39.0	82	0	21	51	11.1	7.6	0.4
Grand Total	174.9	325.1	589	11	79	224	50.5	50.2	32.1

[a] Damage based on visual inspection for mechanical damage, rust, and sediment build-up

Table 4.4 Road density in subwatersheds of the Trask watershed.		
Subwatershed	Area (mi^2)	Road Density (mi/mi^2)
East Fork of South Fork of Trask River	29	3.6
Elkhorn Creek	17	3.8
Lower Trask River	22	5.6
Middle Fork of North Fork of Trask River	13	2.8
North Fork of North Fork of Trask River	13	5.6
North Fork of Trask River	29	3.0
South Fork of Trask River	23	2.8
Upper Trask River	28	3.2
Total	175	3.7

Table 4.5 Length of road segments less than 200 ft from a stream and on steep slopes (>50%, >65%, and >70%), by subwatershed.

Subwatershed	Road Length Surveyed (mi)	Length <200 ft from Stream (mi)	Length <200 ft from Stream and on Steep Slope (mi)		
			>50% Slope	>65% Slope	>70% Slope
EF of SF Trask	105	16.9	0.7	0.1	0.1
Elkhorn	66	11.0	1.9	0.7	0.4
Lower Trask	126	10.8	0.6	0.3	0.2
MF of NF Trask	37	6.0	0.2	0.01	-
NF of NF Trask	71	13.2	2.9	0.6	0.3
NF Trask	86	14.4	3.2	1.2	0.8
SF Trask	64	11.1	1.4	0.4	0.3
Upper Trask	89	14.7	2.2	0.8	0.4
Total	645	98.2	13.1	4.1	2.6

the bay than any of the other rivers in the Tillamook Basin. Nevertheless, in comparison with other rivers in western Oregon, water quality in the Trask River is considered fairly good.

4.1.4.1 Temperature

Stream temperature is of vital importance to salmonid health and well-being. It influences the metabolism, growth rates, availability of food, predator-prey interactions, disease-host relationships, and timing of life history events of fish and other aquatic organisms (Spence et al. 1996). Temperature requirements vary by species and life stage (Table 4.6), and conditions most frequently approach harmful levels in the late summer when air temperatures are high and streamflows are low.

Table 4.6. Optimum and lethal limit stream temperatures for coho and chinook salmon. (Source: ODEQ 1995)		
	Fish Species	
	Coho	Chinook
Preferred juvenile temperature range	54-57^{o}F	50-60^{o}F
Adult migration, holding or spawning	45-60 ^{o}F	46-55^{o}F
Lethal limit	77 ^{o}F	77 ^{o}F
State water quality standard for rearing and migration	64 ^{o}F	64 ^{o}F

Many studies have concluded that stream temperature increases in response to timber harvesting, especially when vegetation is removed up to the edge of the stream (Levno and Rothacher 1967, Meehan 1970, Feller 1981, Hewlett and Fortson 1982, Holtby 1988, ODF and ODFW 2002). Allowing riparian vegetation to remain near the stream has been shown to reduce the effects of harvesting on stream temperature (Brazier and Brown 1973, Kappel and DeWalle 1975, Lynch et al. 1985, Amaranthus et al. 1989, ODF and ODFW 2002). Consequently, forest management policies now require the maintenance of a riparian vegetation buffer along streams on private, state, and federal lands. A study conducted by ODF to assess the effectiveness of Riparian Management Areas found that the state water quality temperature standard (64 ^{o}F) was exceeded 9.4 % of the time, and concluded that, "…consistent, if not significant, increases in stream temperature below harvested reaches indicate that the forest protection rules may not always provide adequate protection to meet water quality standards" (Dent and Walsh 1997). However, this study focused on medium and large streams, and lacked pre-harvest data for comparison. In general, the response of stream temperature has been found to vary based on stream size and the amount of stream surface exposed by harvesting. When more forest canopy is removed, more solar radiation reaches the stream surface, increasing the temperature (Beschta et al 1987). For small, headwater streams, there is the potential for temperature increases to diminish within 500 ft downstream of harvest activity, although the magnitude of recovery is highly variable (Caldwell et al. 1991, ODF and ODEQ 2002).

Riparian corridors develop a microclimate characterized by cooler air temperatures and higher relative humidity as compared with unvegetated streamside areas. For example, riparian vegetation removal increased near-stream air temperatures by up to 8EF, based on research along 20 small streams in western Washington (Dong et al. 1998). Near-stream ground temperatures can be an even greater source of heat to the stream because the heat conductivity of soil is typically 500 to 3,500 times greater than that of air (Halliday and Resnick 1988). Brosofske et al. (1997) estimated that a minimum stream buffer width of 150 ft was required to maintain soil temperatures that reflect those of a normal microclimate.

<u>Shade Analyses</u>

In the Trask watershed, three assessments of stream shade have been conducted over the past decade. Shade conditions were recorded by ODFW field crews during stream habitat inventories between 1990 and 1997. The mainstem of the Trask River, the North Fork, and the North Fork of the North Fork were studied and shade was modeled by ODEQ for the TMDL. Finally, ODF commissioned a graduate student to study and map stream shade from aerial photos (Falcy 2002). The ODFW and ODF studies produced similar results with regard to stream shade. Based on the stream shade analysis of ODF lands by Falcy (2002), the subwatersheds having the lowest percentages of stream in the high (> 70%) shade category are the Lower Trask (43%), Upper Trask (86.3%) and North Fork of the North Fork (87%) subwatersheds (Table 4.7). All other subwatersheds were judged to have at least 93% of the stream length on ODF lands rated as having high shade.

Table 4.7. Stream shade on ODF land (Falcy 2002)

Subwatershed	Stream Shade					
	Low (< 40%)		Medium (40-70%)		High (> 70%)	
	mi	%	mi	%	mi	%
East Fork of South Fork of Trask River	1.8	1.4	0.4	0.3	128.4	98.3
Elkhorn Creek	0.9	1.9		0.0	44.8	98.1
Lower Trask River	0.5	32.6	0.4	24.3	0.7	43.0
Middle Fork of North Fork of Trask River	0.7	1.9	1.2	3.2	36.1	94.9
North Fork of North Fork of Trask River	1.5	4.8	2.6	8.1	28.1	87.1
North Fork of Trask River	2.3	1.6	2.6	1.8	135.2	96.5
South Fork of Trask River	4.9	4.8	2.2	2.2	94.8	93.0
Upper Trask River	6.6	8.7	3.8	5.0	65.3	86.3
Total	19.3	3.4	13.2	2.3	533.4	94.3

Similar results were obtained by ODFW in their aquatic inventories, which included stream lengths on BLM and private lands as well as ODF lands (Table 4.8). The lowest shade was found in the Lower Trask (32%), Upper Trask (60% to 67%), and the North Fork of the North Fork (72% to 79%) subwatersheds. Shade conditions were frequently above 90% in other subwatersheds. These data suggest a particular need for shade-enhancing activities by private landowners in the Lower Trask subwatershed, and by all ownership classes in the Upper Trask subwatershed and throughout the North Fork of the North Fork tributary system.

ODEQ measurements of shade are summarized for the mainstems of the Trask River, the South Fork, and the North Fork (including the North Fork of the North Fork) in Figure 4.2. Shade levels were lowest for the Trask mainstem, at 30% canopy cover, and the North Fork was 61% canopy cover. The South Fork had the highest canopy cover, at 91% (Figure 4.2). Field measurements of effective shade and canopy cover by ODEQ are currently about 40% higher in

Table 4.8. Average percent stream shade from ODFW Aquatic Habitat Inventories (1990-1997).			
Subwatershed	ODF	BLM	Private
East Fork of South Fork of Trask River	93.7		96.3
Elkhorn Creek	93.6	91.0	91.4
Lower Trask River			32.0
Middle Fork of North Fork of Trask River	82.8	76.0	97.0
North Fork of North Fork of Trask River	79.2		72.0
North Fork of Trask River	80.9	67.7	98.0
South Fork of Trask River	92.3	100.0	95.1
Upper Trask River	60.6	63.3	67.8
Total	83.3	79.6	81.2

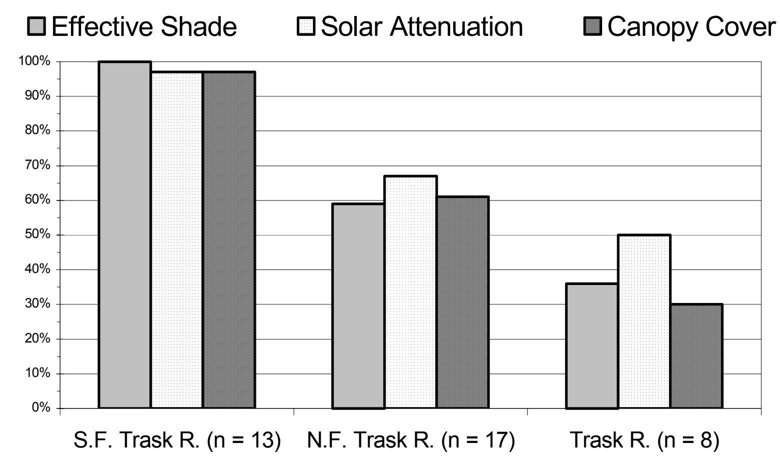

Figure 4.2. Comparisons among the mainstem South Fork, North Fork, and Trask River subwatersheds with respect to effective shade, solar attenuation, and canopy cover, based on ODEQ data, which did not go far up into the tributaries. (Source: ODEQ 2001).

the South Fork Trask River mainstem than they are in the North Fork mainstem (Figure 4.2), and this is likely an important reason for the higher stream temperatures in the North Fork mainstem (Figure 4.3).

GIS analyses also indicate that the North Fork of the North Fork system has a greater percentage of its drainage basin facing to the south (" 45E) than does the upper South Fork system (31% versus 20%). In addition, the geomorphology of the North Fork of the North Fork subwatershed may contain fewer springs and seeps, and exhibits lower summer flows (c.f., Falcy 2002). Thus, it is perhaps not surprising that the North Fork mainstem is consistently warmer than the South Fork (Figure 4.3), and the differences become more pronounced later in the season as the water temperatures increase. By late summer in 1998, the North Fork was about 4EF warmer than the South Fork.

It has been hypothesized that current shade conditions in many areas may actually be higher today than prior to Euro-American settlement (ODF and ODEQ 2002). Based on a comparison of historical forest age class distributions from 1850 to 1929 by Botkin et al.(1995) and current age class distributions on non-federal lands (Robison et al. 1999), it appeared that much of the area that was once occupied by age classes that provided “moderately high” to “very low” shade (the 0 to 3 yr and 200+ yr age classes), are now covered by age classes that provide "moderate" to "very high" shade levels (the 4 to 50 yr age class; ODF and ODFW 2002). However, the specific distribution of forest age classes in historical times in the Trask watershed, and the degree of shade provided by each, is unknown. Furthermore, the degree to which riparian vegetation was similar to upslope vegetation is also uncertain.

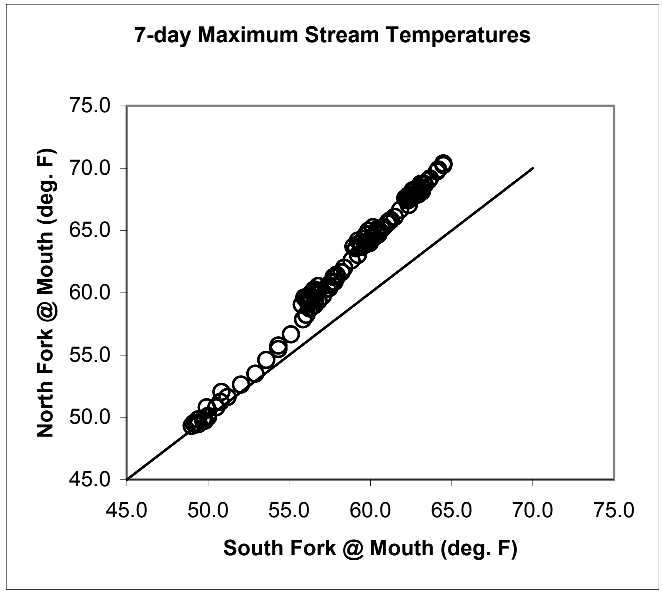

Figure 4.3. Comparison of 7-day maximum stream temperatures during the period May to October 1998 between the North Fork and South Fork Trask River (@ mouths). (ODEQ data)

Stream primary productivity can be augmented as a result of increased light reaching the stream, and this can add to the available food for salmonids (MacDonald et al. 1991, Murphy and Meehan 1991) and also can increase salmonid production and/or growth in the short term (Tschaplinski 1999). Under reference conditions, it is likely that shade was higher along mainstem reaches, but perhaps was generally lower and more variable than it is today at many upstream locations.

Temperature Monitoring

Whereas assessments of shade are frequently used as a means of estimating water temperature conditions in the absence of temperature data, several studies in the Trask have gathered stream temperature data using automated data loggers.

Falcy (2002) collected continuous stream temperature data at 16 upper tributary sites in the Trask River watershed between late July and late September, 2002. None of the monitors recorded a 7-day moving mean of daily maximum temperature above the 64EF critical value for salmonid migration.

In contrast, based on ODEQ continuous temperature monitoring data, stream temperatures were above desirable levels for extended periods of time during July through October, 1998 along the mainstems of the Trask River, North Fork and North Fork of the North Fork. These stream reaches had been included on the 303(d) list for temperature, but are now under a TMDL. The best (coolest) temperature conditions were found in the South Fork of the Trask system. Based on ODEQ data collected in 1998, early August temperatures in the Trask River were generally in the upper 50EF range in the headwaters and warmed to the 70EF range in the lower river (Plate

13). The temperature criterion to protect migrating salmonids is 64°F, but it is not known if the lower river was usually below that value, even under reference conditions.

It is important to note that the temperature monitoring data collected by Falcy in 2002 and ODEQ in 1998 are not necessarily in conflict. The former showed small tributary reaches below the salmonid migration temperature criterion and the latter showed some mainstem reaches above the criterion. It is not known whether conditions differed between study years or to what extent the measured high temperatures in 1998 were confined to mainstem reaches.

High stream temperatures along the mainstem streams were attributed by ODEQ primarily to historical near-stream vegetation disturbance and removal, and secondarily to channel modifications and widening, with consequent increased width-to-depth ratios (ODEQ 2001). In addition, it is possible that riparian disturbance from the 1996 floods temporarily reduced shading in some areas. Stream temperatures have been shown to increase in the Oregon Cascade Mountains in response to debris flows that removed riparian vegetation (Johnson and Jones 2000).

ODEQ found that water temperatures in the Trask River headwaters are often more than 10EF cooler than near the mouth, and vary in a consistent fashion with distance from headwaters (Figure 4.4). To some extent this pattern is driven by shading, which is much reduced in lowland areas. It is also likely, however, that water temperatures would rise as the water moves downstream even if maximum potential shading was realized basin-wide, largely because the stream becomes wider than the cover provided by vegetation. Thus, there is a natural component to this observed pattern, but it is also influenced by past and present land use and land cover.

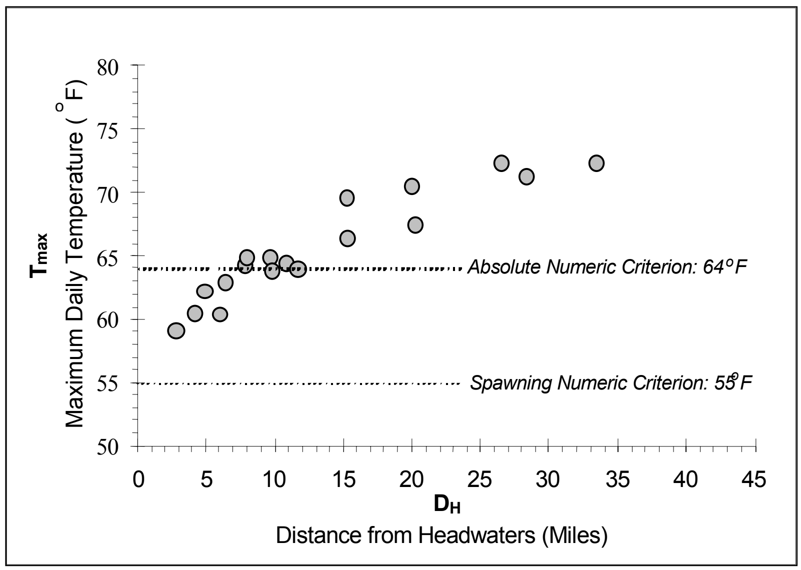

Figure 4.4. Maximum daily temperature in the Trask River as a function of distance from headwaters. (Source: ODEQ 2001)

Limited time series data suggest that stream temperatures may have generally been decreasing in recent decades (Figure 3.16), probably in response to continued gradual vegetation development subsequent to large-scale deforestation associated with the Tillamook Burn fires and salvage logging. Despite apparent recent improvements, however, stream temperatures exceeded the salmonid migration criterion for extended periods of time in 1998 at several locations (Table 3.12).

ODEQ Modeling

A limiting factor in our ability to reduce the extent of longitudinal stream heating is the natural maximum level of shade that a given stream is capable of attaining, based on tree height, stream width, and stream aspect relative to solar azimuth. The site potential effective shade (ES) is defined as the effective shade of that stream, given the natural stream geometry and mature riparian vegetation. Effective shade is given by (c.f., ODEQ 2001):

$$ES = \frac{Solar_1 - Solar_2}{Solar_1}$$

where $Solar_1$ = potential daily solar radiation load in the absence of vegetation, and

$Solar_2$ = measured daily solar radiation load at the stream surface.

There is a strong inverse relationship between effective shade and temperature of largely mainstem reaches in the Tillamook Basin (Figure 4.5). ODEQ concluded that these data suggest that an effective shade of 80%, averaged over all reaches analyzed by ODEQ (2001), would likely result in stream temperatures below the 64EF water quality standard. However, it is unclear to what extent 80% effective shade is achievable on the wider mainstem reaches.

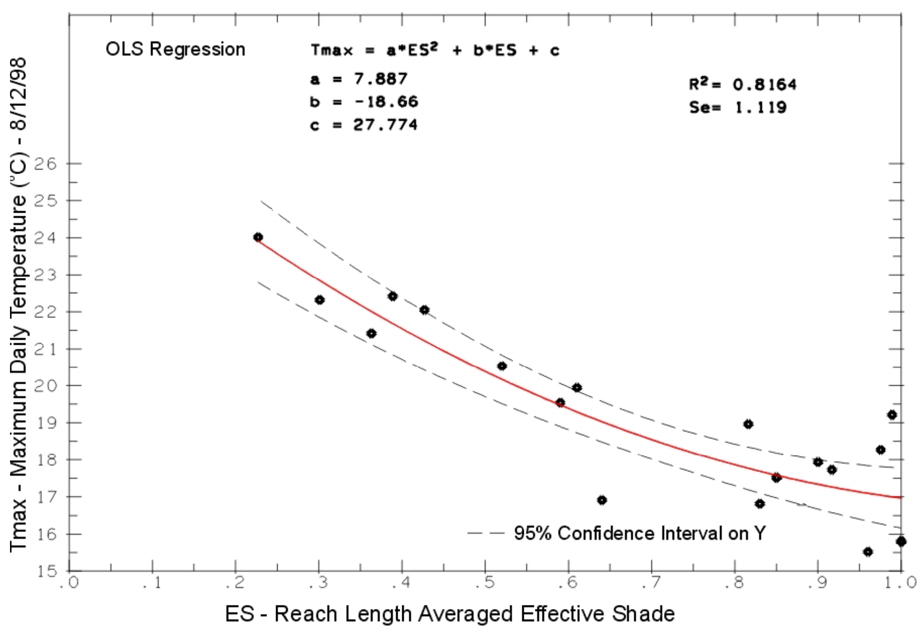

Figure 4.5. Maximum daily stream temperature as a function of reach length averaged effective shade for rivers throughout the Tillamook Basin. (Source: ODEQ 2001)

In the areas of the Trask River where temperature criteria are exceeded, ODEQ considers attainment of "system potential" temperature conditions, as measured by percent effective shade, to demonstrate compliance with the temperature standard. This compliance is intended to be obtained through protection and restoration of riparian vegetation, channel morphology, and hydrologic processes. ODEQ (2001) simulated, using Heatsource 6.5, the thermal effects on system potential riparian vegetation and channel morphology, thereby minimizing the influence of human-caused increases in stream temperature.

ODEQ (2001) analyzed and simulated 74.6 miles of the mainstem Trask, Wilson, and Kilchis Rivers during the critical period (August 12, 1998). This analysis suggested that 59% of the mainstem river reaches had temperatures in the range of 68EF to 72EF, and 24% of the river reaches exceeded 72EF. In contrast, the actual measured ambient temperature conditions showed 98% of the analyzed mainstem reaches currently having maximum daily water temperature during the critical period greater than 64EF, with about 85% exceeding 68EF, and 24% exceeding 72EF (Figure 4.6). The simulated system potential condition suggested that 73% of river reach should have temperature between 60EF and 64EF, 26% between 64EF and 68EF (and therefore above the standard), and no temperatures above 68EF.

ODEQ modeling conducted for the Tillamook Basin TMDL also suggested that ground-level shade along the mainstem Trask River decreased from near 80% at RM 30 to near zero at RM 0, and that there was an increasingly larger divergence downstream between current shade conditions and model estimates of system potential shade. The model results suggested that the system potential shade exceeded about 50% throughout the entire mainstem. In contrast, estimated current shade was less than 50% in most portions of the mainstem within about 26 miles of the mouth. The system potential shade was simulated using the Heatsource 6.5 model by increasing tree heights and densities to those expected in mature riparian communities, assumed to be 125 ft in lowland areas (higher percentage deciduous) and 175 ft in upland areas (primarily conifers).

Model estimates of the difference between current early August temperature conditions and system potential temperature conditions ranged from generally near 5EF difference between RM 20 and 30 to near 10EF difference near the mouth. Even under system potential conditions, however, ODEQ (2001) concluded that the Trask River would not meet the numeric temperature criteria of the water quality standard for salmonid rearing and migration in many places, particularly in the lower reaches of the watershed.

An important limitation of this analysis, however, was the assumption by ODEQ that the natural riparian stand would be uniformly vegetated with 80- to 100-year-old trees. This conflicts with our understanding of riparian vegetation under reference conditions, which likely included a mosaic of stands of different ages and species, created by periodic disturbances (Botkin et al. 1995, Reeves et al. 2002). Based on an analysis of central Coast Range riparian areas along first- to fourth-order streams that were subject to stand-replacing fires about 145 years ago, Nierenberg and Hibbs (2000) concluded that riparian areas in the Coast Range were spatially and temporally diverse prior to settlement. Conifer frequency increased with distance from the stream, and appeared limited in the near-stream zone by the competitive advantage of hardwoods and shrubs. Thus, the shade target produced in the TMDL might have resulted in average estimated shade

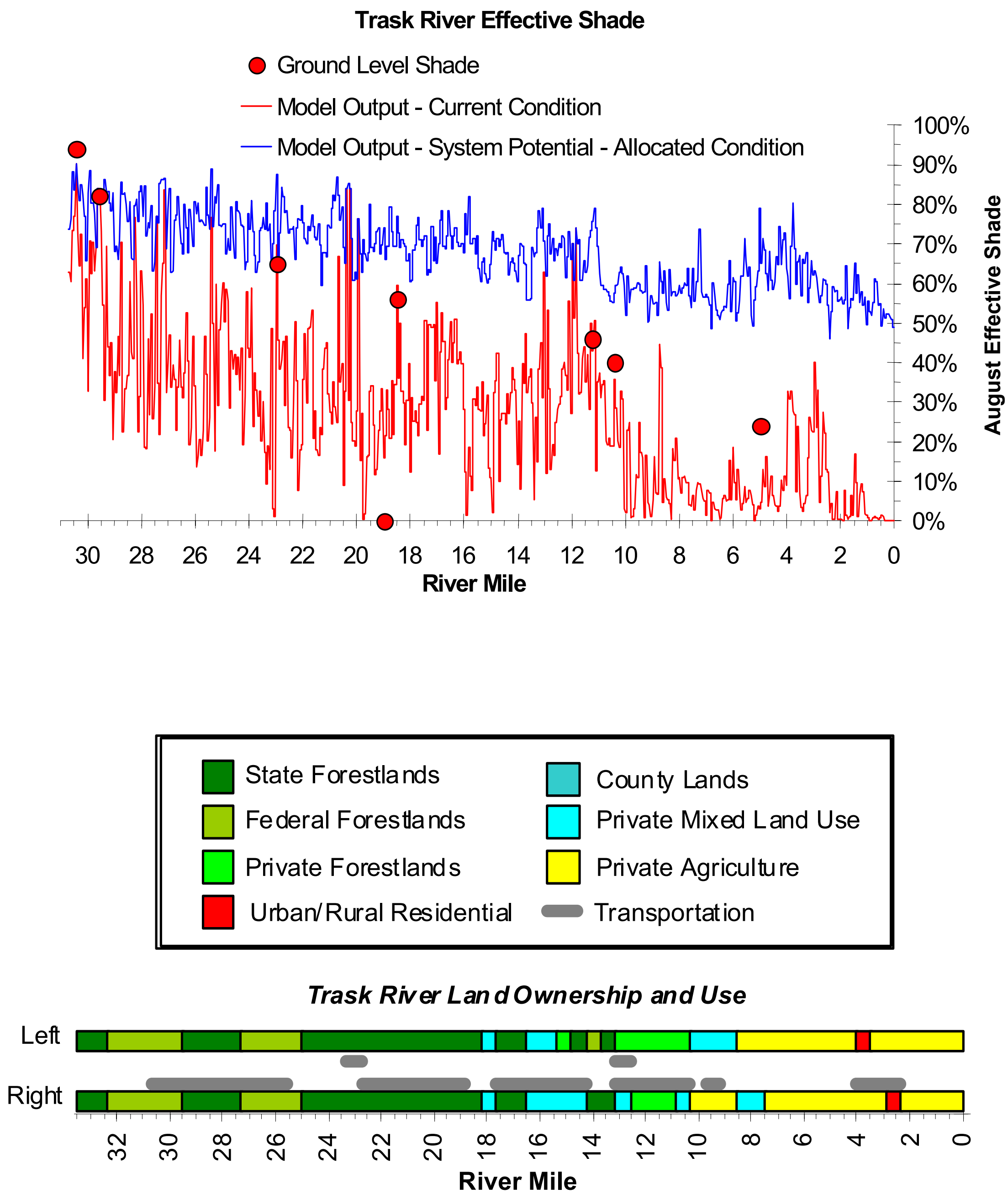

Figure 4.6. Model estimates and limited measured values (filled circles) of effective shade along the lower 30 miles of the Trask River. Effective shade was modeled as both current condition (upper data sequence) and system potential (lower data sequence). Most ODF and BLM land is upstream from river mile 18. (Source: ODEQ 2001)

levels that were higher than what actually occurred historically (ODF 2001). Nonetheless, it is also possible that an older forest having a multi-layered canopy might maintain cooler near-ground air temperatures, even if shade levels were slightly lower. Cooler air temperatures, especially within the riparian zone, would allow less heating of streamwater.

Influence of Other Factors

Other factors, some of which are related to shading, are also at least partially responsible for the observed high stream temperatures in 1998 in the mainstem reaches that were monitored. They include:

- riparian corridor (and, to a lesser extent, forest-wide) microclimate
- prevailing watershed aspect (S- and W-facing are warmer than N- and E-facing)
- prevalence and temperature of seeps, springs, and groundwater inflow
- amount of exposed rock in the stream channel (which can effectively absorb solar heat)
- reduced summer flows

In addition, even if some reaches have elevated solar radiation and stream temperature levels, an adequate supply of deep pools can provide cold-water refugia from adverse temperature conditions. Temperature differences between the stream surface and stream bottom can range up to 8EF in deep pools (Matthews et al. 1994, Nielson et al. 1994). Deep pools are less prevalent today than during reference conditions, mainly because of the reduction in LWD.

Preliminary Conclusions Regarding Stream Temperature in the Trask Watershed

Stream temperature is an important issue because a substantial portion of the Trask River system was 303(d) listed and is now under a TMDL, and because stream temperatures in some listed areas are potentially influenced by ODF and BLM management actions. Despite the importance of the issue, however, available data do not adequately reveal the spatial and temporal extent of the problem or the degree to which ODF and BLM management actions currently contribute to high stream temperatures and/or can contribute to temperature reductions. Available data do, however, rather conclusively indicate the following:

1. Stream temperatures in 1998 exceeded the salmonid migration criterion at many locations along the Trask River mainstem and in the mainstem portions of North Fork and North Fork of the North Fork.
2. Stream temperatures in 2002 did not exceed the salmonid migration criterion at any of the 16 monitored upper tributary locations.

3. Stream temperatures in both the mainstem rivers (ODEQ 2001) and upper tributaries (Falcy 2002) increase in a downstream direction. This would occur to some extent regardless of management actions, and undoubtedly occurred under reference conditions.
4. Stream temperatures increase with decreases in effective shade.
5. Effective shade is high throughout most of the upper watershed, but is lower along the mainstem reaches, especially in lowland areas.
6. Under reference conditions, effective shade was variable, in response to a mosaic of disturbed areas and late-successional and younger riparian stands. Deep pools, created by abundant LWD, provided cold-water refugia.
7. Stream temperature at the mouth of the North Fork of the Trask River is generally higher than at the mouth of the South Fork of the Trask River, especially during the warmest times of the year. The amount of shade and the prevailing hillslope aspect are probably important contributors to this observed difference.

Because stream shading is generally high in most areas on public lands, it is not clear that ODF and BLM management actions can be very effective in decreasing stream temperatures throughout the watershed. However, it is likely that 1) shading can be increased along mainstem Trask River and mainstem tributary reaches, especially in the North Fork system, and 2) such increases in shading would lead to decreased mainstem stream temperatures.

It is not clear whether the high stream temperatures documented by ODEQ in 1998 in mainstem locations were influenced by removal of riparian vegetation during the 1996 flood. It is also not clear how far up the tributary systems high temperatures typically extend. Placement of temperature monitors in past studies has not provided a sufficient sampling of temperature conditions simultaneously throughout small tributaries, mid-sized streams, and large streams to determine upstream-downstream effects or basin-wide conditions. The ODEQ data from 1998 did not examine smaller streams, and Falcy (2002) did not examine mid- or large-sized streams. Additional monitoring data would be needed to adequately evaluate the spatial and temporal patterns of high temperature values, including those above the criterion. Frequent-interval (e.g., 30 minutes) monitoring at about 40 locations during one or two summer seasons would provide the needed data.

In April, 2003, the U.S. EPA released new guidance on water temperature standards in the Pacific Northwest (U.S. EPA 2003). EPA intends that Oregon will use this guidance to revise state water temperature standards to protect native salmon and trout, particularly those listed as threatened or endangered. The most substantive changes applicable to the Trask River watershed, as compared with the current standards, include the following:

- reduction of the 64EF salmonid rearing standard to 60.8EF in core rearing areas (this may apply to portions of the middle and upper reaches of the Trask River watershed)
- adoption of a 57.2EF criterion where early stages of steelhead smoltification occur (likely applicable in April and May)

The recommended reduction in the salmonid rearing standard in core rearing areas may have a large impact on temperature compliance throughout much of the Trask River watershed.

4.1.4.2 Fecal Coliform Bacteria (FCB)

FCB concentrations in the lower Trask River were monitored, mainly during rainstorms, between 1996 and 2002. Concentrations commonly exceeded 200 cfu/100 ml during the fall, winter, and spring seasons (Table 4.9; Sullivan et al. 2002). Highest concentrations were generally found during fall rainstorms. Two storms were intensively monitored at 14 locations from RM 0 to 9.0 (Loren's Landing) along the Trask River in the fall of 1997 and spring of 1998 by Sullivan et al. (1998b). Instantaneous FCB loading estimates above the forest/agriculture interface were consistently below about 0.3×10^6 cfu/sec during the fall storm and below about 0.05×10^6 cfu/sec during the spring storm. In contrast, estimated FCB loads at many of the downriver sites, which were heavily influenced by agricultural, rural residential, and in some cases urban land uses, were frequently more than an order of magnitude higher (Sullivan et al. 1998b). Highest loads were generally achieved in the lower two miles or so of river reach. This suggests the cumulative effect of many source areas within the lowlands and/or larger individual contributions of FCB close to the bay.

Table 4.9. Percent of monitored storms having median or geomean FCB concentration in the lower Trask River higher than 200 cfu/100 ml (Sullivan et al. 2002).

Water Year	n[a]	Median	Geomean
1997	2	0	0
1998	5	80	60
1999	6	100	33
2000	5	100	100
2001	5	80	80
2002	3	67	67

[a] n is the number of storms sampled

Evaluation by Sullivan et al. (1998b) of the spatial land use patterns within the contributing drainage areas to each of the monitoring sites revealed that the FCB load contributed from portions of the Trask River watershed to the various monitored sites was not clearly or consistently correlated with any of the identified land use features. However, highest loads were often associated with high percentages of urban, rural residential, and agricultural land use. Large numbers of rural residential building clusters were also frequently associated with high FCB loads. Findings were similar when FCB loads were normalized by contributing area and by length of river segment. These findings provide strong, albeit circumstantial, evidence that the areas that frequently contribute the largest FCB loads within this watershed are primarily influenced by human activities other than, or in addition to, dairy farming. Urban areas appear to be significant contributors, as do rural residential areas. The latter, however, may also contain intensive dairy farming activities in some cases.

These results suggest that the sites which showed the largest contributions of FCB to the Trask River, at least during the storms that were intensively monitored, occurred in association with human habitation, especially the urban and rural residential areas. Highest loads were often found in the lower section of the river, which is heavily ditched and where human activity is concentrated, soils are poorly drained, and runoff potential is high. FCB loads were high throughout the lower watershed, and appear to originate from a variety of sources.

There is little that can be done by ODF or BLM to reduce bacterial contamination in the Trask River. Most of that contamination occurs below the forest/agriculture transition. Control of bacterial levels is important, however, because of impacts on the bay oyster industry and concern about human contact recreation in both the lower river and the bay. There are no data to suggest that high bacteria concentrations have an adverse impact on fish.

In some cases, wildlife contributions of FCB to streams can be substantial, and can result in FCB concentrations considerably higher than the 200 cfu/100 ml health criterion. Such high concentrations have been documented in a small tributary to the Tillamook River that has extensive beaver and elk activity (Sullivan et al. in review). Nevertheless, FCB concentrations in the mainstem Trask River are generally well below the health standard at the forest/agriculture interface and only increase to what might be considered unsafe levels in response to agricultural, residential, and urban land uses further downstream.

4.1.4.3 Total Suspended Solids (TSS)

TSS concentrations exceeding 200 mg/L in the lower Trask River were commonly observed during high-flow periods, especially during large winter storms (Figures 4.7 and 4.8). Comparison of concentrations measured for paired samples collected at approximately the same time from the forest-agriculture interface and the lower mainstem suggested that most of the TSS in the Trask River originates in the upper forested portions of the watershed (Sullivan et al. 2002). Data from the storm-based monitoring effort (Sullivan, et al. 2002) measured the cumulative flux of TSS from the forested, and a large portion of the agricultural and urban, lands in the watershed. These data, therefore, reflect variations in the sediment loading to the lower river and the bay from major erosional sources located throughout the watershed.

TSS values in the lower Trask River are less than about 20 mg/L under low discharge (< 2,000 cfs) conditions. When discharge is above about 6,000 cfs, however, TSS generally exceeds 200 mg/L. Most of the sediment that is discharged from the Trask River to Tillamook Bay is transported as TSS during flood periods. Such floods occur primarily during winter months. Thus, TSS values during winter tend to be much higher than fall or spring values (Table 4.10).

ODEQ does not list a guide concentration for TSS in rivers of the north coast region, although guidelines for TSS and/or turbidity are under consideration (Eric Nigg, ODEQ, pers. comm.,

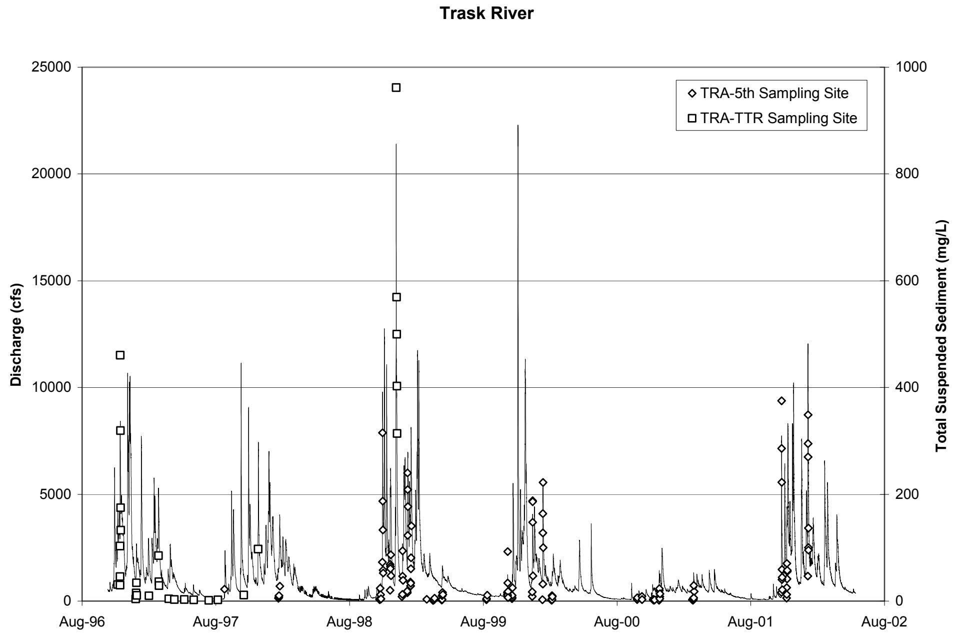

Figure 4.7. Discharge and measured values of total suspended solids in the lower Trask River throughout the period of monitoring from 1996 to 2002 (Sullivan et al. 2002).

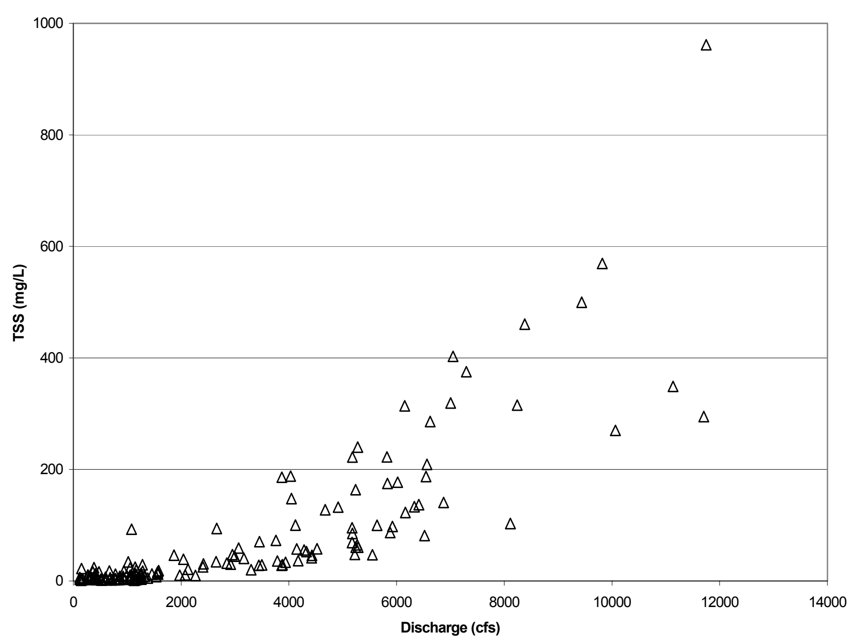

Figure 4.8. Relationship between total suspended solids and discharge for the lower Trask River, 1996-2002.

Table 4.10. FCB and TSS concentrations by season[a] in the lower Trask River, based on data collected during rainstorms between 1996 and 2002.						
	FCB (cfu/100 ml)			TSS (mg/L)		
	Fall	Winter	Spring	Fall	Winter	Spring
Number of samples	87	65	58	54	72	36
1st Quartile	205	93	111	5	18	3
Median	560	234	245	15	54	4
3rd Quartile	1153	440	788	51	152	10
[a] Fall was defined as Sept. 1 to Nov. 30, winter and Dec. 1 to Feb. 15, and spring as Feb 16 to May 31						

September 2002). Discharge-weighted storm median TSS is often above 100 mg/L in the lower Trask River during winter storms (Sullivan et al. 2002). High sediment loads constitute an important environmental concern because deposition of fine sediments can adversely impact the quality and availability of spawning gravel and can contribute to sediment accumulation in the bay. A comparison of bay bathymetric data collected in 1867, 1957, and 1995 (Bernert and Sullivan 1998) did not suggest that the bay was significantly deeper in 1867. Variance in the interpolation approach, combined with errors in the water depth measurements and inadequate documentation of the benchmarks to which the measurements were standardized, were so large as to prevent quantification of actual changes in the depth of the bay. The results were consistent, however, with an interpretation of greater depth complexity and less channelization on average in 1867.

4.1.4.4 Nutrients

Total phosphorus (TP) in the lower Trask River is strongly episodic, achieving high concentrations under high discharge conditions. Based on results of a one-year study at paired sampling locations, it appears that most of the TP in this river originates in the upper forested portions of the watershed (Sullivan et al. 1998a; Figure 4.9). Because the TP concentrations are strongly correlated with TSS (Figure 4.10), it is likely that much of the observed TP is geologic, rather than anthropogenic, in origin. Studies in neighboring watersheds have found high P levels in some sedimentary rock types (Dave Degenhardt, ODF, pers. comm., July 2003).

Concentrations of inorganic nitrogen, most of which is in the form of nitrate, are relatively low in the lower Trask River compared with rivers that are heavily influenced by urban or agricultural activities, ranging between about 0.3 and 1.1 mg N/L (Figure 4.11). Nevertheless, these concentrations exceed the U.S. EPA guidance value for total N (0.1 mg/L; U.S. EPA 2002). Most of this N originates in the upper, forested portions of the watershed (Sullivan et al. 1998a; Figure 4.12), probably from N-fixation associated with red alder and/or other N-fixing plants. The N concentration data exhibit strong seasonality, with highest concentrations during winter and lowest concentrations during summer (Figure 4.13). This pattern is likely due largely to biological uptake of N from both terrestrial and aquatic watershed compartments during the summer growing season and flushing of nitrate from the soil to the stream system during winter months.

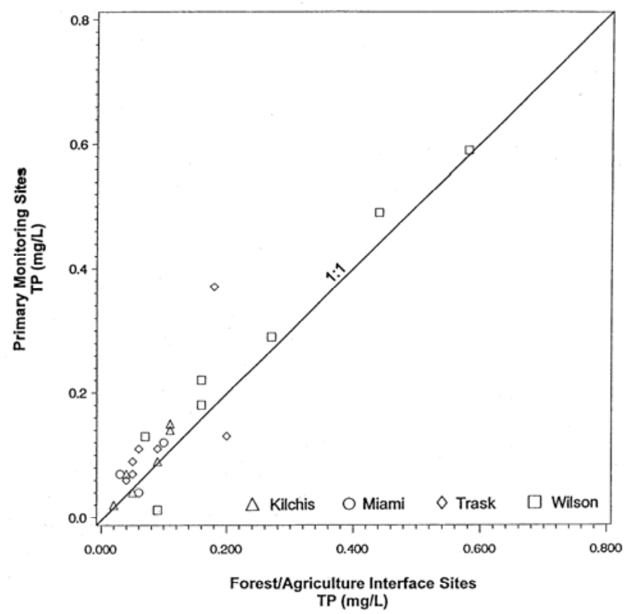

Figure 4.9. Results of paired sample analyses for total phosphorus (TP; mg/L) at the primary site and its respective forest/agriculture interface site for the four rivers in which both types of samples were collected. A 1:1 line is provided for reference. These data suggest that TP concentrations at the forest/agriculture interfaces are generally nearly as high as TP concentrations near the mouth of each of the rivers, respectively. Thus, most TP originates from the upper, forested portions of the watersheds (Sullivan et al. 1998a).

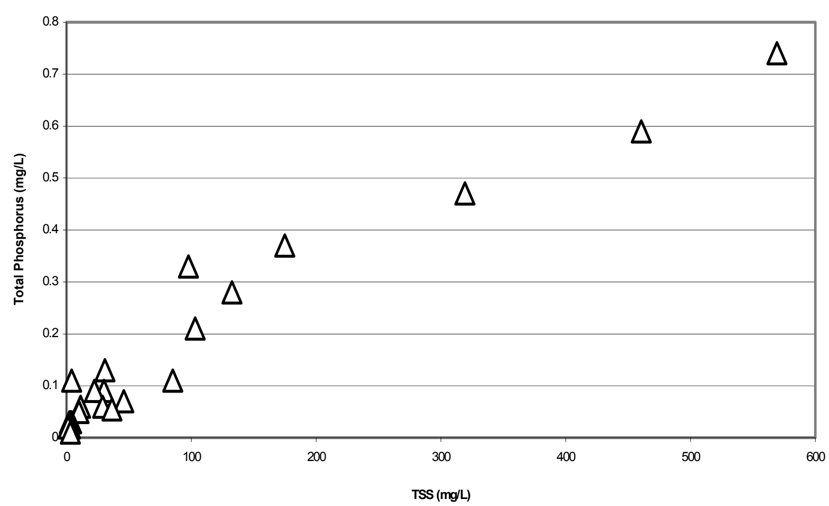

Figure 4.10. Measured values of total phosphorus versus total suspended solids (TSS) for the lower Trask River, 1996-2002.

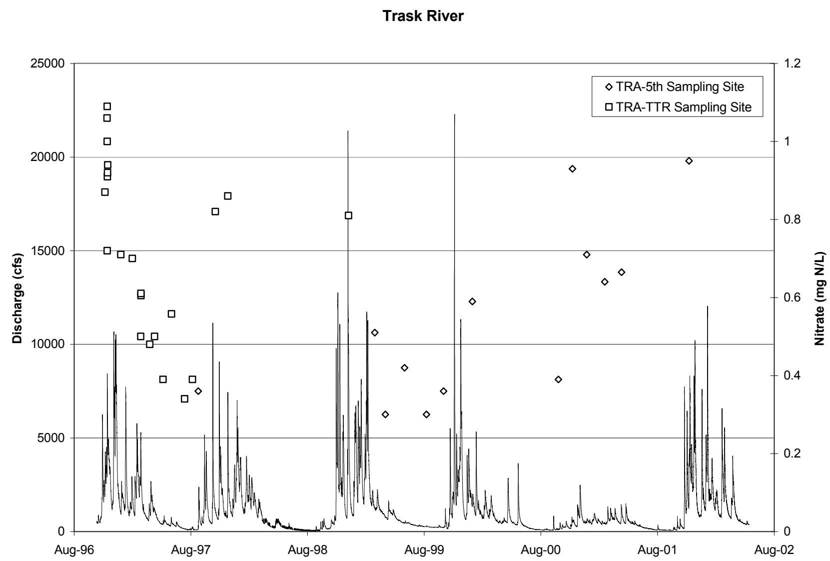

Figure 4.11. Discharge and measured values of nitrate for the lower Trask River (Sullivan et al. 2002).

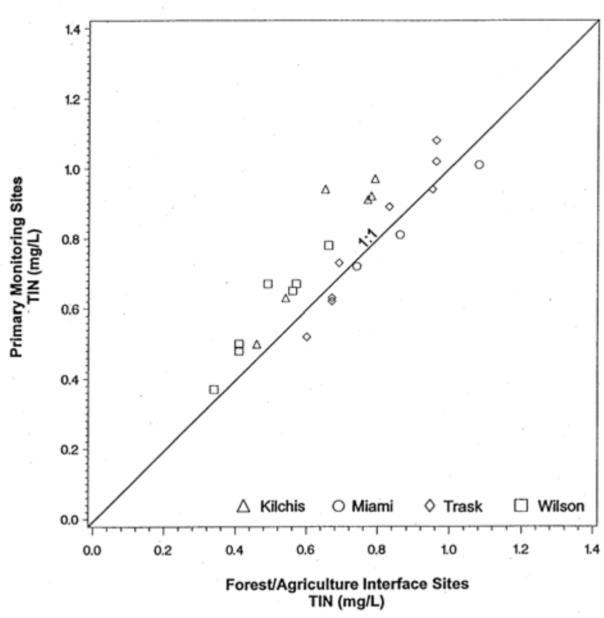

Figure 4.12. Results of paired sample analyses for total inorganic nitrogen (TIN; NO_3-N + NH_4-N; mg/L) at the primary site and its respective forest/agriculture interface site for the four Tillamook Basin rivers in which both types of samples were collected. A 1:1 line is provided for reference (Sullivan et al. 1998a).

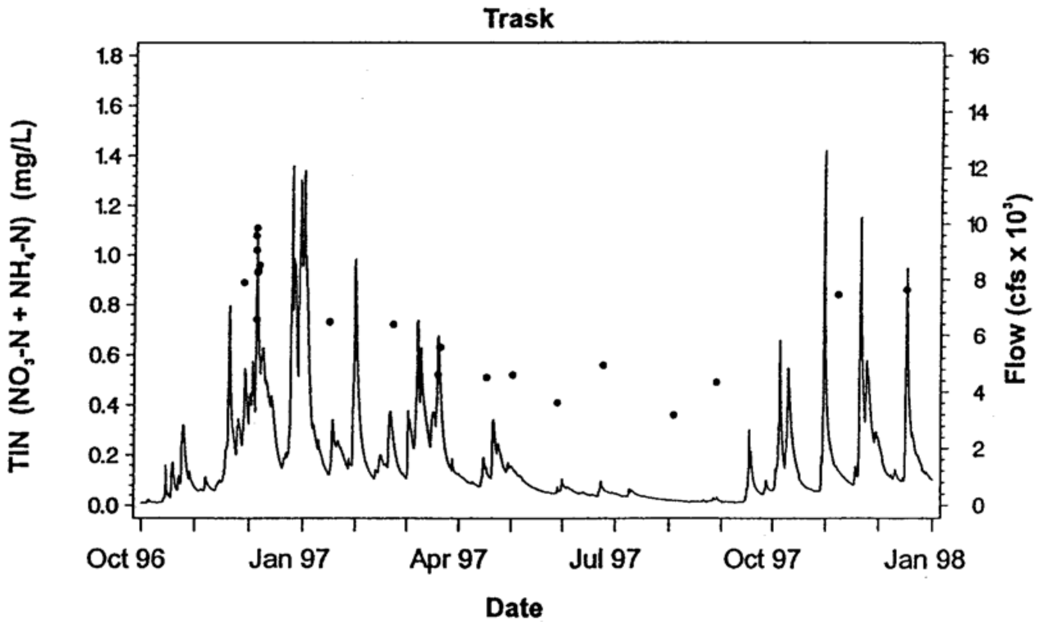

Figure 4.13. Concentration of inorganic N (TIN; mg/L) and river flow (cfs x 10^3) at the primary monitoring site on each river over a one-year period (Sullivan et al. 1998a).

Available data suggest that the concentration of nitrate in the Trask River has been increasing in recent decades (Figure 3.11). We have found similar results in the Miami and Necanicum River watersheds (Snyder et al. 2001, 2002). It is likely that this pattern is attributable to the gradual growth and development of riparian alder stands, with consequent increase in nitrogen fixation.

Eutrophication (nutrient enrichment) is a concern in most estuaries in the United States and will continue to be a concern as coastal populations increase (Day et al. 1989). Tillamook Bay has been classified as moderate to high in the National Oceanic and Atmospheric Administration's (NOAA) estuary eutrophication classification (NOAA 1996). Inorganic nitrogen loads to Tillamook Bay are highly dependent on flow and are therefore much higher during winter than summer. Biological uptake of N in the aquatic, and perhaps terrestrial, environment during summer is likely an additional important determinant of N dynamics in the watershed. Overall, the concentration of N in the Trask River is not especially high compared with rivers elsewhere in Oregon. For example, the median concentration of NO_3-N in the Willamette Basin during the period 1993-1995 was 1.1 mg/L (n=289), with 10% of the samples above 5.9 mg/L (Rinella and Janet 1998). In contrast, flow-weighted average concentration in the lower Trask River in 1997 was 0.8 mg/L and concentrations were always less than 1.3 mg/L (Sullivan et al. 1998a). Nevertheless, in view of the moderately high productivity of Tillamook Bay, and the fact that estuaries are generally N-limited, any enhanced N loading from the watershed to the bay in response to management activities should be avoided.

4.1.4.5 Dissolved Oxygen

Dissolved oxygen concentrations below the 11 mg/L salmonid spawning standard have been found throughout the watershed (Figure 3.5), but such values are likely associated with warm waters during late summer and would therefore not be expected to impact fish spawning. No salmonid spawning occurs in the Trask River watershed in July or August when stream temperatures are warmest. Dissolved oxygen concentrations below the salmonid rearing criterion (8 mg/L) have also been found, almost exclusively in the sloughs in the lower watershed. High temperatures, and perhaps high nutrient and organic matter concentrations, in the sloughs are the likely causes of low dissolved oxygen in these areas.

4.1.4.6 Management Effects on Water Quality

Under reference conditions, riparian forests included a diversity of conditions, including a broad distribution of age-classes and species, maintained by natural disturbances such as fire, floods, landslides, windthrow, and disease. Zones of mature conifer forest were interspersed with hardwood stands and canopy gaps created by localized disturbance. In-stream structural complexity fostered more and deeper pools, interspersed with riffle and drop areas, providing additional oxygenation of streamwater and refugia from periodic high temperatures. Along the mainstem of the Trask River, riparian forests were removed by forestry and agricultural practices, and in the uplands by Tillamook Burn fires and subsequent salvage logging. In part because there was no allowance for riparian buffer strips prior to about 1980, land use activities contributed to greater exposure of the stream to sunlight, causing higher temperature and lower dissolved oxygen levels. Such effects have been reversed by subsequent reforestation. Increased erosion contributed to higher turbidity and suspended solids. Roads, especially those that were poorly constructed in conjunction with salvage operations in the mid-1900s, have contributed, and probably continue to contribute, sediment to streams. Sediment delivery is more likely where roads parallel or cross the stream channel.

Agriculture, rural residential housing, and urban development have contributed to water quality concerns and problems in the Lower Trask River subwatershed. Cultivated soils are more susceptible to erosion. In addition, manure spreading on pasture lands, poorly-functioning septic systems, urban storm drains, and point sources such as sewage treatment plants contribute fecal bacteria and nutrients to the lower Trask River. The filling, draining, ditching, and disconnection of wetlands have reduced their ability to filter pollutants (including bacteria, sediments, nutrients, toxic compounds) from runoff.

The limited available data suggest that water quality may have improved for most parameters in recent decades. In particular, conditions for temperature, fecal bacteria, and phosphorus seem to show signs of improvement, whereas nitrogen concentrations seem to be increasing (Figure 3.17). These improvements in temperature, bacteria, and P, if they are real, may be due, in part, to implementation of BMPs in forestry and agriculture.

It is unlikely that changes in land management practices would have an appreciable effect on P concentrations in the Trask River during low flow summer conditions. Most of the current P load is associated with large winter storm events and is likely derived from erosion in the upper watershed. It is unknown to what extent the high winter P load might influence summer concentrations, but such an influence is probably most pronounced in the lower reaches of the mainstem Trask River and in Tillamook Bay, where fine sediments accumulate. Manure spreading activities, animals grazing in riparian areas, and inadequate septic systems provide additional nonpoint sources of P. Infrequent summer rainstorms provide an important mechanism for transporting P from such sources to the stream channel. Implementation of BMPs in agricultural and rural settings will help to reduce P loading, as will erosion control efforts throughout the watershed. However, such actions would not be expected to have a large impact on P dynamics within the Trask River watershed, especially in the short term.

Similarly, changes in land management practices would not be expected to alter streamwater N concentrations to an appreciable extent, although BMPs to reduce livestock and septic system contributions would be helpful. Over the long term, increasing the presence of conifers throughout some of the riparian zones in the watershed might be expected to have the greatest impact, but such an effect would take decades to develop.

4.1.4.7 Forest Chemicals

Pesticide application methods are designed to minimize the entry of pesticide residue into the stream system, but this issue has not been examined in any detail in the watershed. It is also possible that fertilizer application to forest stands has constituted an episodic source of N to the river. There are no data suggesting that the use of forest chemicals has adversely impacted aquatic ecosystems in the Trask River watershed.

4.1.4.8 Streams on the Oregon 303(d) Water Quality Limited List.

Stream placement on the 303(d) list can generally be attributed to management practices, both past and current, within the watershed. Most 303(d) listings within the Trask River watershed are in the lower river reaches, sloughs, and lowland tributary streams (Table 3.10). Causes for these listings are generally outside the control of ODF or BLM management, and most commonly include such factors as fecal bacteria and dissolved oxygen.

Temperature listings have been more widespread, and included the mainstem Trask River, North Fork Trask River, and North Fork of the North Fork Trask River. There were 101 miles of temperature-limited stream length in the Tillamook Basin, one-third of which was in the Trask River watershed. The TMDL was approved for these areas. The 1998 ODEQ 303(d) list included 30.7 miles of the Trask River listed as impaired for water temperature. Of that total, 62% was along the lower main stem (mouth to South Fork), 23% was the North Fork of the North Fork (mouth to headwaters), and the remainder was the lower section of the North Fork (mouth to Bark Shanty Creek). The mainstem has exceeded the 55EF spawning and rearing criterion during the period June through October, and the 64EF rearing and migration criterion between mid-June and mid-September. ODF and BLM management can have influence on these temperature listings, in part because these agencies control appreciable percentages of the streamside areas in, and upstream from, these river reaches. There are no data, however, to

suggest widespread exceedences of the temperature criterion for salmonid migration in most upper tributary reaches. Additional monitoring is needed.

Temperature-sensitive beneficial uses in the Trask River include:

- anadromous fish passage
- salmonid fish spawning and rearing
- resident fish and aquatic life

To accomplish the goals identified in OAR 340-041-120 (11), no measurable streamwater temperature increase resulting from anthropogenic activities is permitted in the Trask River, unless specifically allowed under an ODEQ-approved management plan.

There are also two reaches listed for flow modification: East Fork of South Fork Trask River and North Fork Trask River. In addition, the mainstem Trask River is listed for habitat modification. It is not likely that current or future ODF and/or BLM management would play an important role in these listings other than future contribution of LWD to the system, although historic logging activities in the uplands undoubtedly had adverse impacts on habitat quality in the mainstem Trask River.

4.1.4.9 Effects of Water Quality on Recreation

Current water quality limits the extent to which the Trask River watershed provides recreational opportunities within lands managed by ODF and BLM. This limitation is entirely indirect, via the impacts of high water temperature on cold-water fishing opportunities. In the lower watershed, high bacterial contamination and eutrophication limit the desirability and public safety of in-stream recreational contact such as swimming and wading. Strategies to enhance stream shading and restore riparian functionality in mainstem reaches throughout the watershed and to reduce bacterial and nutrient contamination in the lower river and sloughs will create conditions more favorable for in-stream recreational opportunities.

Fecal coliform bacteria and *E. coli* are frequently used as indicators of fecal inputs to stream systems. High FCB (and associated virus) levels can cause disease and restrict the beneficial uses of the water, especially for drinking water and human contact recreation. Most of the bacteria data available for the Trask River are for FCB, and therefore this is the parameter of focus for this report.

Results of a recent study of FCB source areas along the Lower Trask River suggested that the most important sources of FCB to the Trask River mainstem during storm events included the following areas (Sullivan et al. 2003):

- below the STP outflow – This area receives effluent from the City of Tillamook's STP and also receives stormwater runoff from an adjacent residential neighborhood and from the western portion of the city.
- below Holden Creek confluence – Bacterial contamination of Holden Creek is believed to be associated with failing private septic systems, runoff from a lumber mill yard, and possibly drainage from adjacent dairy farms.
- distributed sources along lower Trask River – A variety of stormwater drain pipes from urban and residential areas in and around Tillamook and drain pipes from adjacent dairy pastures are believed to constitute important FCB source areas within the lowest river mile of the mainstem Trask River.

4.1.5 AQUATIC SPECIES AND HABITAT ISSUES

4.1.5.1 Aquatic Habitat

The major focus of habitat quality issues within the Trask River watershed concerns anadromous salmonid species, in particular the influence of habitat quality on coho salmon (federally Threatened), steelhead (Candidate for federal listing), coastal cutthroat trout (Species of Concern), and chum salmon (ODFW Critical Status). Other important fish species include chinook salmon (listing not warranted) and Pacific lamprey (Species of Concern). Habitat quality for non-fish species is also important. Amphibian distributions extend to portions of the upper watershed, above the limit of fish distribution. Therefore, managing for fish habitat will not necessarily protect or improve all amphibian habitat.

The characteristics that define habitat suitability differ from species to species and from habitat to habitat. In general, parameters of habitat suitability reflect the needs of a species for food, water, cover, reproduction, and social interactions (Young and Sanzone 2002). Such needs are fulfilled through aspects of the physical, chemical, and biological environment, including water temperature, dissolved oxygen, flow velocity, substrate type, and the presence of predator, prey, and competitor species.

Appropriate habitat conditions in upland streams (i.e., those that will maintain watershed function) would include adequate shading of the stream channel, an abundance of LWD and deep pools, intact riparian vegetation that includes large-diameter conifer trees, adequate in-stream gravel conditions, an absence of passage barriers, and the availability of off-channel refugia. In lowland locations, additional important habitat conditions would include stream sinuosity, connection to estuarine and freshwater wetlands, floodplain functionality, and intact riparian vegetation. Past management practices have resulted in conditions that seldom meet these ideals.

In-stream LWD conditions were rated as 100% undesirable in the Lower Trask, North Fork of North Fork, and Middle Fork of the North Fork subwatersheds, and only slightly better in the Upper Trask subwatershed. Conditions were substantially better in the Elkhorn Creek and South Fork subwatersheds, especially the East Fork of the South Fork subwatershed (Figure 3.22).

LWD recruitment potential was rated as undesirable throughout the watershed, based on ODFW data illustrating the scarcity of conifers larger than 20 inches dbh.

The best salmonid spawning and rearing habitat in the watershed appears to be located in the East Fork of the South Fork and in Elkhorn Creek. Due largely to the Tillamook Burn and salvage logging operations, the quality of much of this (best available) habitat is diminished from reference conditions. In particular, habitat complexity has been reduced in association with LWD removal, inadequate LWD recruitment, increased sedimentation, reduced pool frequency and depth, and the general homogeneity of riparian vegetation. The North Fork Trask subwatershed appears to be particularly limited by poor shade conditions along the mainstem, and the Middle Fork of the North Fork by poor current LWD conditions (Table 4.11). In-stream gravel conditions are best in the East Fork of the South Fork and Elkhorn Creek subwatersheds (Table 4.12).

Management actions to improve salmonid habitat should probably focus primarily on enhancing LWD conditions, improving LWD recruitment potential, and reducing stream mainstem temperatures. Other important activities would likely include identifying and removing fish passage barriers, and reducing erosion. Actions to improve conditions for one species will usually improve conditions for many other species as well. The most dramatic short- to moderate-term improvements in stream shade can be realized through targeted conifer planting and conifer release efforts focused on the mainstem Trask River and North Fork system (including the North Fork, North Fork of the North Fork, and Middle Fork of the North Fork subwatersheds). Benefits to fish may, however, be best realized through efforts focused in and around portions of the highest quality salmonid habitat, which is located in the South Fork system and Elkhorn Creek. Given the length of the mainstem streams lacking large riparian conifers and exhibiting low shading, proportionately greater benefit can be realized by focusing most planting efforts on south and west banks (i.e., plant twice as much stream length, but only on one side). However, where bank erosion is evident along north and east streambanks, these areas should also be planted. LWD emplacement can also be an effective tool for improving LWD conditions in the short term. However, LWD emplacement is expensive and, given a finite funding level, many more miles of stream can be treated with riparian planting and conifer release, as opposed to LWD emplacement.

The East Fork of the South Fork and Elkhorn Creek are believed to provide the best overall salmonid habitat currently. These subwatersheds are notable in terms of generally having high shade, LWD pieces, LWD volume, and gravel in riffles, compared with other subwatersheds (Tables 4.11 and 4.12).

4.1.5.2 Fish

In addition to their fisheries and intrinsic values, the anadromous salmonids in the Trask River watershed function as indicators of stream and estuary ecosystem condition. Habitat quality and quantity are probably to some extent limiting for all of the salmonid species. Anadromous and resident salmonid species inhabit the Trask River system year-round (Figure 4.14; Plates 6, 7, and 8). Rearing occurs during most or all months by some or all salmonid species present except

Table 4.11. Fish use and habitat condition summary, by subwatershed.								
	Stream Miles	Miles Surveyed	Fish Use	% RA2 LWD Riparian Recruitment (ODF)	ODFW Riparian Shade	# LWD PIECES	LWD VOL	KEY LWD
EF of SF Trask	177	35	FC, SC, WS, SS, Coho	17	94	17	29	0
Elkhorn	105	10	FC, WS, SS, Coho	29	92	19	37	1
Lower Trask	89	11	FC, SC, WS, SS, Coho, Chum	9	32	2	3	0
MF of NF Trask	81	6	FC, SC, WS, SS, Coho	31	82	0	0	0
NF of NF Trask	77	4	FC, WS, SS, Coho	17	77	0	0	0
NF Trask	193	17	FC, SC, WS, SS, Coho	6	79	17	42	2
SF Trask	151	14	FC, SC, WS, SS, Coho	9	93	14	21	0
Upper Trask	197	19	FC, SC, WS, SS, Coho, Chum	4	66	8	24	0

Table 4.12. Fish use and in-stream habitat condition summary, by subwatershed.							
	Stream Miles	Fish Use	Pool Frequency[a]	Percent Pools[b]	Residual Pool Depth (m)	Gravel in Riffles (% area)	Rating of Gravel in Riffles
EF of SF Trask	177	FC, SC, WS, SS, Coho	57	10	0	37	Good
Elkhorn	105	FC, WS, SS, Coho	10	26	1	38	Good
Lower Trask	89	FC, SC, WS, SS, Coho, Chum	21	25	2	25	Fair
MF of NF Trask	81	FC, SC, WS, SS, Coho	5	44	0	23	Fair
NF of NF Trask	77	FC, WS, SS, Coho	6	37	1	19	Fair
NF Trask	193	FC, SC, WS, SS, Coho	8	28	1	21	Fair
SF Trask	151	FC, SC, WS, SS, Coho	14	19	1	32	Fair
Upper Trask	197	FC, SC, WS, SS, Coho, Chum	14	22	1	28	Fair

[a] Pool frequency was calibrated to stream size
[b] Percent of pools was expressed as the percent of the channel area in pools

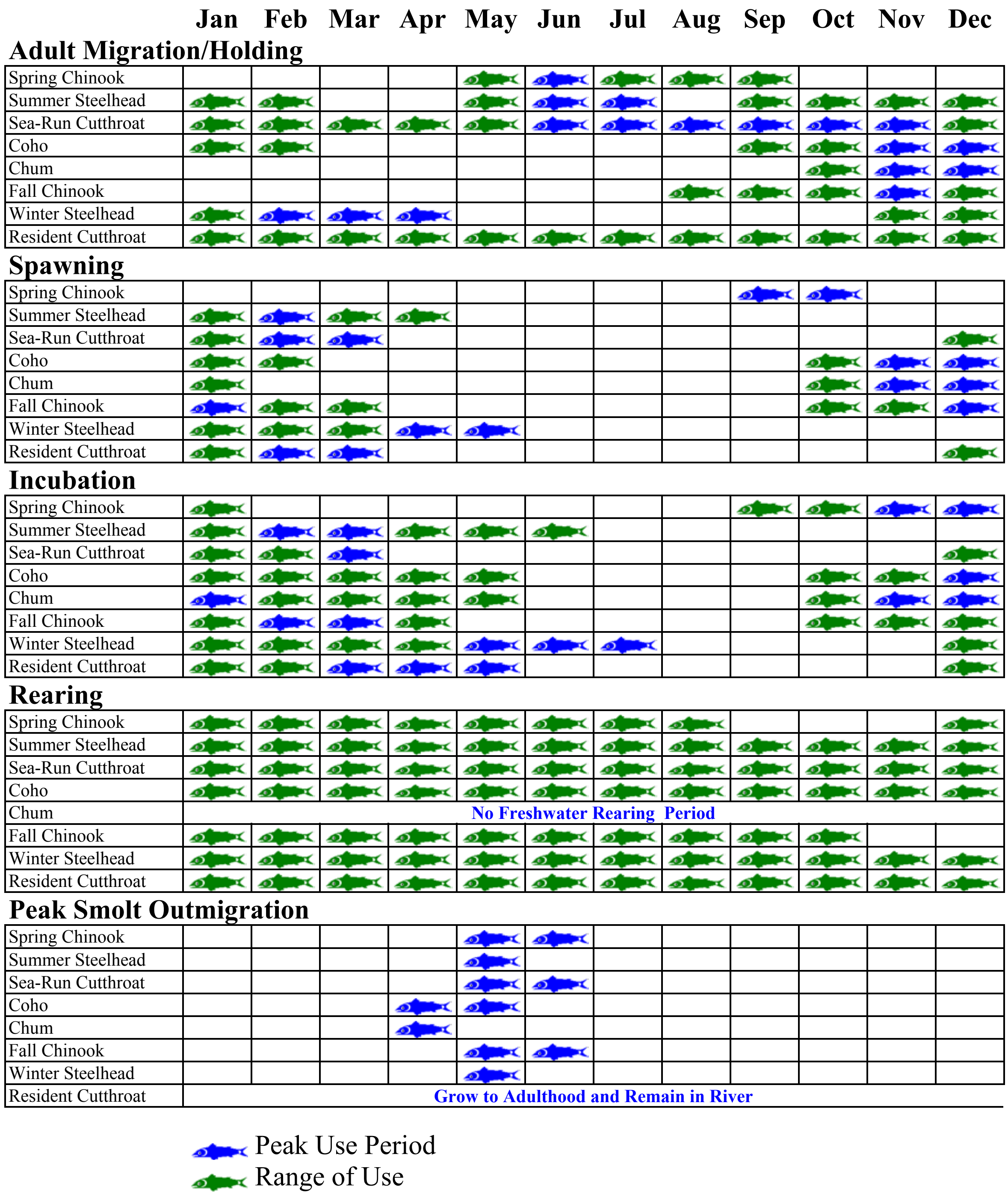

Figure 4.14. Salmonid use of the Trask River system. (Source: ODEQ 2001)

chum salmon, which does not rear in freshwater. Peak use times vary by species, but peak use occurs for at least one salmonid species during every month of the year.

Mainstem sections of the Trask River are used as migration corridors by all species of anadromous salmonids present. In addition, chum salmon use much of the mainstem within the Lower Trask River subwatershed and into the Upper Trask River subwatershed for spawning (Plate 6). Coho spawning and rearing occur primarily in the mainstem sections of the SouthFork, East Fork of the South Fork, and North Fork subwatersheds. Chinook salmon and steelhead use almost the entire mainstem (as well as much of the upper watershed) for spawning and rearing (Plate 7). The mainstem exhibited a greater prevalence of LWD during the reference period, which implies more extensive pool development. Stream shading in the Lower Trask was substantially better prior to Euro-American settlement, and off-channel refugia were abundant. Channelization and disconnection of the mainstem from much of its floodplain and estuarine wetlands have contributed to the loss of extensive salmonid rearing habitat for all anadromous species. Increased water temperature and habitat degradation in the lower river have also likely been detrimental to Pacific lamprey, which have similar habitat requirements to salmonids. Larval Pacific lamprey probably utilized off-channel areas extensively, and this habitat has been dramatically reduced.

Migration of salmonids has been impeded by roads and culverts in some locations. The degree of impedance is not known. Migration may also be inhibited by low-flow conditions on occasion, a problem that could be exacerbated by water diversions. Unscreened diversions may pose an additional hazard to migrating and rearing fish.

4.1.6 WETLANDS: MANAGEMENT IMPACTS

4.1.6.1 Wetland Quantity and Quality

Wetlands are, and historically were, located mainly in the Lower Trask River subwatershed. Many of these wetlands are, and were, estuarine, and provide(d) important rearing habitat for anadromous fish and other species of aquatic biota. The National Wetlands Inventory (NWI) shows 962 acres of wetland in the watershed, but NWI data are only available for the lower watershed sections.

Human activities have reduced the extent of both estuarine and palustrine wetlands within the watershed by an appreciable, but unquantified, amount. River channelization, construction of dikes and levees, tidegate installation, and ditching have collectively converted extensive estuarine wetland areas to pastures and urban areas. In addition, much of the remaining wetland area has lost some of its connection to the river system. Palustrine wetlands in the lowlands have been converted to agricultural land through channelization, ditching, and installation of tile drains. Beaver trapping has reduced the density of smaller wetlands throughout the watershed. Livestock grazing in wetlands and the introduction of non-native plant species have also resulted in wetland degradation, especially in the lower watershed.

Although wetlands are not common in forested portions of the Trask River watershed, those wetlands that do occur and are hydrologically connected to the stream system can provide important salmonid rearing habitat and off-channel refugia from high-flow conditions. Protection and enhancement of palustrine wetlands throughout the watershed could be an effective management goal. Estuarine wetland management is not under the direct control of ODF or BLM. However, estuarine wetlands provide critical habitat for supporting salmonid life cycles, and estuarine wetland protection and restoration may provide good opportunities for outreach and collaboration with other watershed stakeholders.

4.1.6.2 Impacts of Wetland Changes Upon Species

Loss of wetland habitat has likely reduced the abundance of wetland-dependent species within the watershed, but quantitative data are not available. It is assumed, for example, that the abundances of many amphibians, waterfowl, and fish have been reduced as a consequence of the historic loss and degradation of wetlands. For salmonid fish, it is possible that the extensive loss of lowland rearing areas has had a significant impact on potential population size for several species. Off-stream wetlands formerly provided refugia from high-flow conditions, as well as abundant food sources and shelter. Riparian habitat degradation, with the accompanying loss of side channels, has further exacerbated the adverse impacts associated with wetlands loss, degradation, and disconnection.

4.2 TERRESTRIAL

4.2.1 ROAD-RELATED ISSUES

Roads provide many useful benefits, including access for timber extraction, fire suppression, and recreation. However, road construction can result in a high level of disturbance to the forest ecosystem, potentially affecting the hydrology, soil stability, fish passage, and downstream transport of material through the stream network. Road construction can expose bare soil on cutslopes, fillslopes, and ditches, which is vulnerable to erosion until it becomes vegetated. In order to withstand traffic by log trucks and heavy vehicles, a compacted, impervious surface is created, and in some cases runoff is re-directed along roadside ditches. Roads have long been the focus of concern regarding erosion and sedimentation of streams. However, the extent of impact is dependent on many factors, including road location, proximity to stream, slope, and construction techniques. Ridge top roads on slopes less than 50% generally have little impact on streams. Valley bottom, and mid-slope roads, especially those on steep slopes or near streams, can have great effects on sediment delivery to streams.

In the upland, forested portion of the Trask watershed, the majority of the roads were constructed for salvage logging purposes after the Tillamook Burn. Older roads such as these (i.e. constructed prior to 1960) have been found to contribute more erosion by landslides than more recently constructed roads because of poor location, fill design, and drainage (Skaugset and

Wemple 1999). Road-related landslides and debris flows were frequent during large storm events subsequent to the Tillamook Burn, delivering large quantities of sediment to the streams.

However, road construction practices have changed significantly over the past 30 years. Improved road location, design, drainage and maintenance practices have all served to address problems associated with roads. Full bench and end haul construction practices on steep slopes prevent fillslope landslides, and frequent cross-drain culverts divert road surface runoff before it reaches a stream channel. In addition to improvements in the construction and management of roads, other changes in forest management practices have served to reduce the impacts of roads. In particular, changes in timber harvesting practices, such as the use of long-span high-lift cable systems has reduced the need for roads, resulting in a reduction in road density. Protection zones around streams and riparian buffer strips have served to mitigate negative road impacts.

Nonetheless, recent studies have confirmed that even contemporary road construction practices contribute increased sediment from debris slides and debris flows (Skaugset and Wemple 1999). Continued improvement of the road system, including closure of unnecessary or problematic road segments, replacement of undersized culverts, and ongoing maintenance, will be necessary to minimize the impacts of roads on sediment delivery to streams.

The ODF Forest Roads Manual provides extensive guidance on the location, siting, and construction of roads and road drainage structures. The following sections provide a summary of the road design criteria presented in the manual.

4.2.1.1 Considerations Related to Road Design

Effective road construction should disperse water from the road, minimizing erosion and direct discharge of runoff to streams. Drainage structures such as dips, water bars and cross-drain culverts should be located to avoid stream crossings, and ditch relief culverts should be placed at appropriate distances to eliminate direct connection between road runoff and streams. ODF guidelines specify that road grades will be kept between 2% and 18% whenever possible. A minimum of 2% road grade facilitates water drainage from the road prism. Road grades above 15% should be avoided, except where needed to keep roads off steep slopes or away from streams. Where steep grades are necessary, extra consideration is required of drainage structures, including culvert spacing, water bars, water dips, road grade reversals, and road surface maintenance.

Stream crossing structures must be designed to protect aquatic and riparian conditions and provide fish passage. Road/stream crossings create added risk of erosional inputs to the stream and potential migratory hazards to anadromous fish. Where culverts are too small, or become blocked, there is added risk of road washouts, contributing to further erosion and sedimentation problems. Streams should be left in their natural channels, and not diverted to crossing structures; stream crossing structures must be sized to allow for a 50-year storm. Safety features should be utilized in case the structure becomes plugged or fails, including lowered fill heights, dips in the road, armored fills, and overflow culverts.

4.2.1.2 Siting of Roads

In general, roads should be located in areas that minimize the risks of blocking fish passage and contributing sediment to the stream system. Wherever possible, steep slopes, slide areas, wetlands, sensitive areas, and road locations parallel to streams should be avoided. Roads near streams are more likely to deliver sediment to streams, and also occupy important space in the riparian zone. Whenever possible, duplication of roads should be avoided, and existing roads should be used.

A useful consideration for road siting is road slope-position, such as whether a road is sited on a ridgetop, midslope, or valley-bottom location. Ridgetop roads have the least likelihood of contributing sediment to the stream system, because they are usually farthest from streams, and on areas of more gentle slope. Midslope roads are more frequently located on steep slopes than ridgetop and valley roads, and have a high probability of interacting with sediment movement processes, either by initiating landslides, being washed-out by debris flows, or blocking the path of a debris flow. Valley roads more commonly block debris flows, or are washed-out, contributing sediment to a stream (Jones et al. 2000). Valley roads also are the most likely to impede fish passage. Among inventoried ODF roads in the Trask River watershed, the majority of roads were midslope roads; in every subwatershed except the Lower Trask more than half of the roads were located on midslope positions (Table 3.22). Future siting of roads should avoid valley and midslope areas wherever possible, and midslope and valley roads should receive priority for decommissioning.

The highest risk for slope failures and erosion associated with roads occurs in steep lands underlain by geology that gives rise to unstable soils. The locations of steep areas in the Trask watershed are shown on Plate 2. Slope failures create opportunities for enhanced sediment input to streams, especially where roads are located both on steep terrain and in close proximity to a stream. Such roads are concentrated most heavily in the North Fork, North Fork of the North Fork, and Upper Trask subwatersheds (Table 4.5).

federal standards, State Forest Practices Act, and BMPs all agree on the basic principles of minimizing roads and landings, avoiding disruption of natural hydrological flow paths, and adopting guidelines for sidecasting and measures to prevent introduction of sediment to streams. Additional guidelines specify culvert, bridge and stream crossing design, and prioritization of road siting based on current and potential future impacts to ecological value of the affected resources. Road design methods such as outsloping road surfaces, routing runoff away from potentially unstable channels, fills and hillslopes are generally agreed on.

4.2.1.3 Road Construction

Road width should be minimized to meet the needs of the anticipated use. Where possible, roads should be constructed with a balanced cut-and-fill cross-section. Stable fills should be created by using compaction, buttressing, subsurface draining, rock facing, or other effective means of stabilization. On steep slopes and/or high-risk areas, full-bench construction and end-hauling of excess material is required.

According to the ODF Forest Roads Manual, specifications to minimize impacts during construction include the need to:

- Limit construction activities to drier periods of the year, especially any activity involving exposed soil, such as grubbing, excavation or grading.
- Curtail activities on exposed soil during rain events, even when they occur during the dry season.
- Establish and maintain drainage throughout the construction phase.
- Take precautions to prevent siltation when rain is likely to occur. Precautions include installation of hay bales, filter cloth, or other measures placed in ditch lines or other strategic locations to filter runoff water.
- When in-stream work is necessary, it should be accomplished during seasonal periods recommended by a fish biologist. A written plan is required by the Oregon Forest Practices Act and must be approved before working in a Type F (fish bearing) or Type D (domestic use) stream.
- Soils exposed by road construction or improvement that could enter streams will be seeded with grass or other vegetation to prevent erosion. These areas will be seeded at a time conducive to growing new grass and prior to the start of the wet season. Spring and fall periods are generally preferred for grass seeding.

4.2.1.4 Ditches

Ditches can potentially expand the stream network during storms. They can alter both the sediment load and the timing of delivery of runoff to the stream. Proper drainage of roads is important to minimize the adverse impacts of roads on water quality and aquatic habitat.

Ditch construction practices that reduce erosion and dissipate energy include lining the ditch with irregularly shaped rocks, and constructing the ditch with a rounded bottom to prevent sediment sloughing from the walls. Frequent cross-drain culverts can help to prevent excessive contribution of runoff to streams, as well as to minimize the discharge of water below cross-drain culvert outlets.

Proper maintenance of ditches is crucial to reducing erosion and sediment delivery to streams and preventing road-related landslides. Road drainage was associated with half of the debris flows initiated from roads in a study of the road-related slides that followed the February, 1996 storm (Robison et al. 1999).

4.2.1.5 Road Closure

Decommissioning roads can help to reduce the negative impacts of roads on adjacent streams, in addition to reducing maintenance costs. At the present time, ODF is decommissioning roads at twice the rate that they are being constructed (Tony Klosterman, ODF, pers. comm. May 2003).

According to the ODF Forest Roads Manual, roads deemed unnecessary for forest management should be closed. Furthermore, roads should be closed and stabilized if they are presently causing, or are likely to cause, serious future erosion; are near fish-bearing streams; or have excessively high maintenance costs. Additionally, roads on midslope positions should be considered for closure if they are not needed. Stabilization of closed roads can include measures such as waterbar installation, removal of sidecast material, culvert removal, and planting of native grasses and other plants.

4.2.2 RIPARIAN HABITAT: MANAGEMENT IMPACTS

The quality of riparian habitat has declined in comparison with reference conditions. Historical timber harvesting and agricultural practices involved removing essentially all of the riparian forest, up to the stream channel. In contrast, more recent forest practices provide for leaving a riparian buffer along the streams. There are currently no regulations that require trees along streams in agricultural lands, but riparian fencing and planting efforts have become more widespread in the lower watershed in recent years.

One of the most effective measures ODF and BLM can take to enhance the overall health of the Trask River watershed is improvement of riparian and associated in-stream habitat conditions. Habitat degradation associated with historic land management and fire occurrence is linked to current problems related to the scarcity of snags and down logs, high stream temperature, erosion, sedimentation, and nitrogen and phosphorus enrichment. Although current forest practices are much more protective of riparian condition than were practices of the past, residual problems remain. In order to maintain watershed function and support healthy populations of salmonid fish, riparian forests should include a greater component of large conifers, including snags and down logs. Riparian plant species diversity and habitat complexity should also be increased.

It will take many decades to restore the historical diversity of riparian conditions, especially the late-successional riparian characteristics needed to maintain watershed function. Therefore, high priority should be placed on preserving areas that currently provide acceptable habitat for riparian-dependent species. Such areas should be managed to further promote the development of desirable features, including large conifers, down logs, snags, and high species diversity. This does not mean that all riparian areas should be converted to late-successional conifer forest. Rather, management should strive for a mosaic of conditions, and that mosaic should include a substantial component of late-successional conifer forest.

The angle of the sun at noon in the southern sky in the Trask River watershed during the growing season ranges from near 50° in April and September to above 60° (to a maximum of 68°) between early May and mid-August. The sun's position can be used to guide placement and selection of riparian plantings in relation to the stream system, in order to optimize the beneficial effects of shading.

4.2.3 WILDLIFE ISSUES

Overall biotic condition is reflected in the condition, health, and viability of populations of all native species within the watershed. Characterizing and/or monitoring all species is not possible from a practical standpoint, however. We therefore focus our attention on species, such as salmonid fish, whose presence or absence indicates the health of the ecosystem, on "special status" species, such as threatened and endangered species, and on game species.

The populations of game species of wildlife within the watershed are probably relatively stable, with little recent change in the abundance of suitable habitat for deer, elk, and waterfowl. There is some concern regarding potential damage to farm and rural residential properties from large herds of elk, which are common in the watershed. Planned aggressive treatment for SNC is expected to greatly increase foraging habitat and decrease cover for big game animals.

Special status terrestrial species in the Trask River watershed include the northern spotted owl, marbled murrelet, bald eagle, red tree vole, white-footed vole, several species of bat, and assorted other wildlife species afforded special status by the state or BLM. Most special status terrestrial wildlife species in the watershed are at least partially dependent on late-successional coniferous forest and/or associated large trees or snags. Such habitat is currently rare within the watershed, and is found primarily along the northern edge of the Upper Trask River subwatershed, primarily on BLM land. Forest management focused on the protection of existing late-successional forest and the future production of additional late-successional forest would be expected to benefit most of these species over the long term. In addition, management of younger stands to more quickly develop late-successional characteristics, such as tree size and age diversity, snags, down logs, variable density, and species diversity, would also be expected to benefit some special status species in the shorter term.

4.2.4 VEGETATION ISSUES

Vegetation patterns have changed dramatically from reference conditions. In the uplands, extensive late-successional mixed conifer forests, interspersed with early- to mid-successional forests and openings created by natural disturbance, have largely been replaced by much more homogeneous young forests of Douglas-fir (with hemlock in some areas) and extensive stands of red alder in riparian and disturbed areas. Botkin et al. (1995) estimated that the Coast Range forest historically consisted of a mix of stand ages and types, in which about half of the forest, on average, was older than 200 years, and the remaining half was distributed across the range of 0-200 year-old stands. In lowland areas, the former mix of forests, wetlands, and prairies has largely been replaced by agricultural land, with some urban and rural residential developments. There are few pockets of uneven-aged, multi-layered, mixed-species conifer stands remaining in the watershed. Important vegetation issues include:

- scarcity of late-successional forest,
- species and age-class homogeneity of riparian forest,
- prevalence of closed-canopy, even-aged Douglas-fir stands,

- management of Swiss needle cast and other forest pathogens.

4.2.4.1 Potential Habitat Management Strategies

A certain minimum amount of intact habitat is required to maintain population viability of native species within the landscape. For example, populations are unlikely to persist where patches of intact habitat are smaller than the home range of the species. In addition to habitat area, the spatial pattern in habitat availability is also important. Both natural processes (e.g., fire, windthrow) and anthropogenic activities (urbanization, agricultural development, silviculture) have influenced the size and distribution of habitat patches within the Trask River watershed. The interactions between natural disturbance and disturbance due to management practices largely determined the risk of species loss. Species that became isolated as a result of fragmentation and were also restricted to specific habitat types have tended to be most vulnerable to extirpation (Young and Sanzone 2002).

Fractal dimension, or the perimeter-to-area ratio of habitat patches, provides an index of patch complexity (O'Neill et al. 1988). Natural areas impacted by natural disturbance regimes tend to have more complex shape and, therefore, a higher fractal value than patches caused by management actions (Krummel et al. 1987, Young and Sanzone 2002). Distance between adjacent patches can influence dispersal ability, or the extent to which species can move between patches, although the quality of intervening habitat can also be critical.

Natural disturbances generally do not produce extensive areas of uniform impact (Turner et al. 1998), but rather create complex patterns of heterogeneous landscape in which disturbance effects range from severe to none. Even very large fires typically leave some stands unburned due to wind shifts and natural fire breaks (Turner and Romme 1994, Young and Sanzone 2002). The mosaic of habitat created by differential disturbance has important influences on biotic structure, diversity, and ecosystem function. These influences are important for vegetation development and for developing appropriate management guidelines (Young and Sanzone 2002). The impacts of natural disturbance are modified by the frequency, intensity, extent, and duration of the disturbance events. Such factors are important regardless of the type of disturbance, for example, fire, flood event, or insect infestation.

Currently, large and very large conifer forests are rare in the watershed. Based on CLAMS data, medium (10-20 inches dbh) conifer stands are most prevalent in the Middle Fork of the North Fork (56%), Elkhorn Creek (40%), East Fork of the South Fork (37%), North Fork of the Trask (30%), and North Fork of the North Fork (28%) subwatersheds (Table 3.25). These areas offer good opportunity for thinning prescriptions aimed at early development of late-successional characteristics in younger stands.

The ODF management strategy, structure-based management, strives to achieve an array of forest stand structures in a functional arrangement that more closely emulates historical variability and diversity, while also providing social and economic benefits. Five stand types are defined for management purposes: regeneration, closed single canopy, understory, layered, and old forest structure. The desired future distribution of each stand type is specified in the

Implementation Plan (IP) for each district. (For more information on structure based management, including descriptions of each stand type, please refer to the FMP.)

The Tillamook District IP specifies a desired future condition of 20% Older Forest Structure. The portion of the watershed most amenable to the development of larger blocks of late-successional forest includes the extensive ODF and BLM holdings in the middle section of the watershed. Many special status species might thrive best in larger blocks of late-successional habitat than will be provided by riparian areas in the future.

Consequently, prospects may be better for species that thrive in smaller patches of late-successional forest and for species that depend on elements of late successional forest that can be cultivated in smaller blocks of younger forest. Suitable habitat for such species can probably best be created and maintained along riparian corridors, such as in Riparian Management Areas on ODF lands and Riparian Reserves on BLM lands. Partnership opportunities might also be possible with private land owners. It is likely that federal, state, and private lands will all continue to provide an abundance of habitat for species that are dependent on early- and mid-successional forest habitats and on edge habitats. It is also likely that such lands will continue to provide an abundance of riparian alder habitat, even as some of those areas are converted to conifer.

Hardwood stands are most prevalent in the South Fork Trask and Upper Trask subwatersheds (Table 3.25). These areas present good opportunities for increasing conifers in patches along the stream. Management should strive to increase riparian habitat heterogeneity in such areas, while enhancing LWD recruitment potential and (where necessary) stream shading.

The Oregon Forest Practices Rules specify an alternative vegetation prescription for sites that are "capable of growing conifers, and where conifer stocking is currently low and unlikely to improve in a timely manner because of competition from hardwoods and brush". The alternative prescription is intended to provide adequate stream shade, some woody debris, and bank stability for the future while creating conditions in the streamside area that will result in quick establishment of a conifer stand. Up to half of the stream length can be included within conversion blocks, not more than 500 ft long and separated from each other by at least 200 ft of retention block.

4.2.4.2 Noxious and Exotic Plants

Noxious and exotic plants will continue to exist in the Trask watershed. This problem is, and will continue to be, most pronounced in roadside and other disturbed areas. Many of the exotic plants in the Trask require high amounts of sunlight to grow rapidly and reproduce. While these plants are a concern, particularly in reforestation efforts, they are not considered to be a long-term threat to the integrity of the forest ecosystem, because they quickly disappear when overtopped by other vegetation. Examples of exotic plants which fall into this category include Scotch broom, Himalayan blackberry, giant knotweed, Canada thistle, and bull thistle. There are currently no known populations of English ivy or holly in the forested areas of the Trask watershed. English ivy and holly can pose a serious threat to the forest community because they are able to grow and reproduce in shaded conditions. Tansy ragwort can be expected to continue to be a problem in lowland areas, and reed canary-grass in wetlands.

Every effort should be made to curtail the spread of noxious and exotic plants, and eradicate isolated patches of noxious weeds, before they become unmanageable. Soil-disturbing activities that result in removal of the forest canopy favor the spread of these plants. Management actions could include limiting vehicular access to areas that do not currently have noxious and exotic weed problems, and cleaning large machinery of weed seeds and propagules to prevent unintentional dispersal of the plants. Such preventative actions would likely be more successful than attempted treatments subsequent to an invasion by a particular invasive species. The BLM strategy for preventing and controlling the spread of noxious weeds on BLM land is described in the document "Partners Against Weeds. An Action Plan for the Bureau of Land Management" (www.blm.gov/education/weed/paws). It lists goals and associated actions necessary for implementing an improved weed management program. They include elements of prevention, detection, education, inventory, planning, coordination, monitoring, evaluation, research, and technology transfer.

It is likely that active forest management on ODF lands in the Trask River watershed will increase in the coming decades. Such activities can potentially increase the likelihood of spreading noxious weeds within the watershed. Thus, it is important to have policies in place to curtail the spread of noxious and invasive plants. The FMP emphasizes integrated pest management principles and cooperation between landowners to address issues related to invasive plants.

4.2.4.3 Factors Affecting the Distribution of Protected Plant Species

Continued expansion of noxious and exotic weed species, especially in disturbed environments, could have adverse impacts on sensitive plants. Because habitat loss for rare plants, and other species of concern, is an important factor considered by ODF and BLM management, preservation of relatively high-quality habitat is of increased importance on state and federal lands. ODF and BLM actively manage for rare and special status plant species. None of the Threatened, Endangered, Candidate, or Special Concern plant species that are known to occur in the Trask River watershed (Table 3.27) are restricted to late-successional forest.

4.2.5 FOREST RESOURCES ISSUES

4.2.5.1 Timber Harvesting

Timber operations within the watershed are expected to produce substantially more wood in both the near and the long term, as compared with the past half century. Since completion of salvage logging subsequent to the Tillamook Burn fires, much of the watershed has been in the process of forest revegetation and regrowth to harvestable age. Opportunities for increased logging will develop in the near future and the pace of logging will probably increase dramatically because of

SNC infection. It is expected that the Trask watershed will soon become an important supplier of timber, from both private and public lands.

Increased timber harvest will be accompanied by increased potential for conflicts with other beneficial uses. Past logging and fire caused substantial erosion, sedimentation, and stream channel problems throughout the watershed, and adversely impacted fisheries resources. Such impacts should be substantially lessened with renewed logging because of improved forestry practices. However, some degree of future adverse impact should be expected. Because lands within the watershed are deficient in late-successional habitat, future management plans should give high priority to protection of existing late-successional forest and promotion of late-successional characteristics in some areas through commercial thinning prescriptions in selected second-growth areas. Because of differing objectives and management practices on private and public lands, the greatest opportunities for protection and enhancement of sensitive habitats will be found on public lands.

4.2.5.2 Management of Snags and Down Wood

The abundance of snags, especially in the more recent decay classes, has been greatly reduced throughout the watershed compared with reference conditions. Due to the lack of mature and late-successional forest, future down wood recruitment potential is limited and will remain so for many decades. Such potential is likely to increase more on public than private lands, except in narrow strips along streams. Leave-tree requirements and creative thinning procedures are expected to gradually increase the supply of large trees (and therefore snags and down wood) over time, especially on federal and state lands. Further active management efforts to increase the abundance of snags and down wood would improve conditions in the short term, and would be expected to benefit a variety of wildlife species, including cavity-nesting birds, bats, and flying squirrels.

Placement of fresh, down Douglas-fir trees can impact the remaining stand via Douglas-fir beetle infestation. USFS entomologists estimated that the number of standing trees killed by beetles following wood placement would be about 25% to 60% of the number of fresh down Douglas-fir trees added to the forest floor (Hawksworth 1999). Trees stressed by root rot are particularly susceptible to beetle mortality. Such mortality should be anticipated, but can further add to snag formation and thereby enhance the diversity of stand structure.

Douglas-fir beetles are attracted to freshly cut logs, and can produce significant amounts of brood in trees which are 12 inches dbh and larger. The threshold for the number of down trees necessary for beetles to produce enough brood to attack and kill additional standing green trees is three per acre. As the diameters of these trees and the numbers of trees increase, so does potential for producing more beetles. This, in turn, increases the risk of additional Douglas-fir mortality in the surrounding area. The rule-of-thumb based on observations in Westside forests is that after blowdown events, about 60 additional trees will be attacked and killed over the subsequent three years for every 100 down trees. It should be noted that generally these observations were in larger, older trees (much larger than 12 inches dbh) in older stands (over 100 years).

Several actions may be taken to reduce the risk of unacceptable amounts of additional beetle-caused mortality, with greater risk being more acceptable in the late-successional reserve LUA than in other management units. Following are recommendations to consider when writing silvicultural prescriptions to fell green Douglas-fir trees for decay class one LWD inputs:

1. When felling trees which are 12 inches dbh or larger, cut the minimum number of trees possible that will allow achievement of the LWD objectives.
2. Fell the trees in areas that are more likely to receive direct sunlight. Studies have shown that beetles produce less brood in logs with less shading.
3. Avoid felling trees in areas where standing live Douglas-fir trees are known to have reduced vigor and where it would be unacceptable for many of these trees to die.
4. Fell groups of trees in separate events that are spaced three to five years apart. Five-year intervals would minimize the risk of the local beetle population building to an unacceptable level.
5. If possible, felling should occur from about August 1 to October 1. This will allow some drying of the cambium before the spring beetle flight, and may lessen beetle brood production. If subsequent beetle-caused mortality is not a particular concern, such as in a late-successional reserve area, timing of tree felling may not be an issue.
6. Postpone felling of LWD trees if bark beetle populations are known to be high, or if there has been considerable amounts of tree mortality in the general area for the previous year or two (based on the Insect Aerial Detection Survey maps available from USDA Forest Service, Forest Health Protection).
7. Fell species other than Douglas-fir for LWD recruitment.

The risk of bark beetle population buildup is less in healthy, young stands than on older, less vigorous stands. The risk of additional tree mortality in a stand 40 years old (common to BLM land in this watershed) or younger is probably very low. This risk probably increases through time, with stands 80 to 100 years old becoming more susceptible to some overstory mortality. Remnant old-growth pockets, in particular, would be at risk of some tree mortality if beetle populations increased significantly in those areas because of LWD creation.

4.2.5.3 Management of Laminated Root Rot, Swiss Needle Cast and Other Forest Health Concerns

Phellinus weirii root rot is likely to cause more extensive damage in managed stands as compared with natural or late-successional stands. Most of the Trask watershed is currently forested with Douglas-fir, which is highly susceptible to root rot mortality. Disease centers become apparent in stands older than about 15 years. Volume production in disease centers can be expected to be less than half that of healthy stands (Thies and Sturrock 1995).

When conducting commercial thinning operations, high levels of root rot infestation are of special concern. Thies and Sturrock (1995) recommended avoiding commercial thinning in stands of Douglas-fir when the disease is present in 20% or more of the stand.

Forest management decisions in the near future are likely to be heavily influenced by the prevalence and spread of SNC, which currently infects a substantial component of the South Fork Trask River and its tributary subwatersheds. Swiss needle cast threatens forest productivity, but is not a major cause of tree mortality. Recommended management options include thinning in low- to moderately-infected stands, and clearcutting severely infected areas. Recent studies have indicated that trees respond positively to thinning, but the degree of response declines with increasing SNC severity (Maguire et al. 2003). Management decisions to counteract the spread of Swiss needle cast may seriously conflict with other forest management goals. Careful monitoring will be important to determine the extent to which the planned clearcutting contributes to higher stream temperature and/or sediment loads.

Swiss needle cast damage was assessed by the Swiss Needle Cast Cooperative (SNCC) in 1997 through 2002 (SNCC 2002). Monitoring was conducted during April and May in 77, randomly-selected Douglas-fir plantations in the northern Coast Range, selected to be representative of all Douglas-fir plantations between 10 and 30 years old (in 1996) and located within 18 miles of the coast, within the zone of greatest SNC damage. Mean needle retention for all plots showed little evidence of change in the degree of damage since 1997. There was a slight, but statistically significant, increase in mean needle retention from 2001 to 2002.

Many of the stands that are moderately to severely impacted by SNC are pure Douglas-fir stands that resulted from reforestation of the Tillamook Burn. According to the Tillamook District IP, management will aggressively treat SNC, consistent with OSU model run 1C-2. This model run calls for harvesting of severely impacted stands (i.e., those with less than two years of needle retention) within the first two decades if they are more than 20 years old. Other management recommendations include the encouragement of non-Douglas-fir species; thinning is not recommended in stands having high damage (Filip et al. 2000).

4.2.5.4 Management of Hardwood Stands

A substantial portion of the watershed, and much of the riparian zone, contains hardwood or mixed hardwood/conifer stands. Red alder is particularly abundant, especially in riparian areas and along roads and other disturbed sites. Red alder was probably always abundant in riparian corridors along the Trask River and its tributaries, but its abundance may have increased substantially since Euro-American settlement. Many of these sites formerly supported (in addition to red alder) western red cedar, hemlock, and other conifers, including Sitka spruce in the lower watershed. In some places, conifers can be actively reestablished; other places are either too wet to support conifers or are not amenable to conifer establishment at the present time because of previous soil disturbance.

It would not be desirable, or perhaps even possible, to remove most of the alder from the riparian zone. Alder leaves constitute an important allochthonous nutrient and food source to the aquatic ecosystem. Nevertheless, the scarcity or absence of other species and age classes in the riparian forest of the Trask watershed is noteworthy when compared with our understanding of reference conditions, although we don't know the abundance of riparian alder in the historic forest. In addition, the prevalence of alder outside the riparian zone may represent a substantial reduction in expected timber volume production. The difference in volume production between alder and conifer stands will become larger over time, as the conifer forests mature.

Releasing conifers, as well as planting conifers in small patch cuts in selected riparian areas, can be an effective management strategy to restore the balance between riparian hardwoods and conifers. Anticipated benefits would include increased stream shading, LWD recruitment potential, stand diversity (species, layers), and habitat suitability for a variety of special status species. In addition, alder removal from some riparian areas would likely cause a decrease in the transport of nitrogen, which contributes to estuarine eutrophication, from the forest to Tillamook Bay. Small-scale efforts to create openings in the alder stands for conifer release (with or without conifer planting) could be considered for implementation as a long-term, ongoing effort.

4.3 SOCIAL

4.3.1 AGRICULTURE

Agricultural production represents an important part of the Trask River watershed economy. Agricultural activities also impact watershed resources and create conflicts with other beneficial uses. Fecal bacteria contamination of streamwater, bank erosion, stream heating, water use, eutrophication, wetlands degradation, stream channel simplification, and blockage of fish passage are all associated with agricultural activities. Such operations create potential conflicts with salmonid fishery, shellfish, and recreational resource utilization. With improved management practices, negative impacts and conflicts can be, and in some cases are being, reduced. For example, there is evidence that fecal coliform bacteria concentrations in the Trask River, which are partially derived from agricultural activities, have decreased in recent decades (Figure 3.17), although concentrations still often exceed health criteria.

Many organizations have been actively involved in implementation of improved farm management and such actions as riparian fencing, culvert replacement, wetlands enhancement, and riparian planting. Active participants have included the Farm Service Agency, Natural Resources Conservation Service, Tillamook County Soil and Water Conservation District, Tillamook Bay National Estuary Project, Tillamook Estuaries Partnership, Tillamook County Creamery Association, Oregon Department of Agriculture, OSU Extension Service, Oregon Department of Environmental Quality, and Tillamook Bay Watershed Council.

4.3.2 RURAL RESIDENTIAL AND URBAN USES

Increases in the human population can be expected to continue in the watershed, with such increases mainly concentrated in urban and rural residential areas in the lower watershed. With population growth, demands will increase on space and natural resources, including increased water use, wastewater generation, and recreational fisheries. As the human population increases, especially the retirement population, additional conflicts between agricultural and urban interests can be anticipated. Increased rural residential development will be accompanied by added pressure on water resources. In addition, either wastewater treatment capabilities will have to be increased or the number of septic systems (and the potential for water quality degradation) will increase.

Urban and rural residential land uses constitute important sources of fecal bacteria to the lower Trask River (Sullivan et al. 1998b, 2003) and also contribute to other aspects of water quality degradation. Such problems are likely to increase in the future, with population growth, unless actions are taken to lessen the adverse impacts associated with storm drains, sewage treatment plants, industrial effluents, septic systems, and animal husbandry. Opportunities for creative partnership among ODF, BLM, and urban and rural residential communities should be explored. The Tillamook Estuaries Partnership may be an important vehicle for fostering such interactions.

4.3.3 RECREATION

Recreational opportunities are dispersed throughout the watershed, and throughout Tillamook Bay, which is influenced by water quality in the Trask River. Recreational fishing for salmonids is very popular throughout the watershed, especially in the Lower Trask subwatershed. Hunting (mainly for elk, deer, and waterfowl) is popular on public and private lands. Hiking, biking, horseback riding, kayaking, wildlife viewing, and off-road vehicle use also take place on public lands watershed-wide. Impacts on natural resources from recreational activities in the watershed are probably generally minimal. However, there is likely some increase in erosion from road and trail surfaces due to vehicular and foot traffic and increased risk of spreading of noxious plants.

4.3.4 CULTURAL RESOURCES

Because Native American tribes utilized the lower watershed extensively prior to Euro-American settlement, there is a high probability that cultural resources exist in many places within the lower watershed. However, Native American utilization of the upper watershed, where most ODF and BLM land is located, was sporadic. BLM is exempt from rules requiring pre-disturbance surveys because of the low probability of encountering cultural resources.

4.4 SUBWATERSHED RANKING

A ranking system was devised to enable comparison among subwatersheds of conditions on ODF and BLM lands regarding seven indicators of aquatic and riparian habitat condition. Results of that ranking are shown in Table 4.13. The ranking on ODF lands probably reflects conditions throughout most of the upper watershed. Overall, Elkhorn Creek and the East Fork of

Table 4.13. Ranking of subwatersheds on ODF and BLM lands based on 7 indicators of aquatic and riparian condition. Each indicator was ranked in ascending order according to the desirability of the condition, (e.g. the highest pool frequency was ranked 1, etc.). The rankings for all indicators were summed to create the rank score. The lowest rank score represents the watershed with the most desirable combination of the 7 indicators. Overall rank lists the rank scores in ascending order based on the desirability of conditions.

ODF Land	Subwatershed Area (sq mi)	Total Road Length in Subwatershed (mi)		Overall Rank	Sum of the Ranks of the 7 Indicators	Road / Stream Crossing Density	Road / Stream Crossing Rank	Roads on Hillslopes >50% (mi of road)	Roads on Hillslope >50% Rank	Stream Shade (% High Shade - from Falcy)	Stream Shade Rank	Conifer LWD Recruitment Potential	Conifer LWD Recruitment Potential Rank	Average of Pool Frequency	Average of Pool Frequency Rank	Average Density of LWD in Stream	Average Density of LWD in Stream Rank	Average of % Gravel in Riffles	Average of % Gravel in Riffles Rank
Elkhorn	8.4	35.6		1	12	10.4	5	3.5	3	98	2	29	2	9	3	17.3	1	52	1
EF of SF of Trask	25.5	87.9		2	17	6.9	3	3.9	5	98	1	17	4	50	1	14.0	3	41	3
MF of NF of Trask	6.0	18.9		3	24	11.4	6	0.5	1	95	4	31	1	6	6	0.0	6	27	6
NF Trask	23.5	70.1		4	25	8.2	4	6.6	7	97	3	6	6	6	5	14.1	2	34	2
SF Trask	18.4	49.4		5	26	6.8	2	5.5	6	93	5	9	5	13	2	13.9	4	37	4
Upper Trask	13.7	39.0		6	32	6.5	1	3.6	4	86	7	4	7	8	4	0.3	5	16	5
NF of NF of Trask	5.4	22.5		7	32	13.0	7	3.2	2	87	6	17	3	5	7	0.0	7	24	7

BLM	Subwatershed Area (sq mi)	Total Road Length in Subwatershed (mi)		Overall Rank	Sum of the Ranks of the 7 Indicators	Road / Stream Crossing Density	Road / Stream Crossing Rank	Roads on Hillslopes >50% (mi of road)	Roads on Hillslope >50% Rank	Average Stream Shade (from ODFW)	Average Shade Rank	Total # of Conifers in Riparian Zone	Total # of Conifers in Riparian Zone Rank	Average of Pool Frequency	Average of Pool Frequency Rank	Average Density of LWD in Stream	Average Density of LWD in Stream Rank	Average of % Gravel in Riffles	Average of % Gravel in Riffles Rank
Elkhorn	3.83	13.4		1	18	12.3	5	1.75	5	91	2	349	2	9.62	1	13.3	2	49.5	1
SF Trask	0.78	3.1		2	19	10.2	4	0.3	3	100	1	0	4	5.5	3	21.9	1	32	3
Upper Trask	3.56	2.0		3	20	0.3	1	0.11	2	63.3	5	679	1	6.67	2	1.1	4	11	5
NF Trask	3.05	3.7		4	23	3.9	2	0.82	4	67.7	4	33	3	4.53	5	2.6	3	34.8	2
MF of NF of Trask	2.0	3.7		5	25	4.1	3	0.03	1	76	3	0	5	5.5	4	0.0	5	17	4

the South Fork subwatersheds were highest quality and the North of the North Fork and Upper Trask subwatersheds were lowest quality. (The Lower Trask subwatershed does not include ODF or BLM ownership.) On BLM land, the overall conditions in the Upper Trask, South Fork Trask, and Elkhorn Creek were generally better than conditions on BLM land in the North Fork Trask and Middle Fork of the North Fork subwatersheds.

4.5 DATA GAPS AND FUTURE ACTIONS

4.5.1 DATA GAPS

A number of data gaps were identified in the process of conducting this assessment. In the following section, we describe each data gap, explain its significance, and list steps that could be taken to fill the data gap. However, often it was impractical to estimate the specific amount of time or energy required to fill a particular data gap because of the many potential variables involved. These could include the priority given to the task, the number of staff available, and the spatial extent of the data gathering effort. In many cases, conducting an initial pilot study may be advisable.

Erosion and Sediment

- *Data regarding natural landslide and debris flow occurrence.* The locations of recent landslides, scoured channels, and debris flow fans on mainstem streams are mostly undocumented. A record of the frequency and distribution of natural landslides and debris flows would help to better understand the spatial and temporal erosion regime. The most effective method of identifying landslides and debris flows is on-the-ground inventory following a large storm event (e.g. 30 to 50-year storm), although this requires considerable time and effort. Air photo-based inventories have been used frequently in the past, and are more cost-effective, but often fail to detect landslides and debris flows under dense forest canopy and in old-growth.
- *Data regarding landslides and debris flows originating from harvest units and roads*. Virtually no information exists for landslides in harvest units in the Trask watershed, although the locations of road fill that is sinking, cracking or sliding were recorded in the recent road inventory. Information regarding the frequency, distribution, and characteristics of management-related landslides and debris flows would help to better determine the magnitude of management-related sediment contribution, the management practices most commonly associated with increased sediment levels, and the areas of greatest concern. Data could be collected as part of an inventory of natural landslide and debris flow occurrence, as described above, in addition to the data that are gathered in the road inventory. The road inventory could also be expanded to include both natural and management-related landslides and debris flows, although such an approach would only account for events that are observable from the road network.

- *Likely future debris flow locations, for LWD recruitment.* Information regarding potential source areas of debris flows, with a focus on locations that have a high probability of delivering LWD to important mainstem stream channels, would be useful in prioritizing upland areas for the accelerated development of large trees and older forest structure. Such an analysis would probably require a combination of GIS analysis and field verification of bedrock geology, soils, slope steepness, tributary stream lengths, and tributary junction angles in relation to important mainstem stream reaches.

Stream Channel

- *Field verification and further update of the channel habitat type data layer.* This would be useful if it is expected that channel habitat types will be used as a management tool in the future. Channel habitat types provide a categorization of physical stream characteristics that can help identify locations where high-quality habitat has the potential to occur, indicating where in-stream restoration will be the most effective. Verification of the CHT layer would require a moderate field effort, in addition to updating the GIS coverage.

Water Quality

- *Additional stream temperature data along the mainstem and upper tributaries.* This would be useful to document the spatial and temporal extent of temperature exceedences above the salmonid migration criterion. A well-designed study of stream temperature would help determine the spatial and temporal extent of high temperatures in the watershed. In particular, unresolved questions regarding upstream-downstream temperature changes, tributary vs. mainstem temperatures, and the relationship between shade and temperature in the Trask watershed could be addressed. Gathering the required temperature data would involve placing about 50 stream temperature monitoring devices in carefully chosen locations throughout stream network for one or two summers, and analyzing the resulting data.
- *The location and condition of septic systems on private in-holdings along the mainstem and lower tributary streams of the Trask River.* Leaking septic systems present an important source of fecal coliform bacteria to the lower river and the bay. This project would require cooperation with private landowners to identify locations where septic systems may be leaking. Such an effort would require contacting landowners and perhaps on-site evaluations. This task could be recommended to the Department of Environmental Quality, the Tillamook Estuaries Partnership, or the watershed council.
- *Data regarding fine-scale changes in stream shade and water temperature.* Improved information of fine-scale changes in stream shade and water temperature would help pinpoint locations where stream temperature increases substantially, facilitating prioritization of areas for riparian restoration. Existing riparian shade data, including GIS coverages of shade as well as aerial photos,

could be analyzed for high shade zones along mainstem streams, and verified during visits to the field.

Aquatic Species and Habitats

- *Locations of fish passage barriers (in particular, culverts).* Identification and removal of fish passage barriers would provide access to fish of upstream areas, potentially increasing the amount of available habitat. Fish passage barrier removal is one of the most effective means of improving conditions for fish populations. Field inventories of potential barriers, such as culverts, would be required. Both ODF and BLM have inventoried some culverts on their lands, but many potential barriers have not been assessed for fish passage.
- *Amphibian distribution, especially of sensitive species.* While some species of amphibians may have habitat requirements that are similar to salmonids, others may not. Protecting salmonid habitat may not guarantee that amphibian habitat is available, especially for species that use non-fish bearing streams. Surveys for amphibian distribution and habitat use would help determine if amphibian habitat requirements are being met. A field survey with a focus on small streams would be required, in conjunction with GIS data development.
- *Aquatic macroinvertebrate distribution.* The species composition and distribution of macroinvertebrate communities is very useful for assessing water quality and determining habitat conditions for fish and other species. Macroinvertebrate surveys could be conducted by volunteer field crews, under the supervision of a trained technician. The watershed council may be a good partner for a macroinvertebrate study or monitoring program.
- *Locations of small wetlands in the upland, forested zone of the watershed.* Knowledge of the locations of both existing and historical wetlands and flooded off-channel areas in the uplands would be useful, since wetlands frequently provide rearing habitat for juvenile fish. An analysis of likely locations could begin with an examination of soil maps and topographic maps or digital elevation models (DEMs), followed by visits to the field.
- *Population status and distribution of special aquatic species.* State and federal agencies have a variety of classifications for species warranting special attention. However, with the exception of federally listed Threatened and Endangered (T&E) species, little information exists regarding the condition and distribution of most of these species in the Trask watershed. Often, the difficulty in studying these species is viewed as prohibitively costly, in terms of time and effort. Frequently, it is assumed that if habitat conditions for the species are suitable, then the population is probably sufficiently healthy. However, whenever possible, gathering information on these species is advisable, especially if active intervention can result in stabilizing a population. Sponsoring university graduate students and partnering with fish and wildlife agencies are often the most cost-effective methods of increasing the level of knowledge of a special species.

Wildlife Species and Habitats

- *Distribution and/or presence of special wildlife species.* Like special aquatic species mentioned above, very little information exists regarding the condition or distribution of most non-aquatic species that have been identified as warranting special attention by public agencies, with the exception of the northern spotted owl and marbled murrelet. For more discussion of this topic, see *special aquatic species*, above.

Vegetation

- *Information regarding distribution and trends of establishment for noxious and exotic weed species.* While noxious and exotic weeds do not yet constitute a severe problem in the Trask watershed, often the best opportunity to control them is when the population is still small. Consequently, it is advisable to monitor the status of noxious and exotic weeds in the watershed. The development of a system that allows analysis and characterization of the status of noxious and exotic weeds would be useful. Information regarding the location of weeds could be gathered in the field during routine weed eradication efforts, and the information could be analyzed on a periodic basis to determine trends and spatial patterns of noxious weed populations in the watershed.
- *Locations of large conifers in riparian zones.* Knowledge of the locations of existing large conifers would help to prioritize areas where additional action to improve conifer presence in the riparian zone is warranted. Existing aerial photo-derived information could be used to select riparian forest areas for field surveys. Locations could be mapped using GIS. In low-priority areas, the GIS layer could be updated on an ad-hoc basis, whenever a previously unknown large conifer is identified.
- *Candidate locations for enhancing the prevalence of conifers in hardwood stands.* Encouraging the growth of conifers in the riparian zone would help to accelerate the process of maintaining a steady supply of high-quality LWD to the stream channel, as well as providing shade to moderate stream temperature. Identification of candidate locations for LWD enhancement would require a prioritization of riparian zones based on existing shade, salmonid use, and stream geomorphology or CHT, followed by targeted field surveys.

Roads

- *Location of legacy roads.* In particular, information regarding the location of legacy roads that have the potential to contribute sediment to streams in future large storm events would be useful. The amount of effort required for this task would depend largely on the extent to which this information could be gleaned from archived maps. Where no such maps exist, it would require a significant effort to identify and map legacy roads.

- *Detailed road and culvert condition information, including mapped locations of problem culverts and road segments.* Detailed road and culvert information would help to prioritize actions to reduce erosion and sediment contribution to the stream system. ODF's Road Information System has provisions for the gathering of these data, although the road inventory was not complete at the time of this report. On BLM lands, road information has been gathered for the Elkhorn Creek APU, although data from other areas are absent.

Recreation

- *Locations of OHV damage areas, and areas in need of repair or closure to OHV use.* Knowledge of the locations of OHV-related damage would help to assess the extent of impact by OHV use. This information could be gathered in the field, and then mapped using GIS. While staff members may already have personal knowledge of this information, development of a GIS layer would be desirable. On ODF lands, implementation of the Tillamook State Forest Recreation Action Plan should address this data gap.
- *Information regarding the amount of OHV use, and the impact of OHVs on the forest.* Together with knowledge of the locations of OHV damage areas, as mentioned above, information regarding the amount and severity of impact would make it possible to define management policies that keep damage of the forest to a minimum, and ensure that erosion is prevented. On ODF lands, implementation of the Tillamook State Forest Recreation Action Plan should fill this data gap. The development of a monitoring system in accordance with the Recreation Action Plan that facilitates analysis and query of collected information, in addition to spatial analysis using GIS, would be desirable.

4.5.2 FUTURE ACTIONS

Specific recommendations are provided in Chapters 5 and 6 with respect to actions and/or management decisions by ODF or BLM, and these actions and decisions can, in fact, improve watershed health and increase the amount and quality of aquatic, riparian, wetland, and forest habitat within the watershed. Some issues, however, do not lend themselves very well to unilateral actions on the part of a single ownership category. For example, stream temperatures in the lower watershed are likely to remain above standards for salmonid migration, irrespective of the actions taken by ODF and/or BLM. Similarly, high concentrations of fecal bacteria and low dissolved oxygen concentrations in the Lower Trask subwatershed are not likely to be influenced at all by federal or state land management within the watershed. The temperature and dissolved oxygen water quality problems, which are most pronounced downstream from ODF and BLM land holdings, adversely impact anadramous salmonids that utilize streams on public lands during parts of their life cycle. Only through cooperation that includes private landowners can such problems be effectively addressed.

Among the most important management actions that can be taken by the BLM and ODF to improve water quality and salmonid habitat in the Trask River watershed is the establishment of conifers, and ultimately large conifers, in the riparian zone. This can be accomplished by planting and/or releasing a diversity of conifer species, including western hemlock, western red cedar, Douglas-fir, and (in lowland areas) Sitka spruce along all stream segments that are currently deficient in such plantings. Priority should be given to areas in and around core salmonid spawning and rearing habitat, tributary systems that currently experience excessively high stream temperatures and/or high streambank erosion, and important salmonid migration corridors. The goals of this effort should include enhancement of stream shading, lowering of stream temperatures, stabilization of streambanks, improvement of LWD recruitment potential, reduction of erosion, and ultimately increase in the number and depth of pools. An additional benefit to the terrestrial component of the watershed would be the establishment of (mostly narrow) riparian corridors that exhibit late successional characteristics and the creation of suitable habitat for some Special Status plant and animal species that are dependent upon such habitat characteristics.

In some areas, this planting effort should involve encouraging the establishment and dominance of conifers in riparian areas that are currently alder-dominated. Girdling and felling of alder trees could complement interplanting with conifers to help facilitate conifer release. Care should be taken, however, to not remove alder too aggressively prior to establishment of conifer shading, so as to not temporarily worsen the stream temperature problem. The gradual replacement of alder with conifers in some areas will have the added benefit of reducing nitrogen levels in streamwater, a contributor to eutrophication of Tillamook Bay.

It must be recognized that the benefits of these riparian planting and conifer release efforts will not begin to be seen for several years, and will subsequently be manifested over a period of many decades or longer. Management actions taken now will realize benefits well into the 21st century and beyond.

In addition to actions focused on the establishment of riparian conifers, additional recommended actions to improve both water quality and salmonid health include identification and removal of fish passage barriers, replacement of inadequate culverts, repair or decommissioning of roads, and the restoration and reconnection of off-channel wetlands and other high-flow refugia. Such improvements will open access to otherwise suitable habitat, help restore lost rearing habitat, provide escape from peak flow conditions, improve water quality through filtration of pollutants and removal of fine sediments, and reduce erosion.

Erosion problems in the watershed can be addressed in some areas by the riparian planting efforts described above and especially by efforts to control sediment inputs from roads (both legacy and potential new roads). Emphasis should be placed on road repair and decommissioning in roaded areas that are in close proximity to the stream channel and on steep slopes.

To the extent that new roads are needed to support thinning and/or logging efforts, streamside locations and steep slopes should be avoided where possible. Road construction, road repair, and road decommissioning should be accompanied by planting with native species to minimize erosion and establish vegetation cover.

When portions of the watershed are to be newly opened or are subject to increased vehicular and foot traffic to support forest management efforts, a noxious weed control program should be prepared and implemented. BLM currently has a noxious weed eradication program. Noxious weed eradication is much more difficult and expensive than preventative measures.

The most important potential management action to promote the health and diversity of terrestrial ecosystems on forested portions of the Trask River watershed is the protection and development of late-successional forest habitat. Such habitat should be fostered, where possible, in large blocks rather than small patches. BLM and ODF each provide methods for addressing this need. BLM provides for development of late-successional reserves. ODF intends to use Structure Based Management to increase the amount of forest in Understory and Older Forest Structure classes within the watershed, as presented in the Forest Management Plan and Implementation Plans. Increased prevalence of late-successional forest habitat will benefit a large number of species that utilize such habitat for their prosperity or survival. This effort should be accompanied by thinning and interplanting actions intended to encourage the development of elements of late-successional character in forests of only moderate age. Such elements include increased tree species diversity, multi-layered canopy, variable tree spacing, down logs, and snags. To some extent, these kinds of actions can help to enhance the value of riparian buffers, but should not be done at the expense of shading potential. However, riparian buffers will provide, at best, narrow strips of high-quality forest habitat. Many species require much larger blocks of good habitat.

CHAPTER 5. RECOMMENDATIONS FOR ODF

5.1 GENERAL APPROACH

The following recommendations are intended to work in accordance with the strategies of the Northwest Oregon Area Forest Management Plan (FMP). In keeping with the intent of that plan, the general approach of the recommendations incorporates elements of cooperation, strategic approach, priorities, and alternatives. This chapter was prepared jointly by E&S and ODF personnel.

5.1.1 COOPERATION

Opportunities to improve watershed health in the Trask watershed can most effectively be addressed through partnerships that involve cooperation among private landowners and state and federal agencies. Local watershed groups, including the Tillamook Estuaries Partnership and the Tillamook Bay Watershed Council, can play vital roles in facilitating such cooperation. Specific recommendations can be provided here with respect to actions and/or management decisions by ODF, and these actions and decisions can, in fact, improve watershed health and increase the amount and quality of aquatic, riparian, wetland, and forest habitat within the watershed. Some issues, however, do not lend themselves very well to unilateral actions on the part of a single ownership category.

For example, stream temperatures in the mainstem Trask River are likely to remain above federal standards, irrespective of the actions taken by ODF and/or BLM. Similarly, high concentrations of fecal bacteria and low dissolved oxygen concentrations in the Lower Trask subwatershed are not likely to be influenced at all by federal or state land management within the watershed. The temperature and dissolved oxygen water quality problems, which are most pronounced downstream from ODF and BLM land holdings, adversely impact anadromous salmonids that utilize streams on public lands during parts of their life cycle. Only through cooperation that involves private landowners can such problems be effectively addressed.

5.1.2 STRATEGIC APPROACH TO ADDRESSING AQUATIC/RIPARIAN ISSUES.

Historically, ODF has often implemented improvements related to resource issues opportunistically. That is, these improvements have been implemented in connection with timber sales. This approach offers advantages. First, there is a direct geographical connection between the funding source and the area of improvement. Second, the improvement projects are often able to take advantage of equipment already in the area.

While these advantages are important, a purely opportunistic approach may result in the most important issues not being addressed. It is here proposed that a three-tiered approach be applied to watershed management. This approach would incorporate the following strategies:

1. Make improvements in connection with timber sales.
2. Make improvements as part of normal maintenance activities.
3. Employ focused management to make improvements, independent of other management activities.

Based on policy, cost, and operational factors, ODF resource managers will determine the appropriate times to use each of these strategies.

5.1.3 PRIORITIES

Watershed improvement strategies can often be performed most effectively if a prioritization scheme is implemented. Toward that end, this chapter identifies two types of priorities: subwatersheds that should be treated based on resource needs, and watershed characteristics that need to be addressed to meet resource objectives. Additionally, the watershed-related issues of greatest concern within Salmon Anchor Habitat subwatersheds are identified.

While the opportunistic and strategic approaches offer two different perspectives toward addressing resource issues, they are not necessarily exclusive. Indeed, there may be opportunity to incorporate the priorities identified within this watershed analysis in future implementation plans.

5.1.4 ALTERNATIVES

These recommendations are intended to address the primary watershed health issues identified earlier in the watershed analysis. They provide general guidance to develop projects to move toward desired conditions. In most cases, they do not prescribe a specific solution. Except where these considerations reiterate guidance from ODF planning documents, they are to be considered as alternatives for use in future planning. Site-specific projects and practices need to be designed and implemented by local managers and personnel based on local conditions.

5.2 RECOMMENDED MANAGEMENT ACTIONS TO ADDRESS MULTIPLE RESOURCE CONCERNS

- Establish conifers in the riparian zone

  One of the most important management actions that can be taken by ODF to improve water quality and salmonid habitat in the Trask River watershed is the establishment of conifers, and ultimately large conifers, in the riparian zone. The FMP, Appendix J, specifies that the inner riparian zone (25-100 feet from stream) will be managed to develop mature conifer forest, except in those areas where hardwood-dominated conditions are expected to be the natural plant community. Based on this watershed analysis, many areas would benefit from a greater conifer component. This can be facilitated by several methods:

1. Release of existing conifers
2. Planting conifers
3. Alder conversions

Where abundant understory conifer is present, release of existing conifers will likely be the preferred method. In other areas, management should consider planting a diversity of conifer species, including western hemlock, western red cedar, SNC-resistant strains of Douglas-fir, and (in lowland areas) Sitka spruce.

The following considerations apply when performing conifer plantings:

- Focus planting efforts primarily on S and W streambanks to maximize shade value relative to labor and planting material costs.
- In areas where bank erosion is prevalent on the N or E bank or where the stream is too wide for effective shading from one side only, planting on both sides is recommended.
- Plant tubing may be necessary to minimize animal damage.

Aquatic and Riparian Strategy #4 of the FMP provides that alternative vegetation treatments should be applied when necessary to achieve habitat objectives. In order to achieve LWD objectives in some alder-dominated areas, it may be desirable to plant conifers in small patches. Girdling and felling of alder trees could complement interplanting with conifers to help facilitate conifer release. Care should be taken, however, to not remove alder too aggressively prior to establishment of conifer shading, which could cause temporary increases in stream temperature.

The goal of this activity is eventual establishment of mature conifer forest. This will provide the following potential benefits: improvement of LWD recruitment potential, establishment of stream shading, lowering of stream temperatures, stabilization of streambanks, and reduction of erosion. An additional benefit to the terrestrial component of the watershed would be the establishment of riparian corridors that provide suitable habitat for plant and animal species dependent upon habitat characteristics associated with mature and older forest structure.

Priority for conifer establishment should be given to areas in and around core salmonid spawning and rearing habitat, such as the East Fork of the South Fork and Elkhorn Creek subwatersheds. Priority consideration should also be given to tributary systems with low in-stream structural complexity, high stream temperature, high streambank erosion, and those that are important salmonid migration corridors.

It must be recognized that the benefits of these riparian planting and alder conversion efforts will not begin to be seen for several years, and will subsequently be manifested over a period of many decades or longer. Management actions taken now will realize benefits well into the 21st century and beyond.

5.3 RECOMMENDATIONS FOR SPECIFIC RESOURCES

5.3.1 AQUATIC

5.3.1.1 Erosion Issues

Issue: Certain harvest methods, layouts, and techniques associated with logging on high landslide hazard locations can lead to increased landsliding.

Recommendation*s*:

1. Continue to follow existing FMP guidance related to high landslide hazard slopes (e.g. riparian aquatic strategy 6).
2. Continue to consult with ODF geotechnical experts to evaluate site-specific hazards and risks on high landslide hazard lands. This procedure should include an evaluation of potential benefits provided by the landslide, such as addition of wood to streams (FMP aquatic and riparian strategy 6 and soils strategy 2).

Special emphasis subwatersheds for recommendations 1-2:

- Upper Trask, South Fork Trask, North Fork Trask: High incidence of steep lands, expected heavy cuts to abate Swiss needle cast (SNC).
- East Fork South Fork Trask: Although lower incidence of steep lands, heavy SNC abatement cut planned. Also Salmon Anchor Habitat.

Issue: Road cuts are often associated with accelerated landsliding. This is particularly the case with roads created prior to implementation of current standards.

Existing strategies for dealing with issue: The ODF Roads manual prescribes specific road construction and maintenance techniques designed to minimize landslides.

Recommendations:

3. Continue to follow road manual guidance related to road stability.
4. Update road inventory to reflect current status of roads. Develop schedule for fixing known road problems.
5. Develop procedure for monitoring condition of roads with identified high landslide hazard. Evaluate roads for improvement or replacement.

Special emphasis subwatersheds for recommendations 3-5:

These recommendations should be emphasized in subwatersheds with a high incidence of roads on steep slopes and known road washouts. These include the North Fork Trask subwatershed, which has the highest proportion of road slippage problems. The South Fork and Upper Trask subwatersheds were identified in section 4.1.3.4 as priority areas to address erosion issues (sec 4.1.3.4). The North Fork North Fork subwatershed is also a priority because it has a high incidence of near-stream roads on steep slopes.

Issue: High rates of streambank erosion were identified during ODFW aquatic surveys within the Elkhorn and East Fork of the South Fork Trask subwatersheds. No cause was identified for this erosion.

Recommendation:

6. Investigate causes of streambank erosion within the Elkhorn and East Fork of the South Fork Trask subwatersheds.

5.3.1.2 Hydrology Issues

Issue: Roads that are hydrologically connected to streams can alter hydrology and contribute sediment to those streams. Hydrologic connection was not completely inventoried during the last road inventory.

Recommendation:

1. Consult with ODF transportation planner regarding opportunities and methods of updating road inventory to include hydrologic connection information.

Emphasis subwatersheds for hydrology recommendation 1:

All subwatersheds with ODF-maintained roads.

5.3.1.3 Stream Channel Issues

Issue: Channel structure has been simplified. On ODF lands, this is expressed as a lack of LWD and decreased quantity and quality of pools.

Recommendations:

1. Establish conifers in the inner riparian zone. This is performed with the eventual objective of establishing mature conifers in this zone. Section 5.2 gives alternatives for conifer establishment.
2. Place key pieces of LWD in streams. This will provide short-term benefits to channel structure. However, it should be noted that many stream reaches are prone to LWD blowout. Placement projects will need to be carefully designed to ensure LWD stability. This can partially be achieved by placing key pieces at natural deposition points and in appropriate channel habitat types.

3. Pursue cooperative efforts to improve channel structure on stream segments that have multiple ownerships.

Emphasis subwatersheds for stream channel recommendations 1-3:

All subwatersheds would benefit from these recommendations. However, Elkhorn Creek and the East Fork South Fork subwatersheds should receive priority because of their status as Salmon Anchor Habitat. Areas that might be considered for emphasis because they are most deficient in LWD include the North Fork of North Fork, Middle Fork of the North Fork, South Fork, and Upper Trask subwatersheds.

Measures to improve salmon anchor habitat on Elkhorn Creek should focus on improving density of key LWD pieces, pool depth, and gravel area. Long-term solutions designed to increase conifers in the inner riparian zone should be emphasized. For the short term, placement of key pieces of LWD should also be considered.

Measures to improve salmon anchor habitat on the East Fork of the South Fork should focus on improving density of key LWD pieces and increasing the area and frequency of pools. Depending upon site-specific conditions, improvements in LWD may result in improved pool characteristics. Long-term solutions designed to increase conifers in the inner riparian zone should be emphasized. For the short term, placement of key pieces of LWD should also be considered.

5.3.1.4 Water Quality Issues

Issue: Summer stream temperatures are above federal standards for rearing salmonids in many parts of the watershed. On ODF lands, the principal causes for, and distribution of, high temperature reaches are uncertain.

Recommendation:

1. Expand the temperature monitoring network, determine the location of reaches where temperature exceeds the salmonid migration criterion, and locate stream segments where rapid heating occurs.

Priority subwatersheds for water quality recommendations 1 and 2:

- The North Fork and North Fork of the North Fork subwatersheds. Temperature appears to be highest along the North Fork and its tributaries. In particular, the North Fork of the North Fork appears to be above federal standards quite close to its headwaters.

Issue: Many water quality concerns cannot be addressed solely by ODF management. These include concerns related to high concentrations of fecal bacteria, which are concentrated in the lower portion of the watershed, and temperature concerns, which are distributed across multiple ownerships.

Recommendations:

2. Work with the Performance Partnership and Tillamook Watershed Council to promote Best Management Practices related to shading, sedimentation, and bacteria management on private lands.
3. Cooperate with other landowners to implement in-stream restoration projects and retain and enhance riparian overstory.

Issue: If improperly performed, practices associated with road construction, maintenance, and use can contribute sediment to streams.

Recommendations:

4. Continue to avoid road-building activities within 100 feet of streams. Where these activities are necessary or these roads already exist, use practices from the Roads Manual designed to minimize sediment delivery to streams.
5. Continue to perform road construction, upgrading, maintenance, and closure in accordance with the Best Management Practices, as listed in the ODF Roads manual.

5.3.1.5 Aquatic Species and Habitat Issues

Issue: Salmonids and other aquatic species of concern are not restricted to one ownership. Thus, management for these species is best performed with cooperation among stakeholders.

Recommendations:

1. Maintain active participation in the Tillamook Bay Watershed Council.
2. Participate with local watershed groups to survey all lands for culvert blockages. On ODF lands, blocked culverts will be identified and corrected as part of ongoing maintenance operations.

Issue: Human activities have resulted in stream simplification, including loss and disconnection of fish refugia. Although these impacts have been concentrated below ODF lands, there may be opportunities for improvement on ODF lands.

Recommendation:

3. Identify opportunities to restore and reconnect off-channel wetlands and other high-flow refugia.

Emphasis subwatersheds for aquatic species and habitat recommendation 3:

No special emphasis subwatersheds were identified. However, opportunities may exist along streams with some floodplain development; the lower part of the South Fork Trask may be a good candidate for these activities. Opportunities also exist along the lower part of Type N streams near their confluence with Type F streams.

Issue: Historic changes in vegetation conditions and stream cleaning have contributed to reductions in in-stream LWD and LWD recruitment potential to streams. This has been accompanied by channel simplification, reduction in pools, and loss of habitat for fish.

Recommendations:

4. Work on the long-term development of a more complex riparian zone. This can largely be achieved through the strategies of the FMP, which provide for retention of existing vegetation within the streambank zone and management of the inner riparian zone for mature conifers. As part of this, conifer establishment activities may be warranted. For discussion of conifer establishment, see section 5.2.
5. Place key pieces of LWD in streams. This will provide short-term benefits to channel structure. However, it should be noted that many stream reaches are prone to LWD blowout. Placement projects will need to be carefully designed to ensure LWD stability. This can partially be achieved by placing key pieces at natural deposition points.

Emphasis subwatersheds for stream channel recommendations 1-3:

All subwatersheds would benefit from these recommendations. However, Elkhorn Creek and the East Fork South Fork subwatersheds should receive priority because of their status as salmon anchor habitat. Areas that might be considered for emphasis because they are most deficient in LWD include the North Fork of the North Fork, Middle Fork of the North Fork, South Fork, and Upper Trask subwatersheds.

Measures to improve salmon anchor habitat on Elkhorn Creek should focus on improving density of key LWD pieces, pool depth, and gravel area. Long-term solutions designed to increase conifers in the inner riparian zone should be emphasized. For the short term, placement of key pieces of LWD should also be considered.

Measures to improve salmon anchor habitat on the East Fork of the South Fork should focus on improving density of key LWD pieces and increasing the area and frequency of pools. Depending upon site-specific conditions, in-stream LWD improvements may result in improved pool characteristics. Long-term solutions designed to increase conifers in the inner riparian zone should be emphasized. For the short term, placement of key pieces of LWD should also be considered.

5.3.2 TERRESTRIAL

5.3.2.1 Noxious/Exotic Plants

Issue: Noxious and exotic plants have invaded many portions of the watershed, particularly in disturbed areas.

Recommendations:

1. Treat noxious weed infestations on state forest land through appropriate control measures (manual labor, biological controls, herbicides, prescribed fire), as per FMP Plant Strategy 4.
2. Continue to use native plant species in re-seeding projects on state forest lands.

5.3.2.2 Species Habitat Issues

Issue: Since 1850, fires and human activity have combined to alter the habitat elements available for wildlife species. On ODF lands, these changes have created an abundance of closed single canopy forests at the expense of other structural types. This has had a resulting effect on the distribution and abundance of wildlife dependent upon various structural types.

Recommendations:

1. Follow guidance given in IPs relative to management of habitat for terrestrial species.
2. Continue to implement the principles of structure-based management. As outlined in the FMP, structure-based management provides for a diverse array of forest stand types, habitat function, and key structural components. Under the desired future conditions expressed by the FMP and the IPs, structure-based management will result in a full array of stand types and associated habitat values for species. Because these will be proportionally more diverse and closer to the historical range of natural variability than is currently the case, it is expected that overall value for wildlife will be increased.
3. In planning conifer establishment activities, consider the effects upon riparian wildlife. It will often be important to retain a hardwood component to accommodate wildlife species dependent upon this type of habitat.

5.3.2.3 Upland Forest

No recommendations were made relative to upland forest.

5.3.2.4 Riparian Zones

Issue: In their current condition, riparian areas are unable to provide LWD to streams.

Recommendations:

1. Plan and implement riparian silvicultural projects designed to accelerate growth of riparian conifers and to improve the diversity of species composition and stand structural diversity.
2. Underplant with conifers or release existing conifers in small open areas where hardwoods dominate the riparian zone. Highest priority should be given to zones with high potential for large wood recruitment and stream shade enhancement.

5.3.2.5 Insects and Disease

Issue: Swiss needle cast (SNC) has spread throughout large portions of the watershed, especially close to the coast and on ridge tops and S-facing terrain. It threatens to seriously reduce the productivity of Douglas-fir stands in the watershed.

Recommendations:

1. Actively participate in the SNC Cooperative.
2. Continue current ODF SNC research program.

5.3.3 SOCIAL

5.3.3.1 Recreation

Issue: Depending upon condition and location, off-highway vehicle (OHV) trails can cause erosion and contribute sediment to streams.

Recommendation:

1. Continue to examine the condition and erosion potential of OHV trails within the watershed. Continue to make trail redesignation or closure determinations based on this examination.

Issue: Some dispersed campsites near streams have been known to contribute to inputs of bacteria and sediment to the stream.

Recommendation:

2. Continue to improve dispersed recreation sites to minimize effects on water quality.

5.3.3.2 Road Related Issues

Issue: Depending upon location and condition, roads have the capability to alter hydrologic and erosional regimes, deliver sediment and pollutants to streams, and impair fish migration.

Recommendations:

1. Based on the ODF road inventory, identify roads that constitute barriers to fish, sources of sediment, and those that are likely to fail or contribute to future water quality problems. Reduce road segments that alter flow by closing unnecessary roads that would not be required for access by ODF or neighboring landowners.
2. In future timber harvest activities, continue to reconstruct or maintain roads that will be required for future thinning entries and close unneeded roads. To reduce potential negative impacts, consider upgrading existing roads and using legacy roads rather than constructing new roads.
3. Make efforts to control sediment inputs from roads (both legacy and potential new roads). Emphasis should be placed on road repair and closure of roads within close proximity to the stream channel and on steep slopes.
4. To the extent that new roads are needed to support thinning and/or logging efforts, streamside locations and steep slopes should be avoided where possible. Road construction, road repair, and road decommissioning should be accompanied by planting with native species to minimize erosion.

CHAPTER 6. RECOMMENDATIONS FOR BLM

Recommendations are provided here to identify actions and management decisions on the part of BLM that might improve watershed health in the Trask River watershed. This material was prepared jointly by E&S and BLM personnel.

6.1 AQUATIC

6.1.1 EROSION

1. Where appropriate, restore porosity with subsoiler or excavator in compacted areas such as legacy roads and landings.
2. Further define areas that are sensitive or too fragile to tolerate standard timber management during timber management activity planning and project development. Update the current District's Timber Production Capability Classification System.
3. Implement the BLM road and culvert survey recommendations in the Elkhorn and the Middle Fork of the North Fork of the Trask River subwatersheds. Complete a similar type of survey for the rest of the BLM land in the Trask River watershed.
4. Implement Best Management Practices as described in the Salem RMP for reducing sediment and erosion for all relevant land management practices.

6.1.2 STREAM CHANNEL

1. Elkhorn Creek subwatershed is the highest priority BLM area in the Trask River watershed for in-stream and riparian restoration work. Recommended projects in this area include releasing conifers and, where appropriate, planting riparian species in the riparian zone. Another priority project is to remove the section of road 2-5-10 that is directly adjacent to, and adversely affecting Cruiser Creek. This would be accomplished by redistributing the rip-rap, using an excavator, or by using other methods to restore connections with the flood plain and increase sinuosity.
2. The North Fork of the Trask subwatershed is the second highest priority for in-stream and riparian restoration work. In-stream work could include:
    - Increasing habitat complexity by installing instream structures where LWD is lacking. Mimic natural stream patterns as much as possible. Place key LWD pieces in natural deposition points, such as often occur at tributary junctions and below frequent debris flow sites in medium- to low-gradient streams.
    - Creating woody debris jams to mimic windthrow in intermittent and small perennial streams.
    - Planting native tree or shrub species in riparian areas to increase shading and/or long term LWD recruitment; this may require fencing to exclude beavers and other large herbivores.

- Releasing or thinning of riparian conifers to increase tree size while retaining high shading levels.
- Aggressively removing infestations of noxious weeds that replace native vegetation.
- Pursuing cooperative restoration efforts on stream segments that have multiple ownerships.

6.1.3 WATER QUALITY

1. When conducting forest density management projects inside Riparian Reserves, leave a no-harvest vegetation buffer along all intermittent and perennial stream channels, lakes, ponds, and wetlands. The width of the buffer should be sufficient to maintain water quality standards, including temperature and sediment. Buffer widths should be determined on a site-specific basis.
2. Evaluate stream shade conditions and identify and prioritize potential restoration sites to improve stream shade on BLM lands.
3. Work with the Tillamook Watershed Council and ODEQ to further quantify non-point sources of pollution. Expand the temperature monitoring network and locate stream segments where rapid heating occurs, especially in areas used by salmonids.
4. Cooperate with private and state landowners to implement riparian and in-stream restoration projects and to retain and enhance riparian overstory.
5. Minimize or mitigate for road-building activities within Riparian Reserves that have the potential to impact water quality standards, including temperature and sediment, or fail to meet ACS objectives.
6. Road construction, upgrading, maintenance, and closure should be performed in accordance with Best Management Practices, as listed in Appendix C of the Salem District's RMP and the Salem District's Transportation Management Plan.

6.1.4 AQUATIC SPECIES AND HABITAT

1. Maintain active participation in the Tillamook Bay Watershed Council.
2. Work on the long-term development of a more complex riparian zone. Strategies would include: developing multi-storied canopy layers, felling or placing larger diameter trees in strategic locations along the stream, underplanting small openings with conifers, and releasing existing conifers.
3. Pursue a coordinated effort to inventory culverts for fish passage across the watershed, and then prioritize projects across all land ownerships.

6.2 TERRESTRIAL

6.2.1 NOXIOUS/EXOTIC PLANTS

1. Develop and implement a process for identifying and documenting weed infestation sites.
2. Where appropriate, develop "Memoranda of Understanding" (MOU's) with adjacent landowners and state and county agencies in order to expedite weed control.
3. Where consistent with safety and management considerations, protect existing native vegetation along roads to help exclude the infestation of invasive species. When building new roads, keep the clearing limits as narrow as possible to limit available growing sites for invasive species.
4. Consider cleaning with a pressure washer heavy equipment that will be used on BLM land for management activities. Cleaning should occur before entering BLM land, and removed seeds and vegetation should not be allowed into any potential water course.
5. Control noxious weed infestations through appropriate control measures (manual labor, biological controls, herbicides, prescribed fire), consistent with ecological objectives.

6.2.2 SPECIES HABITAT

1. Evaluate forest stands and, where appropriate, apply silvicultural prescriptions that would benefit the development of late-seral forest habitat. Such treatments could include variable spaced density management thinnings to promote large tree growth, canopy gaps to encourage a second canopy layer and vertical diversity of the overstory, and underplanting with shade tolerant conifers to promote multi-layered canopy.
2. When conducting density management thinnings, consider developing new LWD by creating snags and down wood. Also evaluate forest stands adjacent to planned thinnings that are not being considered for silvicultural treatment for the opportunity to create LWD.
3. Within the LSR and Reserve Pair Area, inventory existing LWD and create new LWD, if needed, to reach the high level of LWD expected for older stands as outlined in the Late-Successional Reserve of the Northern Coast Range Adaptive Management Area, January 1998 (LSRA).
4. Evaluate the non-suitable owl habitat within the Reserve Pair Area for the opportunity to release understory conifers in the primarily hardwood-dominated stands. Apply treatment if feasible.
5. Inventory LSR for use by marbled murrelets. Consider using radar for surveys.

6. Coordinate with ODF to explore the feasibility of establishing a corridor of late-seral forest habitat that would connect the Nestucca Block LSR with the Trask/Little North Fork of the Wilson/Kilchis Late-Successional block. (See pg. 67 Nestucca Watershed Analysis October 1994).
7. Consider closing roads that are not needed for management activities and excluding OHV use, especially in Sections 4, 5, and 8, T.2S., R.6W., W.M. and in the vicinity of the LSR lands. These areas are fairly large blocks of unbroken contiguous forest that may provide good core areas for wildlife that are sensitive to human disturbance, such as spotted owls and marbled murrelets.

6.2.3 UPLAND FOREST

1. Consider releasing conifers in alder-dominated areas on steep rocky slopes in the RPA.
2. Implement variable density thinning throughout the watershed to achieve a variety of habitats in both the overstory and understory which will help create late-successional forest characteristics. These objectives include: developing a diverse multi-storied forest structure that will likely be utilized by marbled murrelets and spotted owls; managing for the long-term supply and maintenance of snags and down logs.
3. In density management areas, surveys should be conducted to determine existing levels of LWD. The guidelines in the LSRA should be followed to determine appropriate levels of future LWD.

6.2.4 RIPARIAN ZONES

1. Plan and implement riparian silvicultural projects which are designed to accelerate the growth of riparian conifers and enhance species diversity and vertical stand structure.
2. Underplant conifers or release existing conifers in small open areas where hardwoods dominate the riparian zone. Highest priority should be given to areas with high potential for large wood recruitment and increased stream shade. This is best accomplished with a management plan for a given stream reach so that each alder stand can be individually evaluated for its overall contribution.

6.2.5 INSECTS AND DISEASE

6.2.5.1 *Douglas-fir Beetle*

Douglas-fir beetles are attracted to freshly cut logs, and can produce significant amounts of brood in trees which are 12 inches dbh and larger. The threshold for the number of down trees necessary for beetles to produce enough brood to kill live trees is three per acre. As the diameters of these trees and the numbers of trees increase, so does the potential for producing more beetles, which in turn increases the risk of additional Douglas-fir mortality in the surrounding area. Based on observations in western Oregon after blowdown events, for every 100 downed trees about 60 nearby trees will be killed over the next three years. Generally, these observations were in mature (100+ years) stands where the trees were much larger than 12 inches dbh.

Several actions may be taken to reduce the risk of unacceptable amounts of additional beetle-caused mortality. How much mortality is acceptable depends on the standards and guidelines of the land use allocation and the existing amount of LWD. Following are general recommendations to consider when writing silvicultural prescriptions to fell green Douglas-fir trees for decay class one LWD inputs:

1. When felling trees which are 12 inches dbh or larger, cut the minimum number of trees possible that will allow achievement of the LWD objectives.
2. Fell the trees in areas that are more likely to receive direct sunlight. Studies have shown that beetles produce less brood in logs with less shading.
3. Avoid felling trees in areas where standing live Douglas-fir trees are known to have reduced vigor and where it would be unacceptable for many of these trees to die.
4. Fell groups of trees in separate events that are spaced 3-5 years apart. Five-year intervals would minimize the risk of the local beetle population building to an unacceptable level.
5. If possible, felling should occur from about August 1 to October 1. This will allow some drying of the cambium before the spring beetle flight, and may lessen beetle brood production. If subsequent beetle-caused mortality is not a particular concern, such as in an LSR area, timing of tree felling may not be an issue.
6. Postpone felling of LWD trees if bark beetle populations are known to be high, or if there has been considerable amounts of tree mortality in the general area for the previous year or two. This information can be gained from the Insect Aerial Detection Survey maps that are available from the USDA Forest Service, Forest Health Protection.
7. Fell species other than Douglas-fir for LWD recruitment.
8. Emphasis on enhancing LWD through snag creation will greatly reduce subsequent mortality from Douglas-fir beetles.

The risk of bark beetle population buildup is less in healthy, young stands than in older, less vigorous stands. The risk of additional tree mortality in a stand 40 years old (common to BLM land in this watershed) or younger is probably very low. This risk probably increases through time, with stands 80 to 100 years old becoming more susceptible to some overstory mortality. Remnant old-growth pockets, in particular, would be at risk of some tree mortality if beetle populations increased significantly in the area because of LWD creation.

6.2.5.2 *Phellinus weirrii*

High *Phellinus weirrii* levels

1. Apply density management between centers of disease infection. The treatment should emphasize the removal of symptomatic live trees where they occur and retention of snags. In addition, thinning should be of moderate intensity, retaining approximately 60 - 100 trees per acre. The trees should be variably spaced to enhance horizontal structure across the landscape. Opening should be planted with western red cedar or other disease-resistant species, such as bigleaf maple, where appropriate.

   The recommended treatment for disease centers is as follows:

   - Retain the snags for their wildlife value.
   - Plant a second stand of *Phellinus*-resistant species in the openings.
   - It may be necessary to manually cut planting spots through the shrub layer to allow planting.
   - Several years of maintenance may be required to control competing vegetation and limit browse until the disease-resistant species can become established.

Low *Phellinus weirrii* levels

2. In areas that have low to moderate levels of *Phellinus weirrii,* a density management thinning of moderate intensity is recommended, retaining approximately 60 - 100 trees per acre. The trees should be variably spaced to enhance horizontal structure across the landscape.
3. When *Phellinus* infections are well defined, they should be surrounded with a “bridge tree cut” which is implemented by removing a ring of susceptible species around the perimeter of symptomatic trees, thus isolating the disease center from the uninfected portions of the stand. The disease centers should be under-planted with disease resistant species, primarily western red cedar.

6.2.5.3 *Swiss Needle Cast*

1. Actively participate in the Swiss Needle Cast (SNC) Cooperative.

Low Swiss Needle Cast levels

2. Density management thinning that favors non-host species is appropriate. Leave trees that have larger and healthier crowns and appear to be non-symptomatic for Swiss Needle Cast. Creating small gaps or openings in which non-host species are planted may be appropriate. Create small openings around advanced non-host reproduction.

Medium to High Levels of Needle Cast

3. Monitor the growth, health, and mortality in stands that are moderately to severely infected. Implement the latest recommendations and findings from the SNC cooperative to develop and maintain late-successional forest structure in stands that are severely infected.
4. Plant non-host species in underplanting and gaps where appropriate.
5. Follow the recommendations contained in Silviculture and Swiss Needle Cast: Research and Recommendations (Filip et al. 2000), as appropriate.

6.3 SOCIAL

6.3.1 RECREATION

1. Conduct an OHV inventory of trails within the watershed. Revisit OHV designations throughout the watershed. Determine if use designations should be changed due to resource, wildlife, or water quality issues.
2. Monitor dispersed recreation sites to determine if use is impacting water quality. Implement corrective actions as appropriate. If water quality issues are present, develop a plan for preventive measures, which could include limiting access, closing area to use, or refurbishing area.

6.3.2 ROAD-RELATED ISSUES

1. Identify BLM roads that pose a present or future threat of blocking fish passage, contributing sediment, or otherwise degrading water quality. Reduce road segments that alter flow by decommissioning roads that would not be required for access by BLM or neighboring landowners.
2. For future density management thinning projects, upgrade existing roads and use legacy roads, rather than constructing new roads, to reduce potential negative impacts.
3. Place large wood collected from road maintenance activities, such as culvert cleanout, in locations where there is potential for the wood to be delivered to a stream.
4. Minimize disruption of natural hydrologic flow paths by installing drivable waterbars on roads that are expected to receive minimal or no maintenance.

There are about 11 miles of surveyed roads on BLM land within the Elkhorn Activity Planning Unit. Reconstruction plans call for:

1. road maintenance and culvert replacement (~ 2.9 mi.)
2. water bar installation and culvert replacement (~ 4.8 mi.)

3. decommission and culvert removal (~ 3.3 mi.)

A total of 20 culverts were rated as poor and are designated as high priority for replacement. In addition, 9 culverts are planned to be removed in conjunction with decommissioning actions.

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APPENDIX

Water Quality Restoration Plan for Federal Lands in the Trask River Watershed

Prepared by
Carolina Hooper – Plans Forester
Bob McDonald – GIS Specialist

OVERVIEW

In coordination with the accomplishment of the Trask Watershed Analysis (WA), the Tillamook Resource Area (TRA) has reviewed its requirements for completing a Water Quality Restoration Plan (WQRP) for BLM-managed land in the Trask River fifth-field watershed. Total Maximum Daily Loads (TMDLs) were established for the Trask River watershed in 1998, by the Oregon Department of Environmental Quality (ODEQ). The TMDLs that could potentially be affected by management on BLM land include water temperature in the North Fork of the North Fork, and on the mainstem of the Trask River from Bark Shanty Creek downstream. In an effort to determine if a WQRP was necessary, we used the "Forest Service and Bureau of Land Management Protocol for Addressing Clean Water Act Section 303(d) Listed Wateers" (May 1999).

We followed the Forest Service and BLM Decision Framework for 303(d) Listed Waters that is listed on page 6 of the above-mentioned document. This framework has seven components that outline an efficient way to address water quality within existing planning processes. These components are listed on page 3 of the document. Using the Decision Framework, we came to the conclusion that the 303(d) water temperature listings on the Trask River are not related to past or present BLM management. The rationale for this finding will be further explained below. In accordance with the Decision Framework, if the 303(d) listing is not related to the management of BLM land, than there is no requirement to complete a WQRP.

VALIDATE LISTING

The first step in determining if a WQRP is necessary is to validate the current 303(d) listing. We have no data to invalidate the listing, and therefore we assumed that the current listing as displayed on Table 3.10 of the WA is correct.

ASSESSMENT

The second step is to determine if the listing is related to management of BLM land. We strongly believe that the 303(d) listings are not related to management on BLM land for the following reasons:

1. Very little active management has occurred on BLM land in the Trask River watershed in the last 35 to 40 years. After the Tillamook burns there were large scale salvage and replanting efforts, but these were almost all concluded by 1965, and many of them were finished 10 to 20 years earlier. Only 65 acres (approximately .7%) of BLM-managed land in the watershed have been commercially harvested since the Tillamook burn.

2. Only 8% (approximately 88 miles) of the streams in the Trask Watershed are on BLM-managed land. Of these streams, only 1 river mile is on the mainstem, (a seventh order stream). BLM-managed land on the mainstem composes only .09% of all the streams in the watershed.

3. Approximately 89% (approximately 78 miles) of the streams on BLM-managed lands are 1^{st}, 2^{nd} or 3^{rd} order streams. These smaller streams tend to have very dense canopy covers, which often exceed 90%.

4. The BLM does not manage any land in the North Fork of the North Fork of the Trask River.

5. The land-use allocations (LUA) in the Trask River Watershed include Adaptive Management Area, Riparian Reserve and Late-Successional Reserve. One of the principle intentions of both of these LUA's is to create late-successional forest (LSF). LSF is characterized by large trees, large dead standing and down wood, and multi-layered canopies. All of these characteristics, especially in close proximity to a stream, have been shown to reduce water temperature.

6. Approximately 3,165 acres (38%) of BLM managed land in the Trask River Watershed drains into Barney Reservoir. The water that leaves the reservoir is not 303(d) listed.

7. Over 99% of the 8241 acres of BLM land in the Trask River Watershed are forested. Only 65 acres (.7%) are less than 30 years old. The vast majority (96%) of BLM managed land are between 26 and 106 years old. These stand ages are typified by dense forest canopies, a high degree of inter-crown competition and high levels of shade on the forest floor. All of these attributes have been shown to reduce water temperature.

NEXT STEPS
The third step is to submit these findings to ODEQ for review. The BLM plans to comply with this step as soon after publication of the Trask River Watershed Analysis as possible.

References:
Forest Service and Bureau of Land Management Protocol for Addressing Clean Water Act Section 303 (d) Listed Waters. May 1999. Version 2.0

Tillamook Bay Watershed TMDL. Appendix D Water Quality Management Plan (WQMP) 1998.

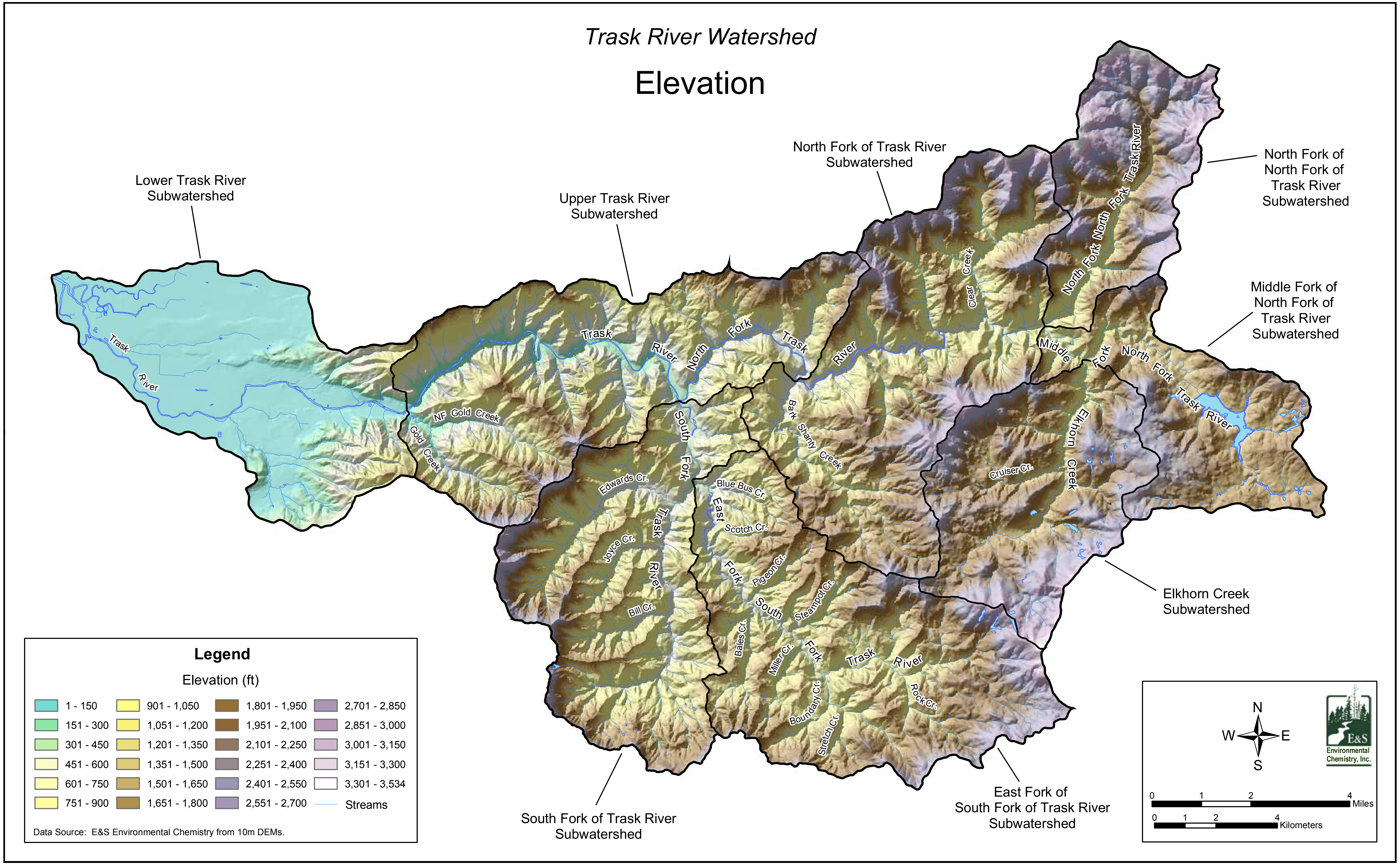

Plate 1. Painted relief of the Trask River watershed.

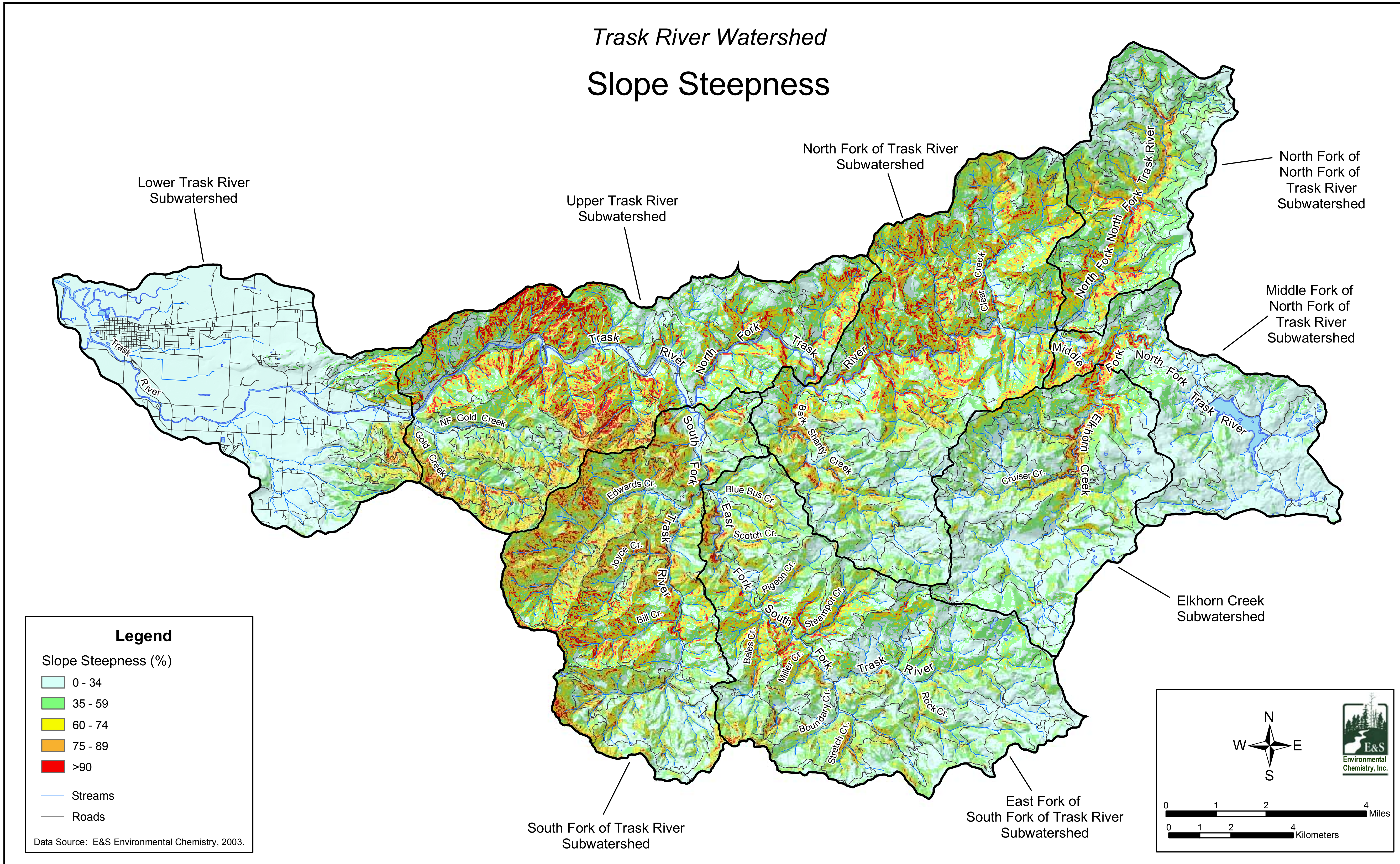

Plate 2. Slope steepness in the Trask River watershed.

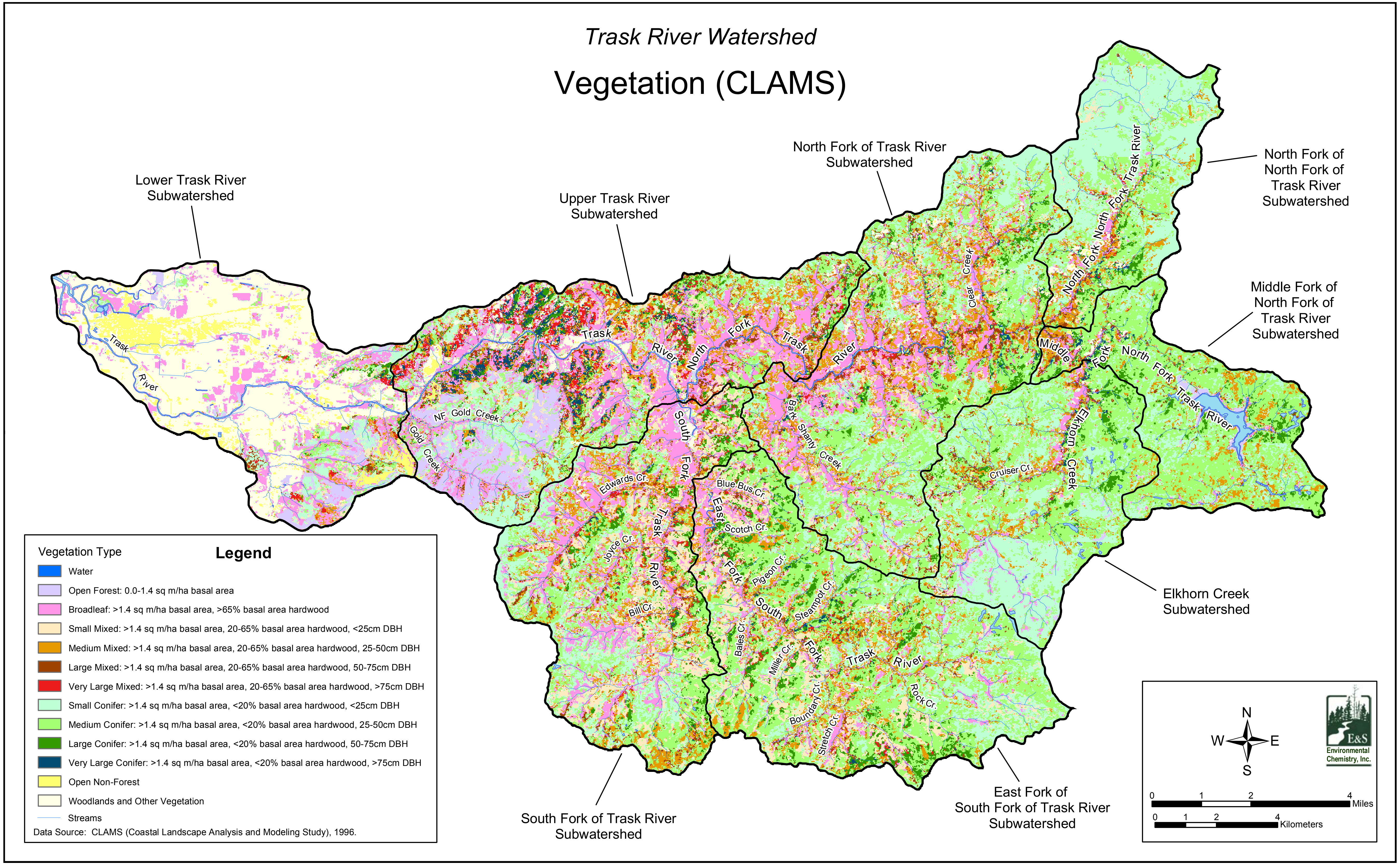

Plate 3. Current vegetation based on CLAMS data.

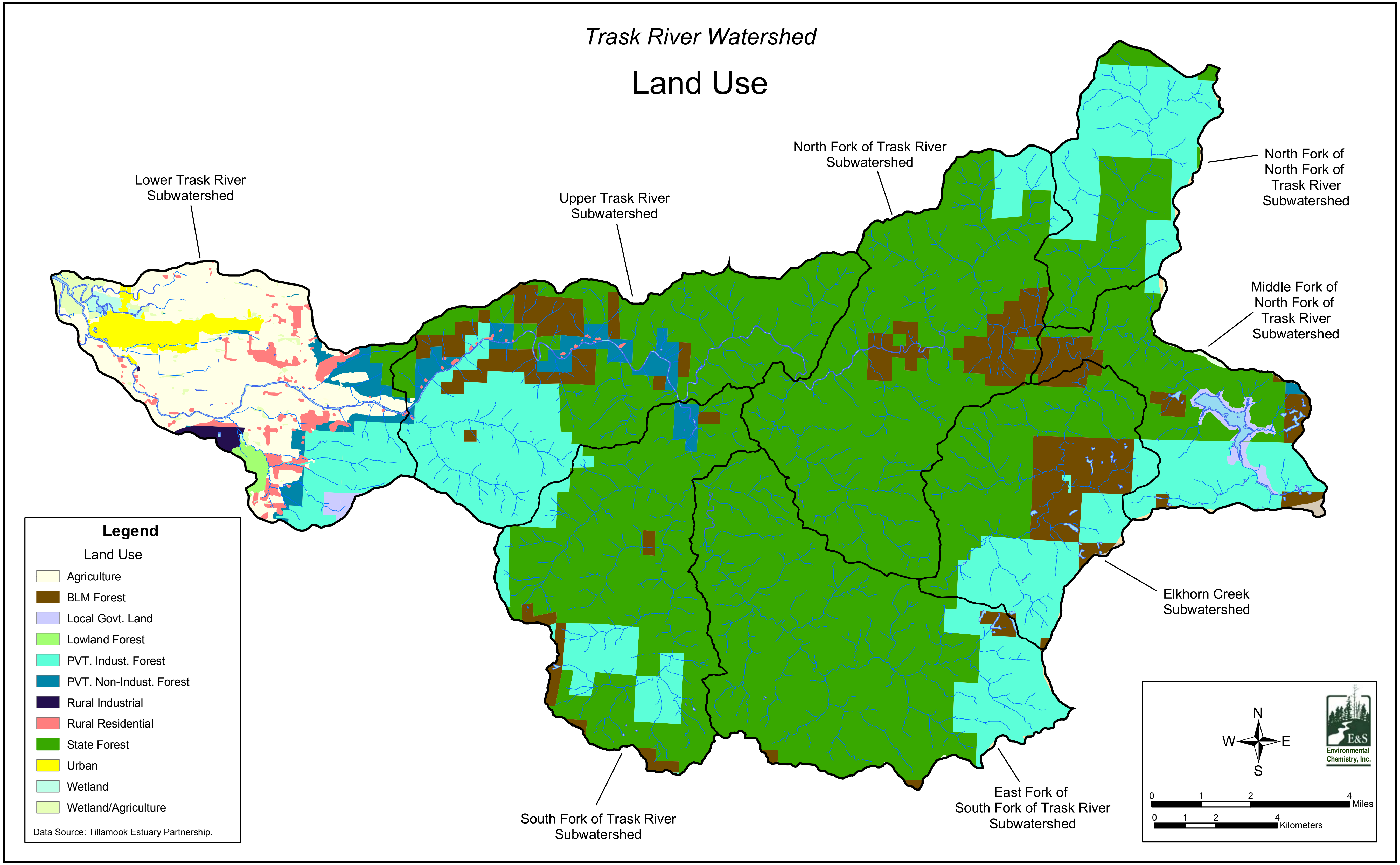

Plate 4. Current land use.

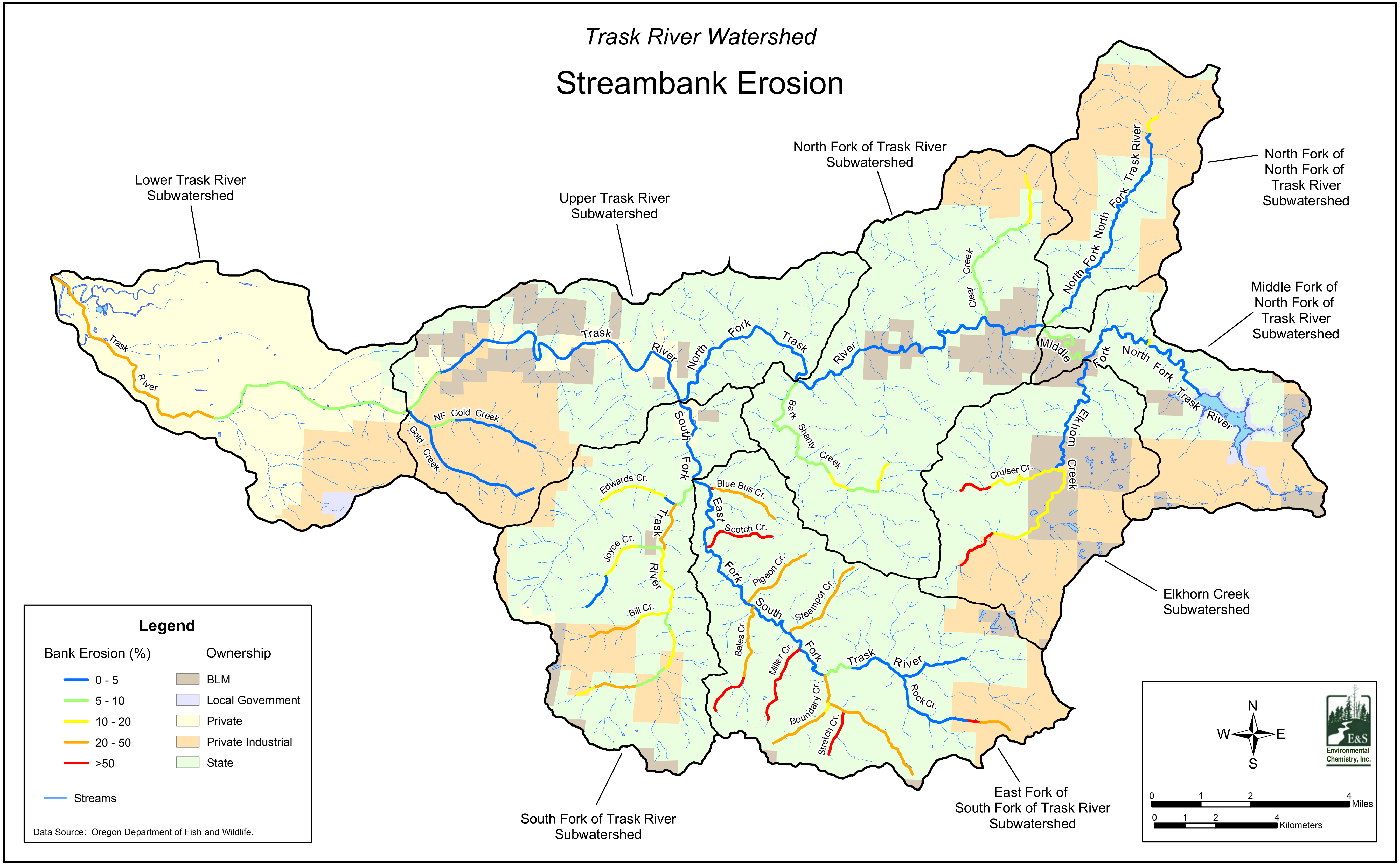

Plate 5. Streambank erosion.

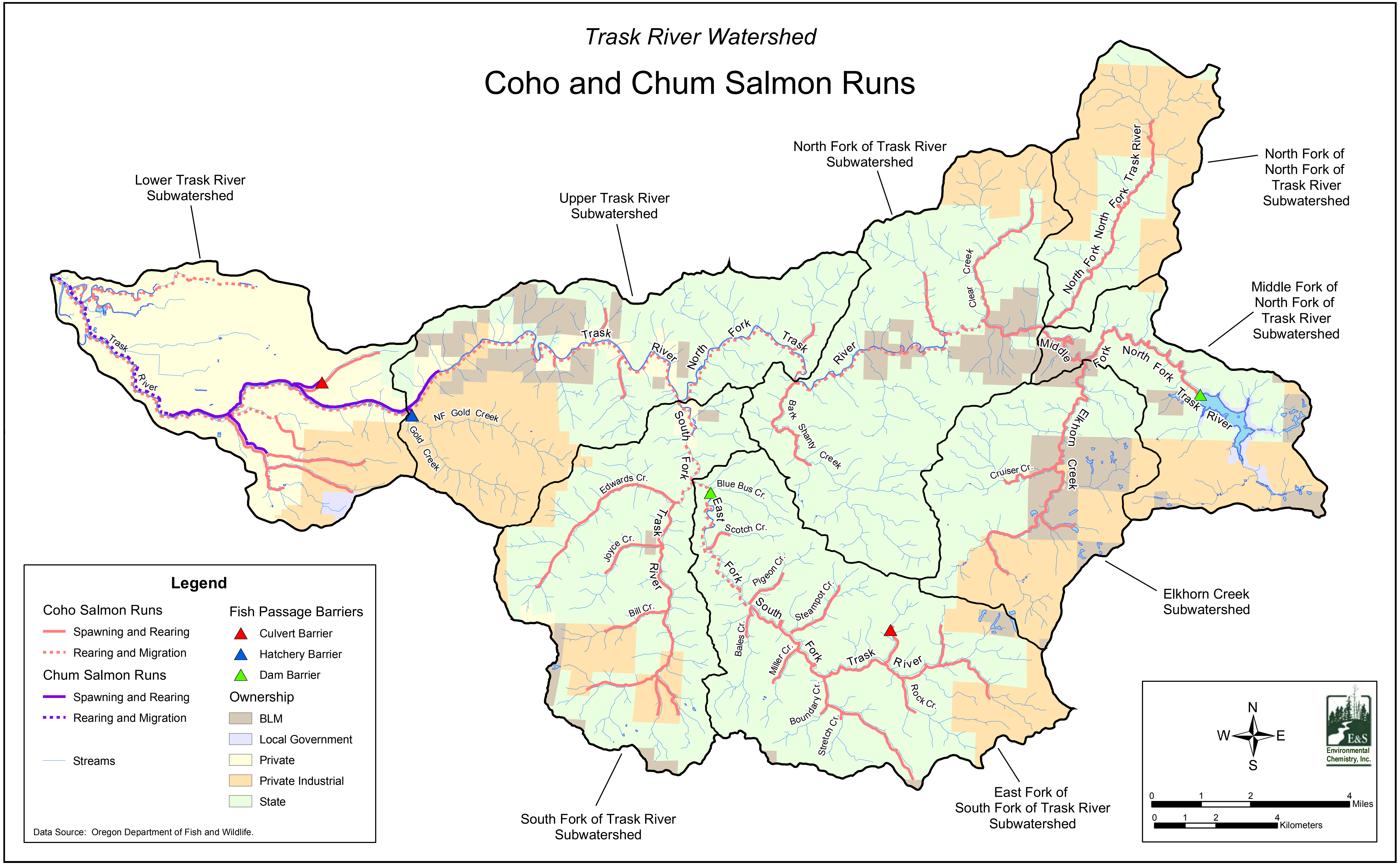

Plate 6. Coho and chum salmon distributions in the Trask River watershed.

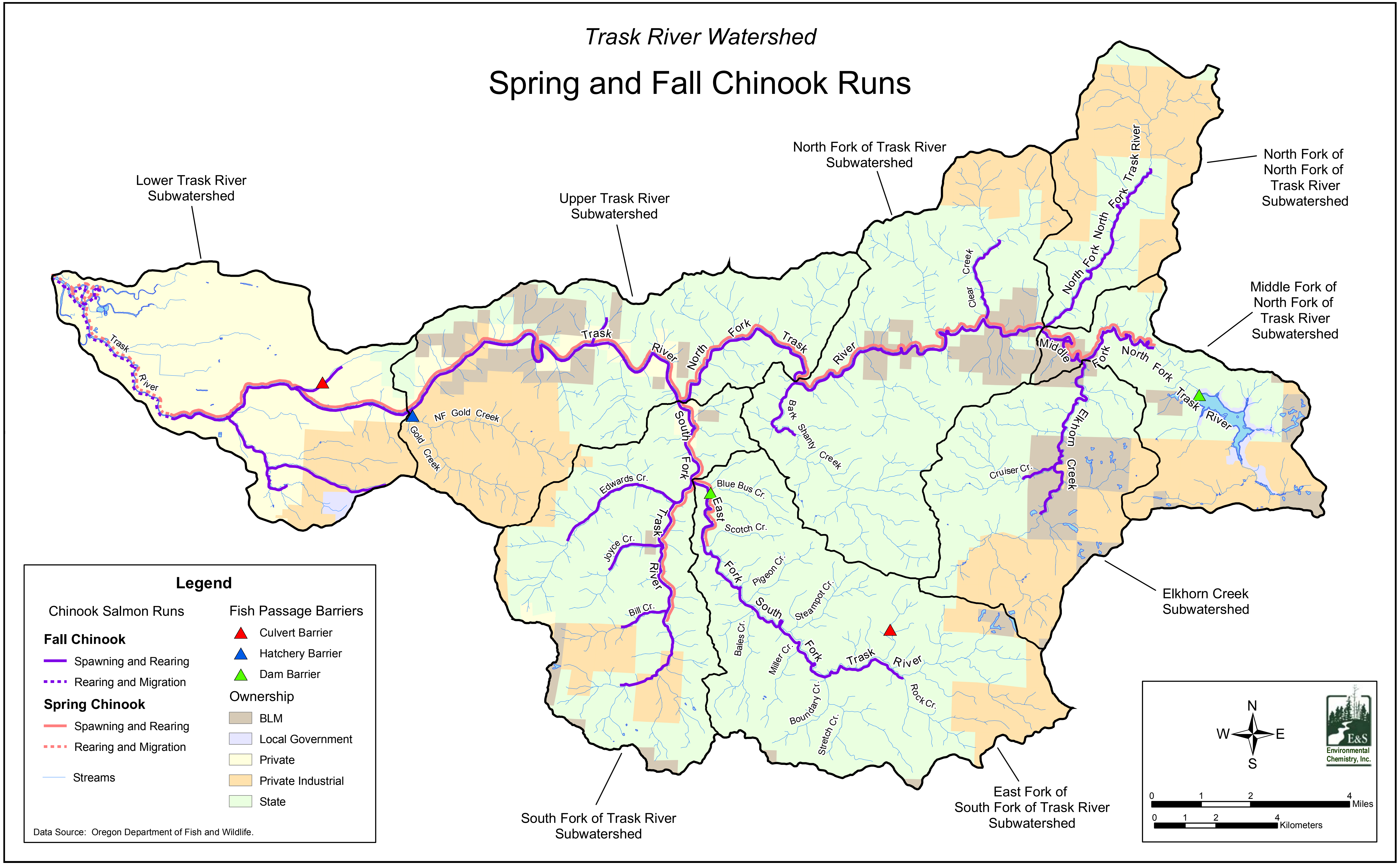

Plate 7. Distributions of spring and fall chinook salmon in the Trask River watershed.

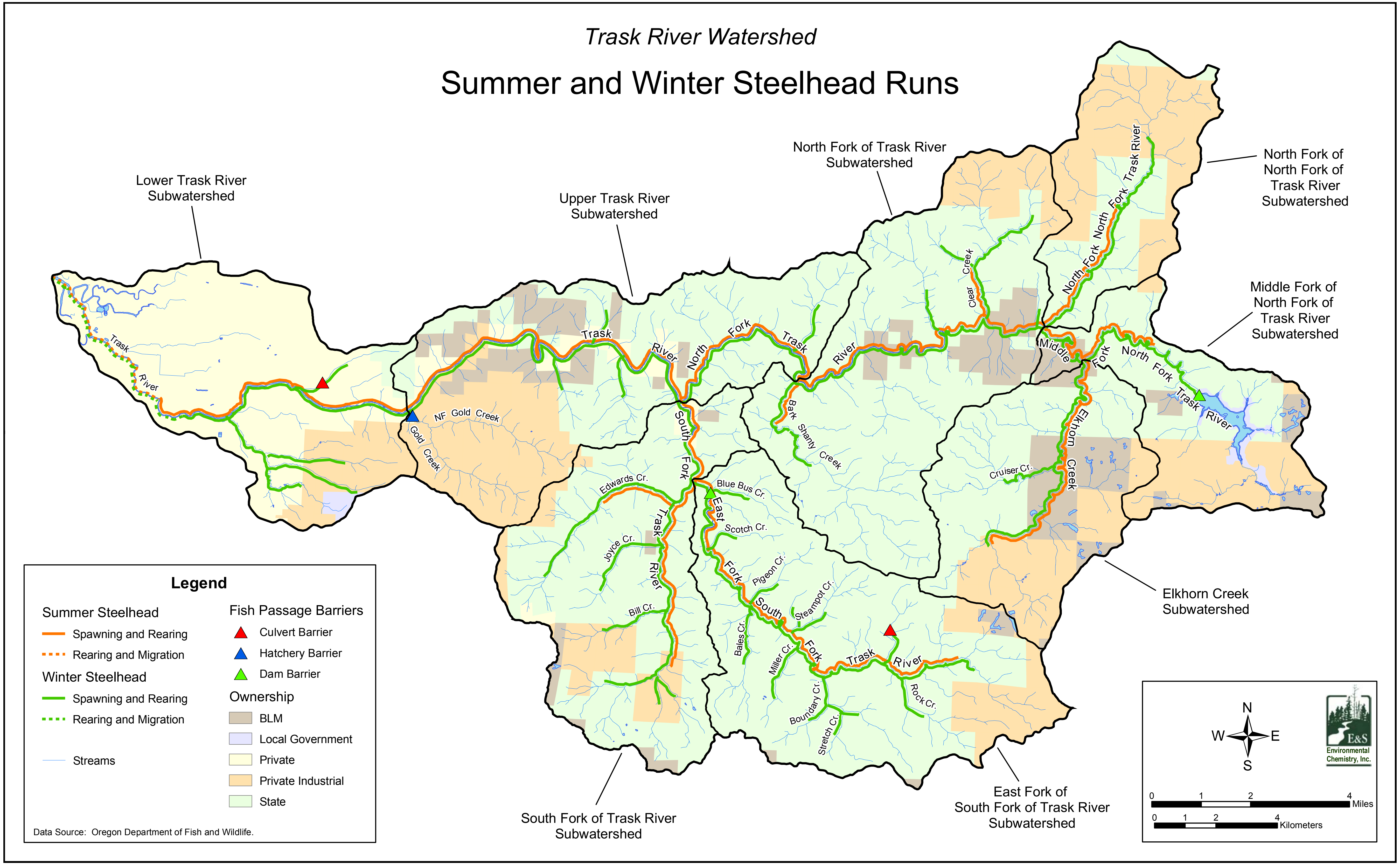

Plate 8. Summer and winter steelhead distributions in the Trask River watershed.

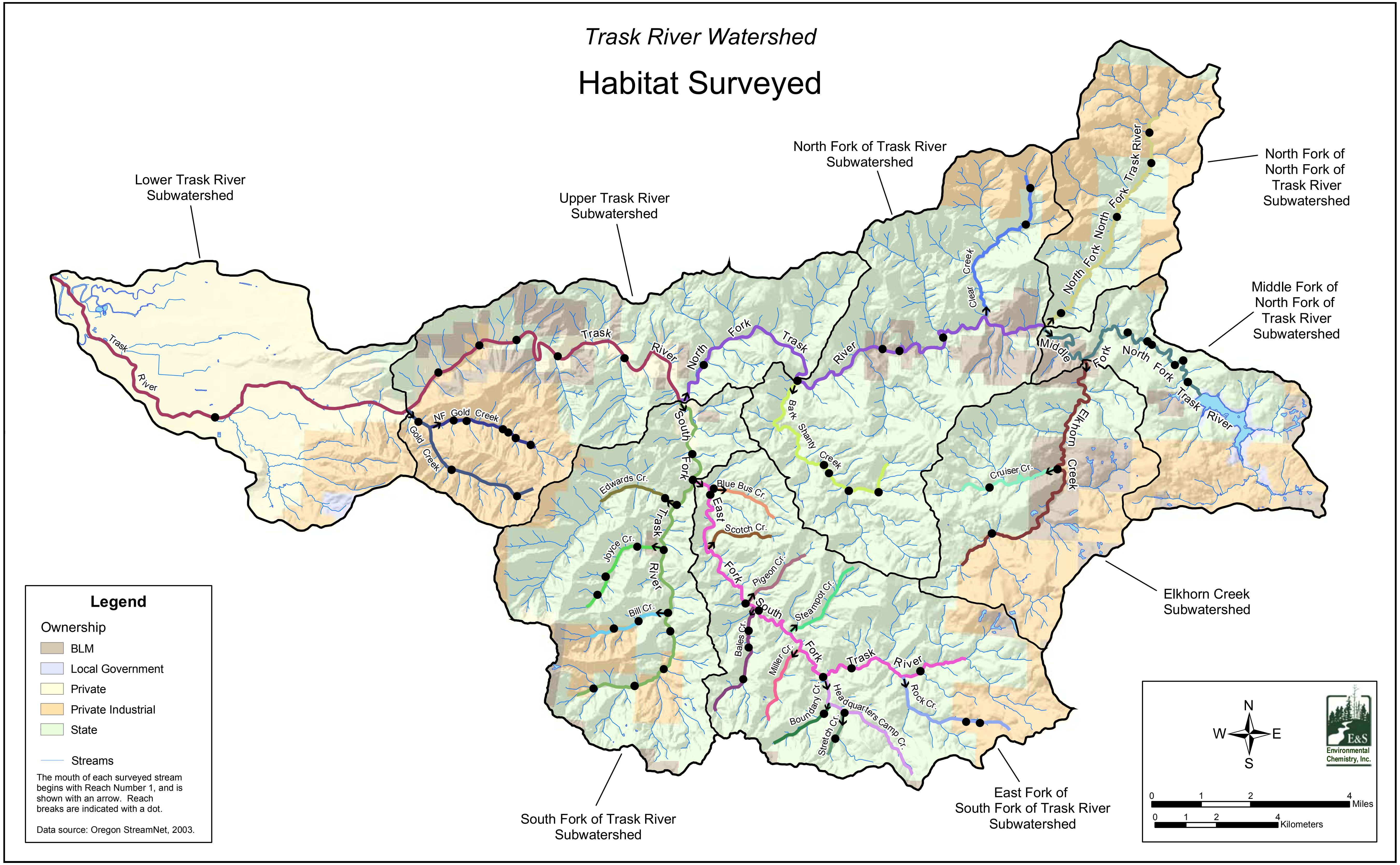

Plate 9. Stream habitat surveys conducted by Oregon Department of Fish and Wildlife.

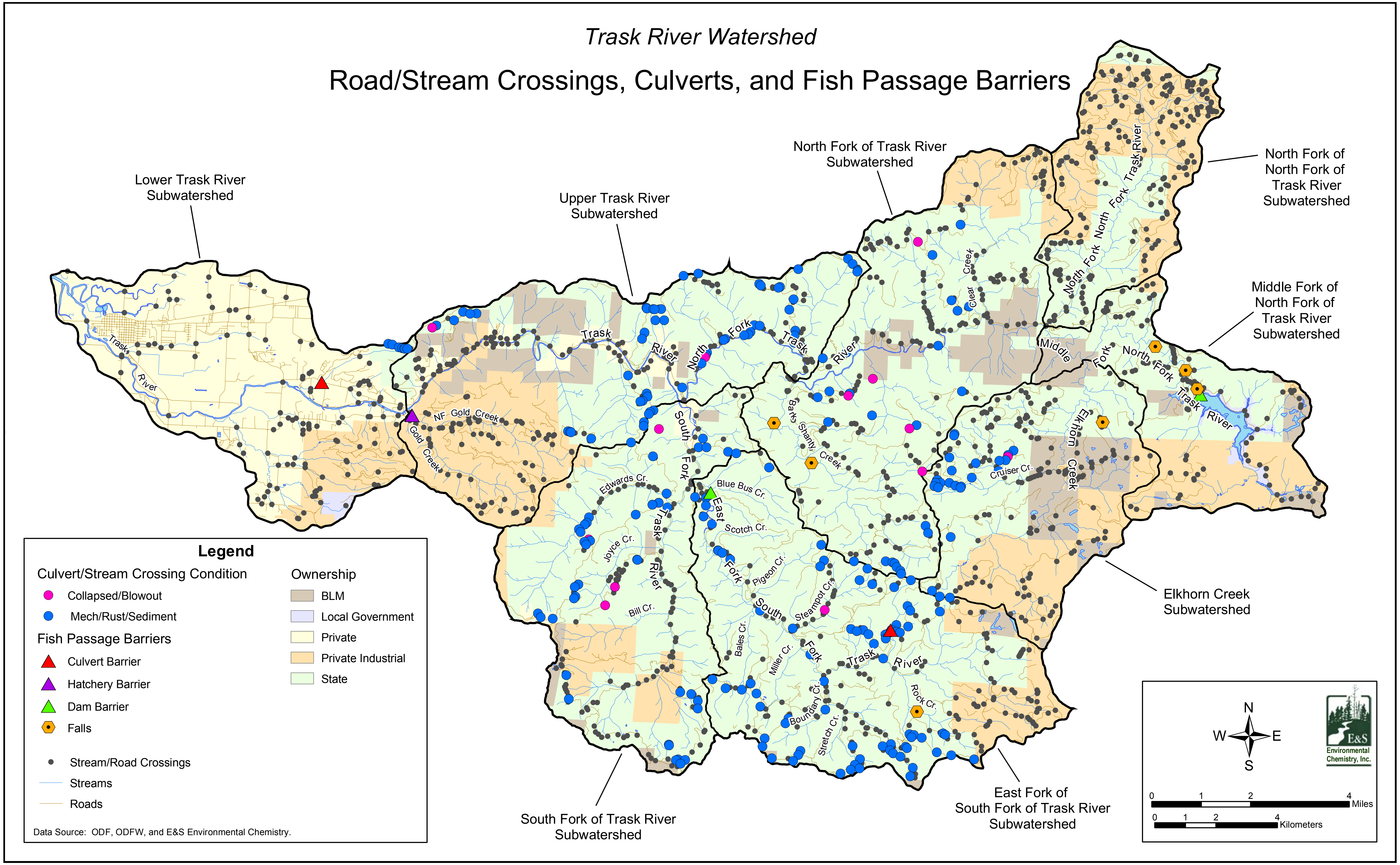

Plate 10. Stream/road crossings, culverts (and existing condition), and fish passage barriers.

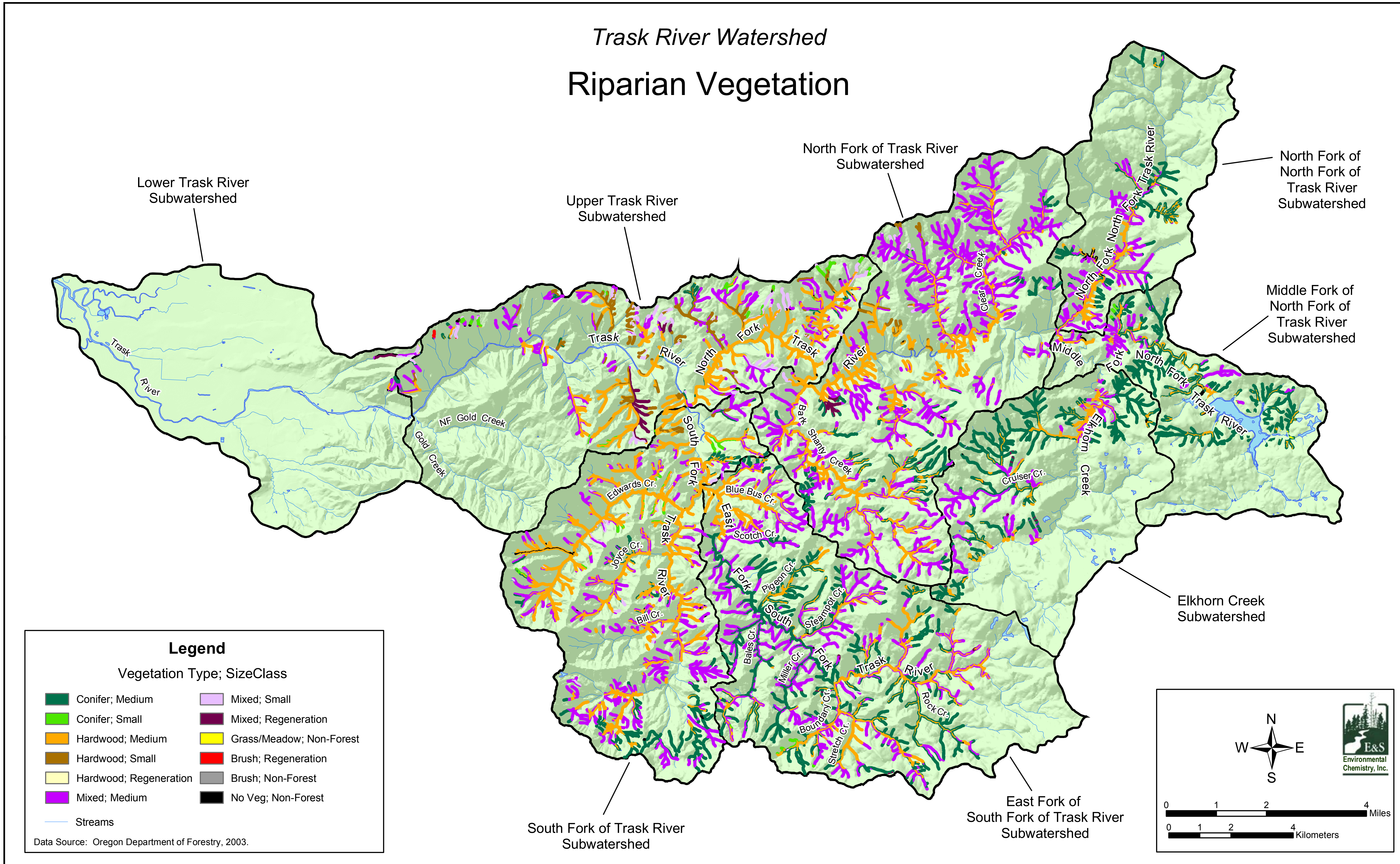

Plate 11. Riparian vegetation from ODF ownership in the Trask River watershed. (Source: Falcy 2002)

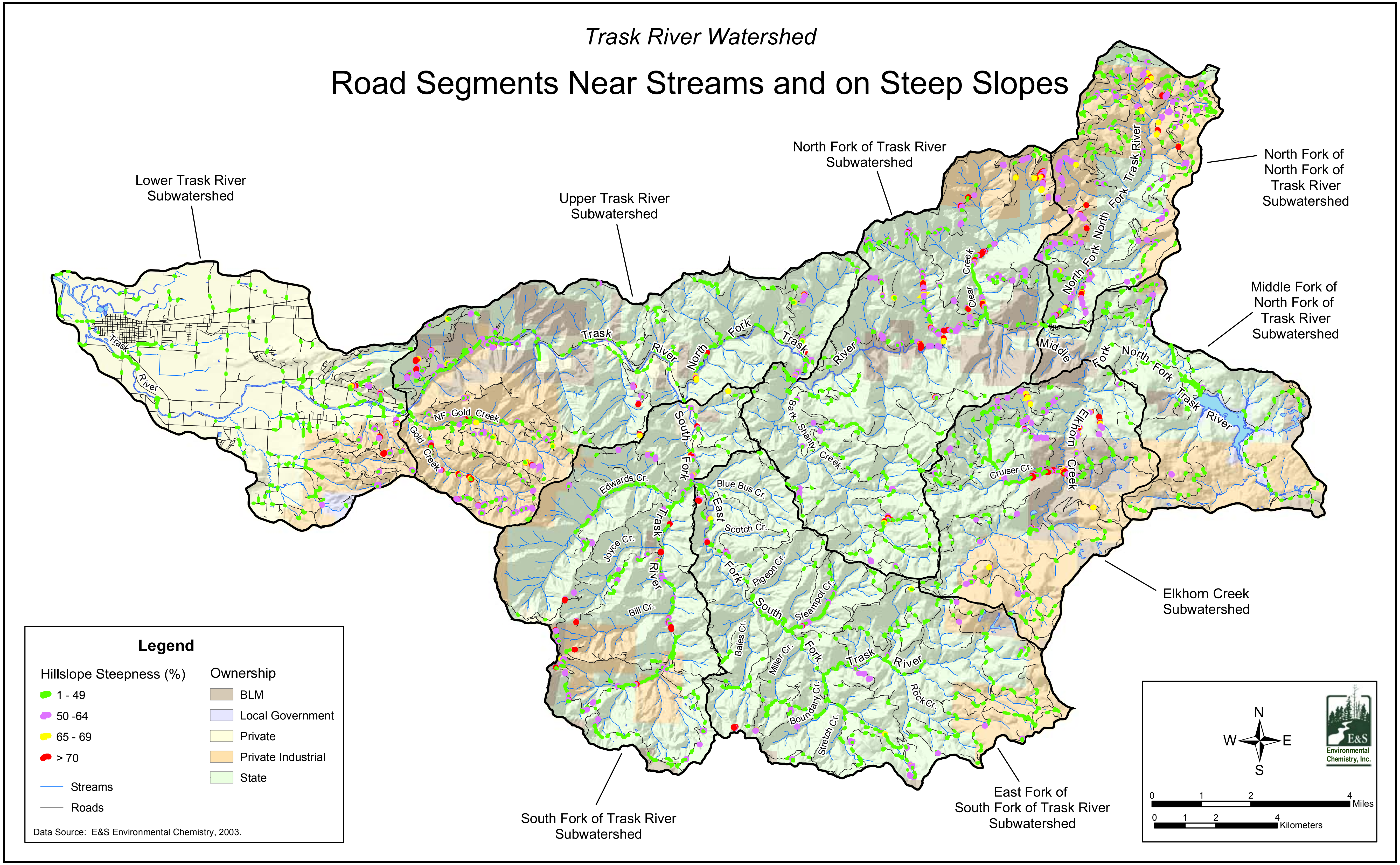

Plate 12. Road segments within 200 ft. of a stream on steep slopes.

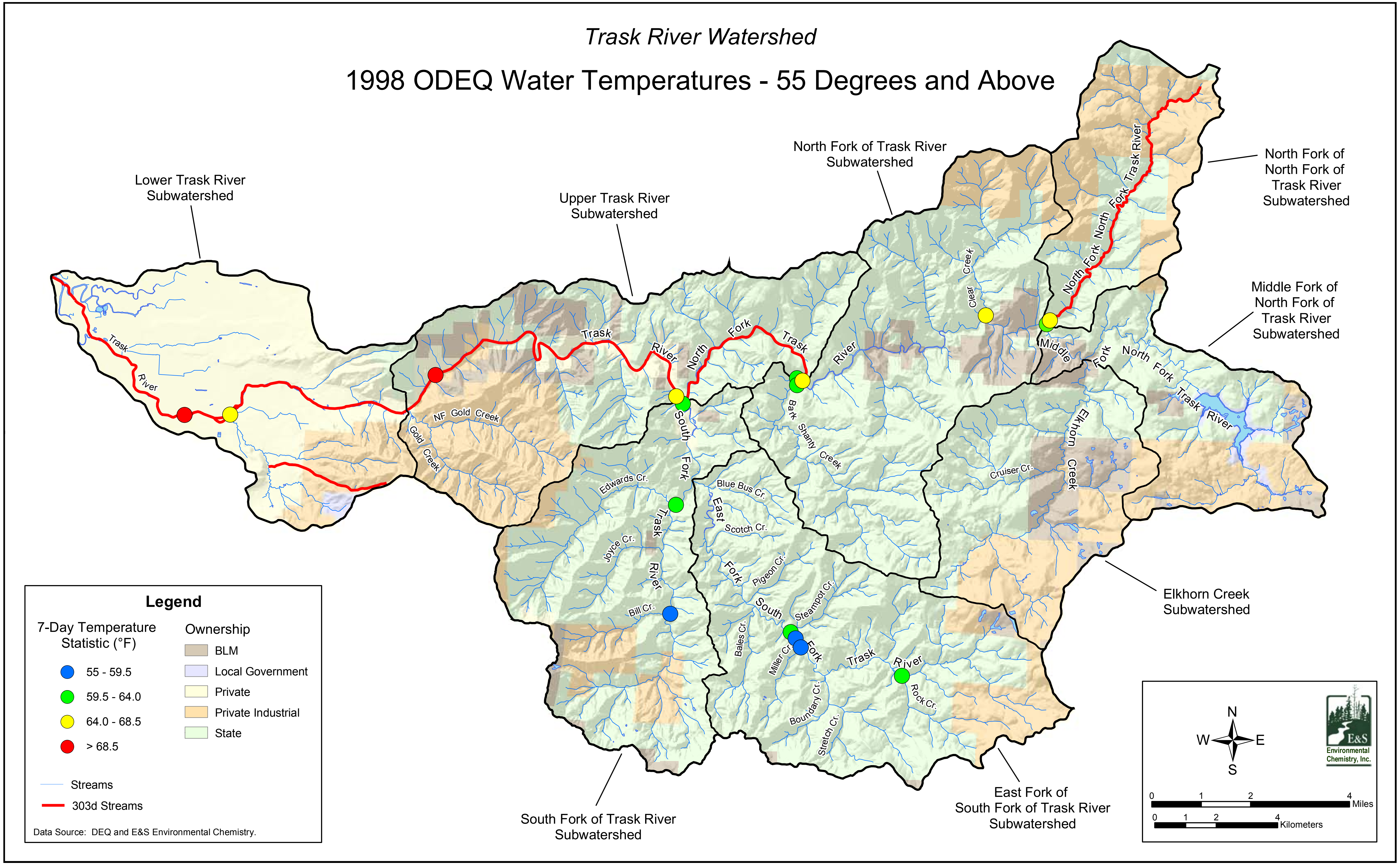

Plate 13. ODEQ water quality sites with temperatures exceeding 55 degrees Fahrenheit.