Netarts Watershed Assessment

January 1999

Original data for this assessment were compiled from multiple sources and may not meet the U.S. National Mapping Standards of the Office of Management and Budget. For specific data sources, dates and scales, additional digital information, or copies of this report contact: Tillamook Coastal Watershed Resource Center, 6385 Tillamook Ave, Bay City, OR 97107 (503) 377-4000.

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Netarts Watershed Assessment

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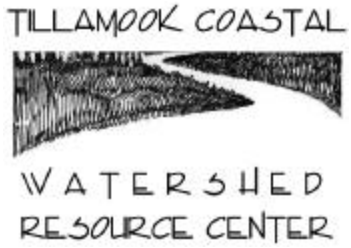

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1. Introduction

A watershed assessment is a process for determining how a watershed is working. The goal of this assessment of the Netarts Watershed (Tillamook County, OR) was to identify areas in the watershed in need of protection or restoration, and to provide the basis for an Action Plan for the Netarts Watershed Council.

This assessment was completed using the draft Oregon Watershed Assessment Manual (10/97 version) and funded by a grant from the Governor's Watershed Enhancement Board (GWEB). The master copy of this assessment including all maps, mylars, forms, computations and notes is housed at the Tillamook Coastal Watershed Resource Center (TCWRC) in Bay City, OR and is available for public use on the premises. The TCWRC can be reached at (503) 377-4000.

The Netarts Watershed (19.3 square miles) consists of a shallow bay (3.6 square miles) enclosed by a sand spit (1.6 square miles) and fed by 14 perennial streams. The streams run approximately east to west and several flow through tidal salt marshes before entering the bay. The land uses/classifications in the watershed are: forestry 70%, urban and rural residential 5%, the Netarts Spit (park) 8%, and Netarts Bay 18%. Netarts Bay is an ocean dominated estuary due to the low volume of freshwater inputs relative to the tidal exchange. There is minimal agriculture (hobby farms) and no industry in the watershed, although there is commercial oyster production in the bay. The forested portion of the watershed ranges from gentle slopes to steep rugged terrain. The primarily conifer-dominated forest is composed of western hemlock, Sitka spruce, red alder, Douglas-fir, and western redcedar. The human population is centered in the town of Netarts with small numbers of people living in rural residential areas primarily scattered along the bay shore. Land ownership in the watershed is presented in Figure 1-1.

The basemap for the Netarts Watershed was prepared by taping together the Netarts and Sand Lake topographic maps (7 1/2 minute, 1:24,000 scale, 40 foot contours). Where appropriate for the assessment the watershed was divided into 16 subwatersheds (Figure 1-2). They are from north to south: Fall Creek, Happy Camp, Hodgdon Creek, Pearl Point, O'Hara Creek, Wilson Beach, Rice Creek, Northbay, Yager Creek, Wee Willy, Whiskey Creek, Midbay, Austin Creek, Southbay, Jackson Creek, and Netarts Spit.

A history of the town of Netarts was prepared by the Netarts Steering Committee (predecessor of the Netarts Watershed Council) which presents a timeline of human activities in the Netarts Watershed. The history also includes historical photographs and a list of suggested readings, many of which are available for check out from the Watershed Council. This information is also available on the internet at: www.oregoncoast.com/Netarts/Nbay1.htm.

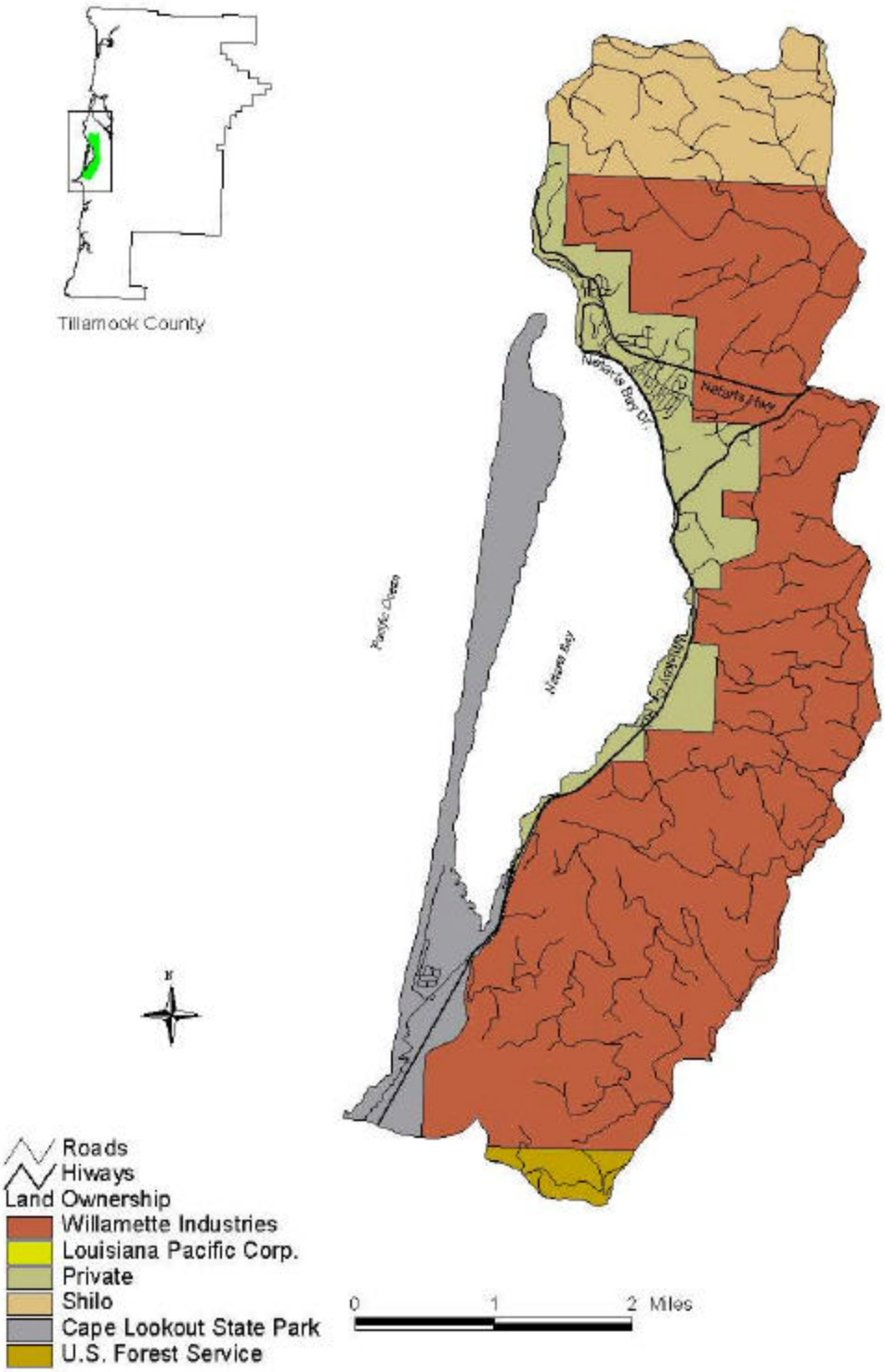

Figure 1-1. Land Ownership in the Netarts Watershed

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2. Channel Habitat Types

The classification of stream channels into channel habitat types (CHTs) is designed to help identify which portions of the watershed have the highest potential for fish utilization. In addition, the classification provides information on how the different channel types respond to land use impacts or restoration actions[1].

All perennial streams in the watershed were classified using the CHT methodology. The lowest stream reaches were classified as WC (connected wetland), MM (moderate gradient, moderate confinement), and SV (steep headwater). The middle reaches included MM, SV, and MH (moderate gradient headwater). The upper reaches of the streams included SV, MH, and VH (very steep headwater). A full compilation of the CHTs for the streams in the Watershed is presented in Table 2-1 and shown on Figure 2-1.

General descriptions of the channel habitat types found in the Netarts Watershed are:

WC – connected wetlands are in low gradient (under 1%) reaches or depressions. The wetlands are connected to a stream channel so that fish (coho, steelhead, resident species) can enter the wetland from the stream and utilize the area for rearing habitat or to escape floodwaters.

MM – moderate gradient (2-4%), moderate confinement channels are in the lower to middle portion of the stream system and can develop a small floodplain. They support spawning (limited for coho, good for steelhead) and rearing (coho and steelhead) habitat as well as good spawning, rearing and overwintering habitat for resident fish species.

MH – moderate gradient (1-6%) headwater channels are found in the middle to upper portion of the stream system in open, gentle valleys and may include productive flats. They provide spawning and rearing habitat (potential for steelhead, important for resident species).

SV – steep gradient (8-16%), narrow valley channels are located in the middle to upper portion of the stream system. They are small streams that are tightly constrained by a narrow valley. They provide rearing habitat (limited steelhead, limited resident species) and spawning habitat (limited resident species).

VH – very steep (16%+) headwater channels are located at the head of streams in narrow valleys. They provide limited rearing habitat for resident fish species.

[1] Governors Watershed Enhancement Board. 1997. Oregon Watershed Assessment Manual.

Table 2-1. Channel Habitat Types By Subwatershed In The Netarts Watershed

Stream Name	Stream #	Stream Order	Stream Length (feet)	Channel Habitat Type	Segment Lengths (feet)			
Fall Creek	100	2	14,000	mm-mh-sv	5,000	4,500	4,500	
Fall Cr. North Fork	101	2	7,000	mm-sv	2,000	5,000		
Fall Cr. West Fork of N Fk	102	1	2,350	sv	2,350			
Hodgdon Creek	200	1	10,600	mm-mh-sv	2,100	7,000	1,500	
O'Hara Creek	300	1	12,900	mm-mh-sv	3,000	5,900	4,000	
Rice Creek	400	1	7,900	mm	7,900			
Northbay – Unnamed Creek 1	500	1	3,600	wc-mh	1,600	2,000		
Northbay – Unnamed Creek 2	600	1	6,850	wc-r-mm-mh	1,750	600	3,500	1,000
Yager Creek	700	2	8,100	wc-mm-sv	1,500	5,500	1,100	
Yager Cr. North Fork	701	1	2,750	mm	2,750			
Wee Willy – Unnamed Creek 3	800	2	5,600	wc-mh-sv	1,000	4,100	500	
Unnamed Cr. North Fork	801	1	1,750	sv	1,750			
Wee Willy – Unnamed Creek 4	900	1	6,500	wc-mh-sv	2,600	2,000	1,900	
Whiskey Creek	1000	2	14,000	mh-sv-vh	4,000	9,000	1,000	
Whiskey Cr. North Fork	1001	2	5,250	wc-mh-sv	2,250	1,750	1,250	
Whiskey Cr. East Trib.	1002	1	3,300	mh-sv	2,100	1,200		
Midbay – Unnamed Creek 5	1100	1	5,500	mh-vh	3,000	2,500		
Austin Creek	1200	1	7,400	sv-vh	2,000	5,400		
Southbay – Unnamed Creek 6 (Crown Zellerbach)	1300	1	6,900	mh-vh	1,400	5,500		
Unnamed Creek 7	1400	1	5,500	mh-vh	1,500	4,000		
Jackson Creek	1500	2	14,600	wc-mm-mh-vh	3,600	2,000	2,500	6,500
Jackson Cr. South Fork	1501	1	5,750	sv-vh	1,750	4,000		
	Total	Length (feet)	158,100					

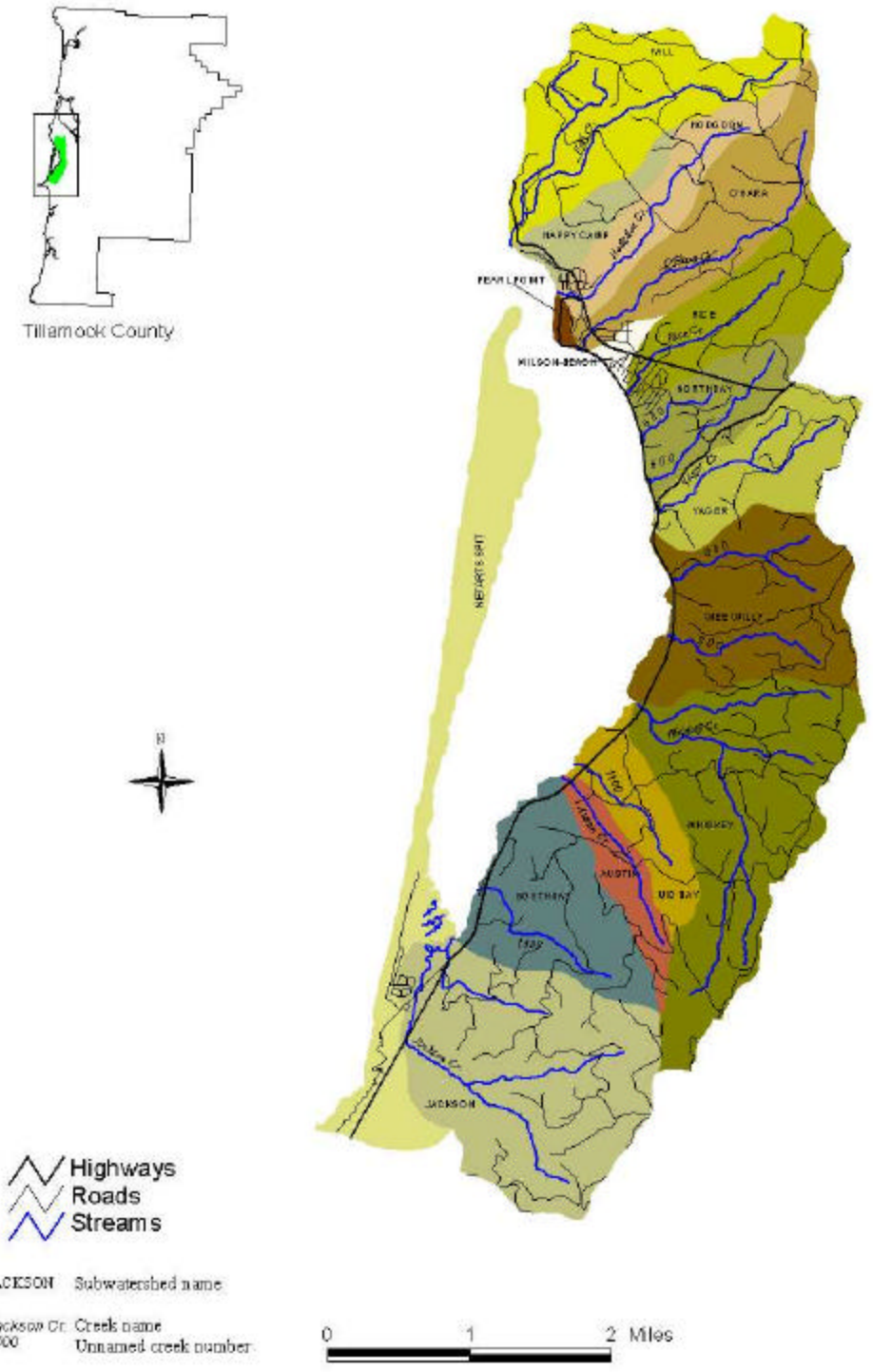

Figure 1-2. Subwatersheds of Netarts Watershed

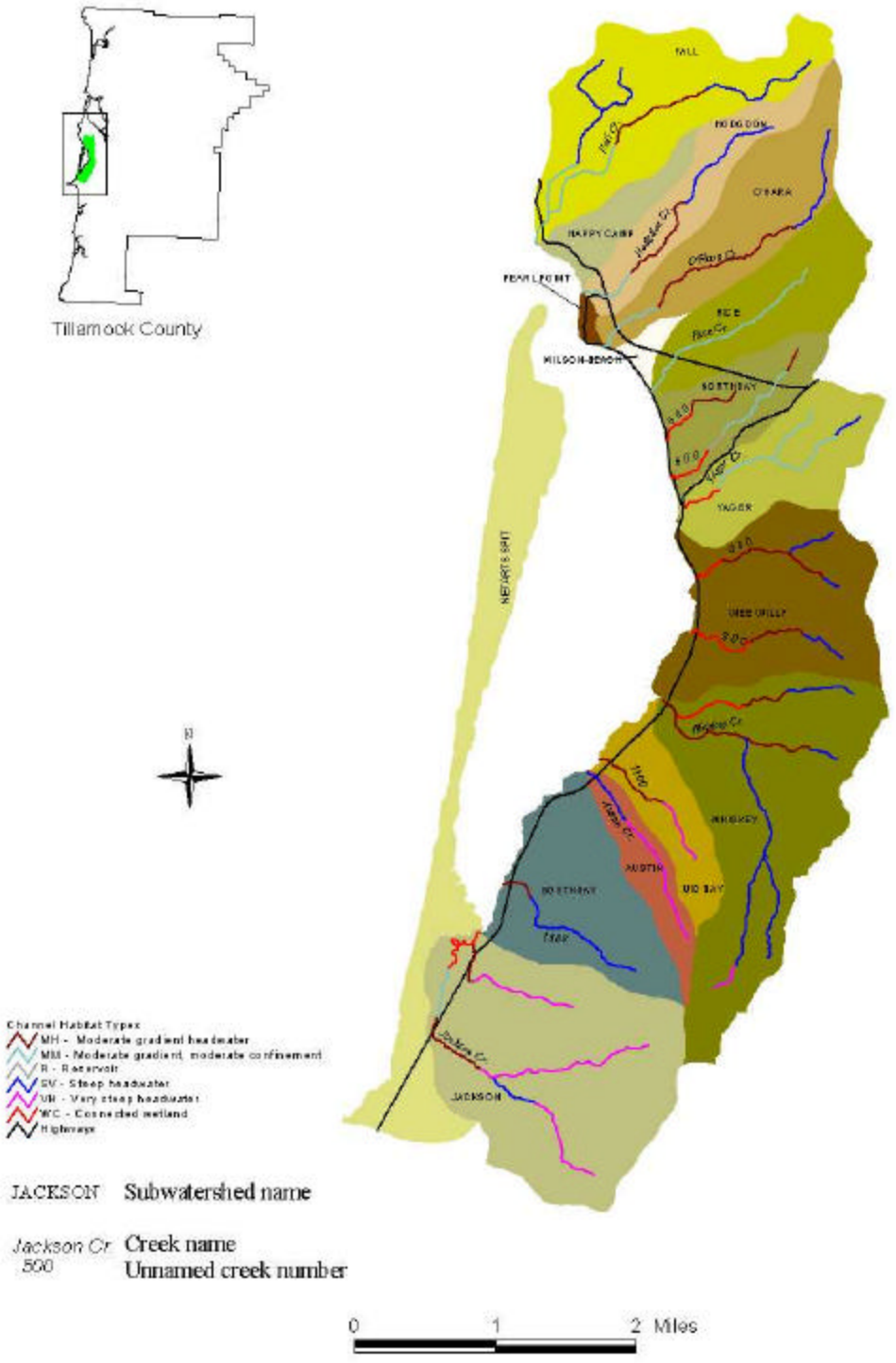

Figure 2-1. Channel habitat types for the Netarts Watershed

3. Fisheries Assessment

Although other species of fish are present in the Netarts Watershed, this assessment focused on salmonids and their habitat. Salmonids are often the preferred choice for monitoring due to their value as game fish and their sensitivity to habitat change and water quality degradation. Salmonid species that are known to occur in the watershed are: chum, coho, winter steelhead, cutthroat trout and chinook. All the published records of salmonid fish distribution in Netarts Watershed that could be found are summarized in Appendix 1. Complete references are listed in Appendix 2.

Of the salmonid species that occur in the Netarts Watershed, four are currently threatened, endangered or under review:

- coho salmon: listed as Threatened under the Endangered Species Act (ESA)
- winter steelhead: candidate for listing as Threatened under the ESA
- cutthroat trout: population undergoing review under ESA
- chum: listed a critical under Oregon Department of Fish and Wildlife Status list

Anadromous Fish Distribution and Abundance

The distribution and abundance of salmonid populations within the Netarts Watershed is difficult to determine since consistent spawning surveys have not been conducted and many of the creeks in the watershed have never been surveyed.

Published references of fish distribution in Netarts were combined with Oregon Department of Fish and Wildlife (ODFW) maps, and personal observations of ODFW biologists to map known, current salmonid distribution in the Netarts Watershed (Figure 3-1).

Direct counts of salmonids have only been conducted on three creeks in the Netarts Watershed: Jackson Creek, Whiskey Creek and Crown Zellerbach Creek. The Oregon Fish Commission conducted spawning surveys on Jackson Creek from 1953 to 1957. The survey unit was from the junction of the channel diversion and Jackson Creek upstream 3/8 mile. During that time 4 coho salmon and no chum salmon were found[2]. During these surveys it was noted that the lower reach of the channel diversion (from the mouth upstream 900 feet) was an area used by chum and coho salmon, and in 1954, 65 chum and 2 coho were counted in this channel. Oregon Department of Fish and Wildlife (ODFW) conducted a spawning survey on Jackson Creek in 1992. The peak count for that survey was 63 live chum; no coho or chinook were found.

Crown Zellerbach Creek was surveyed by ODFW in 1992. The peak count was 15 chum; no coho or chinook were seen. The Oregon Fish Commission, ODFW and Oregon State University have also counted fish on Whiskey Creek. Table 3-1 summarizes the data from these surveys.

[2] Oregon Fish Commission, 1953-1957

Table 3-1. Oregon Fish Commission (OFC) , Oregon Department of Fish and Wildlife (ODFW), and Oregon State University (OSU) Spawning Survey Results For Whiskey Creek, Netarts Watershed.

Year	Type of Count	Agency	Chum	Coho	Chinook
1952	Single Day$^{\nabla}$	OFC	259	7	0
1953	Single Day$^{\nabla}$	OFC	137	0	0
1954	Single Day$^{\nabla}$	OFC	502	0	0
1955	Peak Count$^{\nabla}$	OFC	155	1	0
1956	Single Day$^{\nabla}$	OFC	149	0	0
1957	Single Day$^{\nabla}$	OFC	672	0	0
1958	Single Day$^{\nabla}$	OFC	337	0	0
1959	Peak Count$^{\nabla}$	OFC	323	0	0
1960	Single Day$^{\nabla}$	OFC	159	4	1
1961	Peak Count$^{\nabla}$	OFC	676	0	0
1962	Single Day$^{\nabla}$	OFC	440	2	0
1963	Peak Count$^{\nabla}$	OFC	388	1	1
1964	Single Day$^{\nabla}$	OFC	301	8	0
1965	Single Day$^{\nabla}$	OFC	141	0	0
1966-1967	No survey		No data	No data	No data
1968	Peak Count$^{\nabla}$	OFC	148	0	0
1969	Trap Count	OSU	400	N/a	N/a
1970	Trap Count	OSU	1200	N/a	N/a
1971	Trap Count	OSU	500	N/a	N/a
1972	Trap Count	OSU	1300	N/a	N/a
1973	Trap Count	OSU	1500	N/a	N/a
1974-1991	No survey		No data	No data	No data
1992	Peak Count^{+}	ODFW	667	0	0
1993	Peak Count^{+}	ODFW	25	0	0
1994	Peak Count^{+}	ODFW	79	0	0
1995	Peak Count^{+}	ODFW	10	2	0
1996	Peak Count^{+}	ODFW	0	4	0
1997	Peak Count^{+}	ODFW	22	0	0
1998	Peak Count^{+}	ODFW	19	0	0

∇ Spawning survey area is from the bridge near the mouth of the creek up 1 mile.

+ Spawning survey area is from the bridge near the mouth of the creek up 0.5 mile.

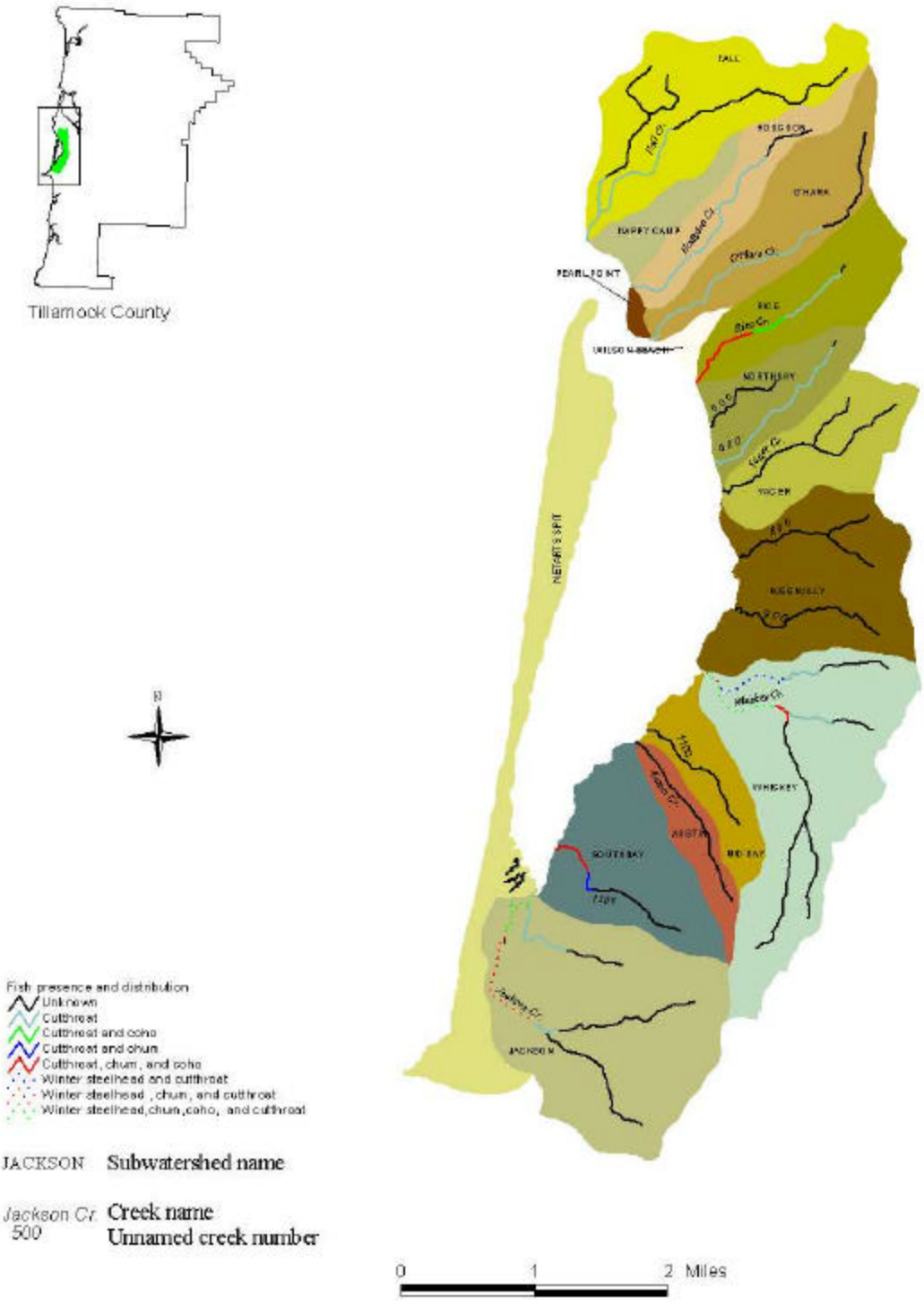

Figure 3-1. Known Current Fish Distribution in Netarts Watershed.

Fish Introductions

Oregon State University began an experimental hatchery facility on Whiskey Creek in 1969[3]. Both chum and pink salmon were used for experiments in 1969 and 1970, however, no pink salmon returned to Whiskey Creek so work continued only with chum. Chum fry were released from the hatchery from 1969 to 1984 and numbers varied from 225,000 to 900,000 per year[4]. In 1988, OSU leased the hatchery to the Tillamook Anglers, a non-profit organization working with ODFW's Salmon and Trout Enhancement Program (STEP). Since 1988, spring chinook have been raised at the hatchery and there have been no releases of any fish into Whiskey Creek (Russ Patterson, Tillamook Anglers, personal communication).

Habitat

Anadromous salmonids require a variety of habitat types: rivers and streams for migration and spawning; estuaries for rearing, adaptation to salt water, and refuge from predators; and marine habitats for rearing and maturation.

Freshwater:

During a watershed assessment a freshwater habitat condition summary is completed by rating channel habitat types within each subwatershed for four parameters measured during ODFW stream habitat surveys: pool area, pool frequency, gravel availability, and gravel quality. The rating of these parameters is then used to produce an overall rating that can be compared to National Marine Fisheries Service and ODFW benchmarks[5]. ODFW has not conducted stream habitat surveys in the Netarts watershed and very little data exists that describe the fish habitat conditions in the watershed. Field notes were taken during the Oregon Fish Commission spawning surveys, but they were very general and performed on limited numbers of streams. During field visits during this assessment, observations were made about habitat conditions. These observations were qualitative and general in nature and should be confirmed with stream habitat surveys. Refer to Figure 3-1 for stream numbers.

Throughout the watershed, creeks are lacking pools. This could be due to the fact that the creeks are short and steep and that there is a lack of large woody debris in the channels. The existing pools are generally small scour pools located around small root wads.

The creeks in the southern portion of the watershed (Jackson Creek, Crown Zellerbach Creek, Austin Creek, Whiskey Creek and 2 unnamed creeks #'s 1100 and 1400) all contain gravel with a limited quantity of fines (sand, silt and/or organic material). Short sections of gravel were observed in all of these creeks in the low gradient reaches of the low portions of the streams. Yager Creek and unnamed creeks #'s 500, 600, 800 and 900 have saltmarshes in the lower portion of the creek. Field checking is needed to verify the habitat condition above the saltmarshes. Rice Creek has excessive fines in the gravel due to a chronic

[3] Lannan, J. E.. 1975. Netarts Bay Chum Salmon Hatchery: An experiment in ocean ranching. Oregon State University Sea Grant Publication no. ORESU-H-75-001.

[4] Pearcy, W.G., C.D. Wilson, A.W. Chung and J.W. Chapman. 1989. Residence Times, Distribution, & Production of Juvenile Chum Salmon, *Oncorhynchus keta*, in Netarts Bay, OR. Fishery Bulletin 87:553-568.

[5] Governors Watershed Enhancement Board. 1997. Oregon Watershed Assessment Manual.

sediment source in the upper watershed. The lower portion of Fall Creek runs through old sand dunes and the bedload sediment consists primarily of sand.

Estuarine:
Table 3-2 summarizes estuarine habitat types used by salmonids and the time these fish spend in estuarine habitats. Netarts Bay covers about 3.6 square miles, The inclusion of marshes increases the total estuarine surface to about 4.2 square miles. In 1979, ODFW summarized the physical and biological characteristics of Oregon estuaries, including Netarts. This report concluded that 12% of the estuary is subtidal (mostly sand substrate), 40% is unvegetated sand and mixed-mud tideflats, and 35% is eelgrass beds[6].

Migration Barriers
Assessment of fish migration barriers is important since salmonids migrate both up and down streams during their lifecycles. Culverts can be barriers to fish due of a variety of factors including: lack of water depth in the culvert, excessive culvert length without resting areas, a high jump to enter the lower end of a culvert, a lack of resting pools above and/or below the culvert, or water velocity in the culvert[7]. Culverts on all paved roads in the lower portion of the watershed were rated during this assessment. The culverts rated as fish barriers and natural fish barriers are shown in Figure 3-2.

Table 3-2. Primary estuarine habitats utilized by juvenile anadromous salmonids and approximate estuary residency times for each species.

Species	Primary Habitat Utilized					Residency Times
	Salt marsh	Eelgrass	Mudflat	Tidal channels	Open water	
Chinook	X	X	X	X	X	Weeks to months
Chum	X	X		X		Days to about 1 month
Coho			X (?)	X	X	Days to months
Steelhead			X (?)	X	X	Days to a few weeks
Sea-run Cutthrout		X		X	X	Weeks to months

Table used with permission from: Hinzman, R. and S. Nelson, eds. 1998. Tillamook Bay Environmental Characterization: A scientific and Technical Summary. Tillamook Bay National Estuary Project.

Original Sources: Healy, M. 1982. Juvenile salmon in estuaries, the life support system. In: V. S. Kennedy, ed., Estuaries Comparisons. Academic Press, New York, NY.

Simenstad, C. and E. Salo. 1982. Foraging success as a determinant of estuarine and nearshore carrying capacity of juvenile chum salmon, Oncorhynchus keta, in Hood Canal, Washington. In: B.R. Miteff and R.A. Neve, ed., Proceedings of the North Pacific Aqauculture Symposium Report 82-2. Alaska Sea Grant Program, University of Alaska, Fairbanks, AK.

Iwamoto, R. and E. Salo. 1977. Estuarine survival of juvenile salmonids: A review of the literature. Report to Washington Department of Fisheries, Fisheries Resources Institute, University of Washington, Seattle, WA.

[6] Kreag, B. 1979. Natural Resources of Netarts Estuary. Oregon Department of Fish and Wildlife Estuary Inventory Report Vol 2, No. 1.
[7] Governors Watershed Enhancement Board. 1997. Oregon Watershed Assessment Manual.

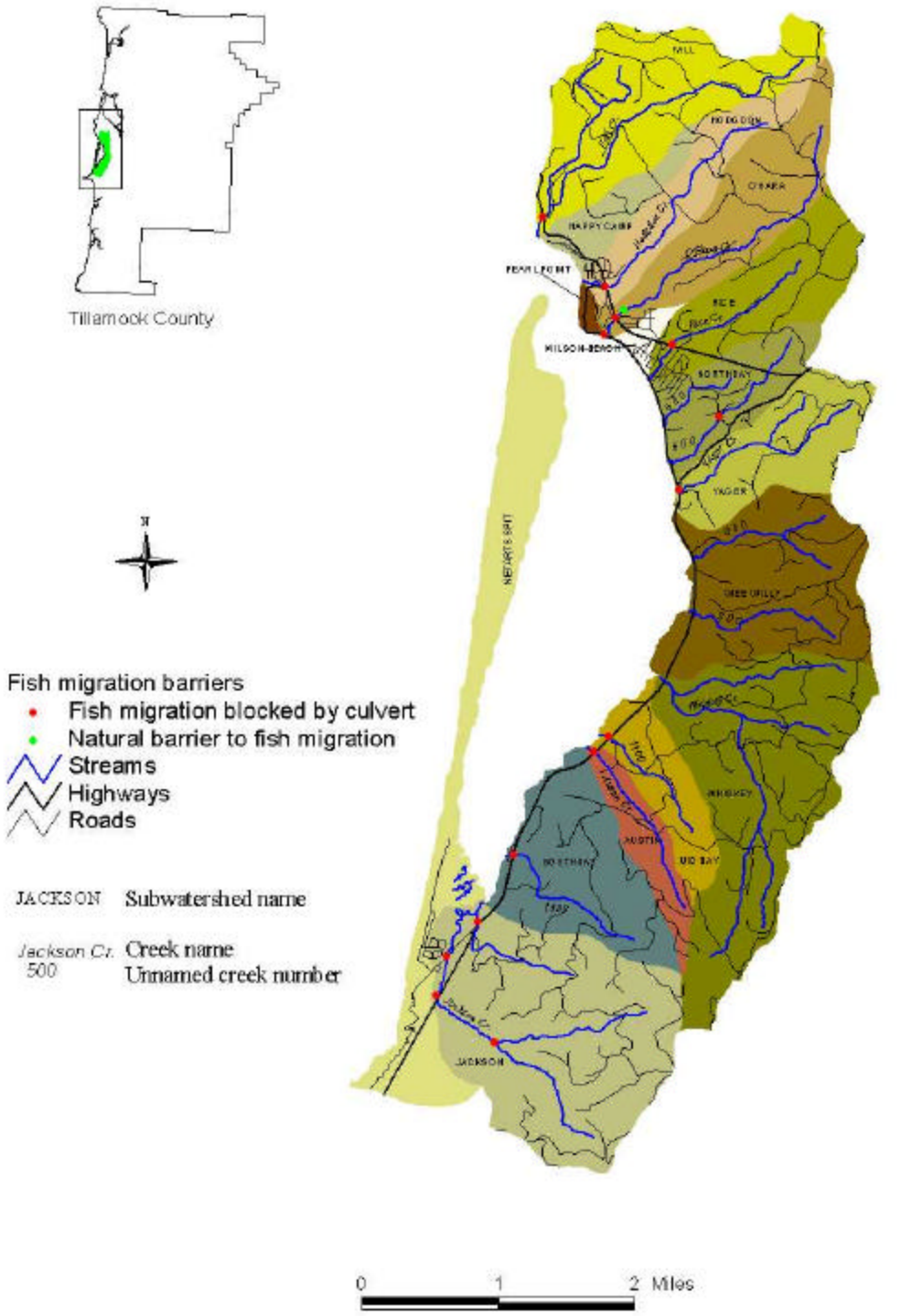

Figure 3-2. Fish Migration Barriers rated in Netarts Watershed

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4. Channel Modification

Channel modifications are classified as either current or historic disturbances to the stream channels. Historic disturbances are important primarily if they have had a lasting effect on the channel, adjacent riparian or wetland ecosystems, or aquatic species populations. Current disturbances may be the direct result of a local activity, or they may be an indirect effect from upstream activities.

Historic Channel Modifications

The historic disturbances in Netarts are: logs were floated down Whiskey Creek, a sea wall was constructed at Cape Lookout Park, the tidal marsh was diked at the south end of the bay, Jackson Creek was diverted from the ocean into the bay, and beaver eradication.

There is an anecdotal report that in very early logging Whiskey Creek was used to float logs down to the bay. There are no apparent signs of this early activity and it is likely that it was very limited.

A sea wall was constructed at Cape Lookout Park to prevent storm erosion in the area of the "A" campground, bathroom, amphitheater, and a section of dunes. The seawall was largely destroyed over the years and the last traces of this seawall were removed in 1998.

Portions of the tidal marsh at the south end of the bay were diked for use as pasture. The agricultural use of the marsh eventually ended, dike maintenance was discontinued, and there remain minor indications of the dike and a fenceline in the marsh.

Jackson Creek was diverted into a constructed channel in 1949 that connnected with the existing channel of an unnamed creek (#400) through the southern saltmarsh to the bay. At some point in the 1950's, the diversion blew out and the creek returned to its original channel. The creek now flows down both channels and the relative proportion is sometimes adjusted during low flow conditions to ensure that both channels remain active. This diversion initially disrupted anadromous fish returning to migrate up the stream from the ocean. An effort was made to capture fish and release them in the constructed channel to establish a fish run from the bay up the creek; the long-term results of this effort are unknown.

Beaver were nearly eradicated very early in Tillamook County and the rest of northwest Oregon by fur trappers. They were later reintroduced and have since repopulated much of their former range. Beaver are currently widespread in the Netarts watershed, but there is no information to determine if their current population numbers are similar to their historic population.

Current Channel Modifications

Current channel modifications in Netarts are: the county boat launch fill, the Yager Creek and unnamed creek (#600) reservoirs, muted tidal flows to saltmarshes at the outlets of

creeks, riprapping of the bayshore to protect the highway, the hatchery facility on Whiskey Creek, and modification of the Fall Creek channel near the confluence with the ocean.

Construction of the county boat launch included filling five acres of intertidal bottom and putting O'Hara Creek into a culvert. The five acres included a productive clam bed, that has been permanently lost. O'Hara Creek formerly supported runs of cutthroat, chum, coho and winter steelhead, of which only cutthroat is thought to still inhabit the creek. The bay channel past the boat launch may have been diverted by the fill causing erosion of the end of the spit. Examination of the 1939 Army Corps of Engineers aerial photo set could confirm the pre-construction condition of the end of the spit.

The Yager Creek and unnamed creek (#600) ponds were constructed by private parties – presumably for water storage, aesthetic and recreational purposes. Both block fish passage upstream, but may allow young fish to pass downstream through the outlet structures. ODFW personnel believe that the only anadromous species formerly on these creeks was cutthroat trout. The Yager Creek reservoir has resulted in extensive sediment accumulation; the pond is dominated by freshwater marsh vegetation. If the outlet structure were modified to allow fish passage it would result in the conversion of the vegetation to a saltmarsh community due to reestablishing tidal influx.

Tidal flows to saltmarshes at several small bay inlets and at the outlets of perennial creeks (#'s 500, 600, 800, 900, and Yager) were reduced by the installation of undersized culverts during highway construction. This resulted in an increased rate of sediment accumulation in the marshes and may have blocked fish passage at some water elevations. All of the perennial creek culverts (except on #800) under the highway have been subsequently replaced by concrete box culverts or larger pipe culverts. Although there are still cumulative effects from the sediment accumulation, the replaced culverts restored tidal flows that will help to eventually flush away the excess accumulated sediments. Culverts on the small bay inlets not associated with perennial streams were not rated for this assessment and do not appear to have been replaced.

A related modification was the riprapping of the bayshore to protect the highway from storm erosion. This resulted in the loss of some saltmarsh habitat and isolation of small tidal channels. The primary impact for salmonids from the culverts and riprap is the degradation of saltmarsh rearing habitat. The current salmonid populations in Netarts underutilize existing saltmarsh habitat due to their low numbers, but if population numbers increased dramatically the availability of adequate saltmarsh would have to be evaluated in detail. Approximately 60 acres of saltmarsh have been added at the south end of the bay this century due to sediment accretion, which is a large net increase in saltmarsh acreage for an estuary system of this size.

The hatchery facility at Whiskey Creek includes several minor channel modifications designed to supply the hatchery with water and to control fish access to the stream. The cumulative effects of these structures on the stream appear to be minor.

The lowest reach of Fall Creek was modified during the placement of a sewer line along the north side of the canyon and subsequent slumping of the underlying dune formation. The channel appears to have been straightened somewhat, riparian vegetation was removed, and some riprap was placed on the engineered slope. The primary effects are simplification of channel complexity and habitat in the reach (500' long), and the partial loss of riparian cover. These impacts could be partially mitigated by the planting of willows into the riprap. Establishing larger tree species on the banks could result in further slumping of the dune and should not be attempted.

5. Sediment

The sediment assessment uses several measures to rate whether a subwatershed is at risk for serious erosion. The potential for landslides is found wherever steep or unstable slopes exist[8]. The areas with potential for landsliding, or mass wasting, were identified using geologic maps from DOGAMI. Areas with 50-70% slopes were classified as having moderate potential for mass wasting and areas with over 70% slope were classified as having high potential for mass wasting. The sediment assessment measures and their values for the Netarts watershed are listed below:

- high mass wasting potential (370 acres);
- moderate mass wasting potential (710 acres);
- roads through high/moderate potential areas (39.5 acres);
- cropland (0 acres);
- rangeland (0 acres);
- urban (470 acres);
- mining (80 acres);
- dirt/gravel roads at stream crossings (39 crossings); and
- roads closely paralleling streams (3.03 miles).

This evaluation results in approximately 10.7% of the watershed area rated as having potential to contribute sediment from mass wasting and soil erosion, and 5.0 miles of roads contributing sediment to streams.

The number of miles of unpaved road per square mile of land is a good indicator of the level of effects of forest roads on the watershed. The density of unpaved roads in the Netarts watershed varies from 1.4 to 5.1 miles of road per square mile of land (Table 5-1). A high density (greater than 2 miles unpaved roads/square mile of land) is indicative of possible elevated sediment delivery.

[8] Governors Watershed Enhancement Board. 1997. Oregon Watershed Assessment Manual.

Table 5-1. Total Area And Unpaved Road Density For Each Subwatershed Of Netarts

Subwatershed	Area	Unpaved Roads
	(sq. mile)	(per sq. mile)
Fall Creek	1.5	3.8
Hodgdon Creek	0.7	1.4
O'Hara Creek	1.1	2.7
Rice Creek	0.9	3.1
Northbay	0.7	1.6
Yager Creek	0.9	5.1
Wee Willy	1.6	3.4
Whiskey Creek	2.3	3.7
Midbay	0.5	3.6
Austin Creek	0.4	2.0
Southbay	1.2	3.1
Jackson Creek	2.5	3.4

These figures show that most of the subwatersheds have road densities that could result in elevated sediment delivery to streams. Willamette Industries has conducted a Forest Road Hazard Inventory for its land in the watershed using the ODF inventory protocol. They are currently addressing the erosion hazards identified by the survey beginning with the highest priority projects. An example was the replacement of all undersized culverts (approximately two dozen) on the access road leading from the main ridgeline haul road down into the Whiskey Creek subwatershed. The new culverts are sized to carry runoff from a 50 year storm (Teagle, B., Willamette Industries Forester, personal communication).

6. Riparian

Riparian communities are the groups of trees, shrubs, and other plants that live alongside streams, rivers and lakes. Riparian conditions affect streams, fish and wildlife through many complex pathways. Some important factors are: vegetation and land uses in the floodplains, streambank stability and erosion, inputs of leaf litter and other material for insect and fish production, streamside shading to control water temperature, and large woody debris (LWD) to create habitat.

The riparian assessment covers the following characters:

- riparian width, composition and continuity;
- current large woody debris levels and potential for future LWD; and
- stream shading and water temperature.

Riparian Characteristics

The lowest riparian community that occurs next to the bay are connected wetlands (channel habitat type WC). This type has a band of riparian trees surrounding an emergent saltmarsh. The trees grow on slightly higher ground adjacent to the saltmarsh. They are usually Sitka spruce or red alder and have moderate to sparse density. The large woody debris potential is moderate since only trees falling towards the marsh from the forested fringe will be recruited.

The next channel habitats that occur low in the watershed are moderate gradient with moderate confinement (MM) and moderate gradient headwater channels (MH). These habitat types usually have continuous riparian stands that merge uninterrupted with the forest on either side. The MM and MH riparian stands are usually dense and are composed of either young conifers or mixed conifers and hardwoods. When these types extend to the bay, the stands are frequently composed of mature mixed conifers and alder. The potential to supply large wood to the streams is good because of the stand density and mixture of species.

In the middle to upper watershed the steep headwater (SV) and very steep headwater (VH) channel habitat types have continuous riparian stands that merge uninterrupted with the forest on either side. The young, dense stands are composed of mixed conifer and hardwood. The potential to supply large wood to the streams is good because of the stand density and presence of conifer species.

Large Woody Debris

Only limited information is available on the current levels of LWD in the streams because there have not been any ODFW stream habitat surveys performed in the Netarts Watershed. The stream segments that were visited in the field were mostly rated as fair for current LWD content except in the urban area, where LWD has presumably been removed from the channels to prevent erosion or enhance aesthetics. Most of the lower stream sections in the forest appear to have very little old growth LWD in them indicating that either the streams were cleaned for fish passage or the logs were salvaged for lumber. No written records were found of either activity.

Stream Shading

Based on qualitative observations, all stream segments visited are providing adequate shading of the stream channel to maintain low water temperatures. The riparian stands near the bay are sparser than the dense stands higher in the watershed, but the trees are larger and the water does not flow far enough under these partial sun conditions to warm up before entering the bay.

Water Temperature

No records of systematic water temperature measurements in any of the streams were located during this assessment. It is assumed that there have been no temperature measurements taken except in Whiskey Creek, where the water temperature was routinely recorded during spawning surveys in the late fall (average mid-40's Fahrenheit). Since the summer low-flow temperatures are those that are most likely to be outside the preferred range for fish, the spawning temperatures are not discussed in detail. It is assumed that water temperatures are within the preferred range for salmonids because the stream shading is adequate, and the streams are short with relatively high gradients. Water temperature measurements in the bay recorded by ODEQ indicate a mean temperature of 54 degrees Fahrenheit with maximum summer temperatures in the low 70's.

7. Water Quality

The water quality assessment acts as a screen to identify water quality concerns (exclusive of temperature) where further investigation is necessary. The contaminants covered are: nutrients, bacteria, organic chemicals, heavy metals, and turbidity/sediment. Dissolved oxygen is an additional water quality parameter that is important to aquatic species.

Nutrients

There is very little potential for excessive nutrient contamination of the streams or bay in the Netarts Watershed. The usual sources for nutrients are agricultural operations or sewage effluent and neither of these are present in significant quantities in the watershed. The hobby farms in the watershed do not have significant numbers of livestock and no row crops. The treated sewage effluent produced in the watershed is exported to the ocean through an outfall pipe that is approximately ½ mile in length. Onsite septic disposal systems in the rural residential areas are inspected approximately every ten years. Although a septic tank survey was just conducted on large portions of the county in 1998, Netarts was not included in the survey. Watershed council members could conduct a septic tank survey with training and support from the County Health Department.

Bacteria

There is very little potential for bacteria contamination from humans or livestock other than from onsite septic systems, which were discussed above. Bacteria sampling is conducted in the bay due to the oyster culture and water contact recreation uses. The mean numbers of fecal coliform found are below 10 MPN/100 ml, which is quite low and well within the water quality standards.

Organic Chemicals and Heavy Metals

There is no information for the Netarts watershed on organic chemical or heavy metal contamination in the ODEQ database (STORET). Sources for organic chemicals are agricultural operations, industry, and urban landscaping, and for heavy metals are industrial sources. Agricultural and industrial sources are not present in the watershed.

Turbidity

No records of turbidity measurements in the streams were located for use in this assessment. The stream with the highest observed turbidity is Rice Creek, which has a chronically active landslide in the headwaters[9]. Other streams in the watershed may have pulses of turbidity following landslides or heavy rains, but in general all streams except Rice were observed to run clear shortly after storms. Turbidity measurements in the bay taken by ODEQ indicate an average of 2.43 Hach FTU for all sites, which is relatively low.

[9] The slide/slump on Rice Creek was evaluated by Oregon Department of Forestry (ODF) in 1998. It is a natural feature on the landscape of large proportion and ODF recommended to the landowner that no reasonable work could be done to stop the slide (Joe Hutton, ODF, personal communication).

Dissolved Oxygen

Dissolved oxygen (DO) measurements were collected in the bay between 1967 and 1984 by ODEQ. The average value for all sites were 9.3 mg/liter with highs of 11.1 and lows of 6.6 mg/liter. The average DO is well within the optimal range for salmonids. No measurements of DO were located for streams in the watershed.

8. Water Use

Surface and ground water removal have the potential to impact stream flows and thus impact fish habitat in a watershed[10]. Any person diverting water from a stream must have a water right on file with Oregon Water Resources Department (OWRD). Each water right has a maximum flow rate at which the water can be removed at any point in time; and each water right is designated for a particular use, such as domestic, power, recreation, or fish. The water rights in the Netarts Watershed are shown in Table 8-1.

There is no information on water availability in Netarts Watershed because there are no stream gages. It is difficult, therefore, to determine the net amount of water available per day in each month and to determine if water withdrawal during low flow season is having an impact on instream flow. If streamflow gages were placed within the watershed it would be possible to compare the water availability to the total water rights in the watershed and make conclusions about water deficits. At this time, there is not enough information available to discern if water withdrawals are affecting fish habitat.

[10] Governors Watershed Enhancement Board. 1997. Oregon Watershed Assessment Manual.

Table 8-1. Water Rights In Netarts Watershed.

Certification Number	Application Character	Priority Date	Use	Rate
6327	Surface	6/26/1922	Domestic	0.1
8414	Surface	8/18/1923	Domestic	0.3
8417	Surface	6/25/1924	Domestic	0.03
13362	Surface	8/1/1938	Domestic	0.09
14210	Surface	12/16/1938	Domestic	0.5
14210	Surface	12/16/1938	Domestic	0.2
15560	Surface	4/20/1940	Domestic/irrig.	0.005
15560	Surface	4/20/1940	Power	0.025
31629	Surface	10/29/1940	Recreation	0.3
31629	Surface	10/29/1940	Domestic	0.3
21909	Surface	8/5/1948	Power	0.01
21909	Surface	8/5/1948	Domestic/irrig.	0.01
20931	Surface	6/9/1952	Fish	0.15
20932	Reservoir	6/9/1952	Storage	0.68
39233	Surface	5/7/1962	Irrigation	0.29
38990	Surface	11/26/1962	Group domestic	0.29
38989	Reservoir	3/21/1963	Storage	0.5
44893	Surface	9/18/1972	Fish	1
44894	Reservoir	12/4/1972	Storage	3.5
59090	Surface	2/16/1978	Fish	0.03
55420	Groundwater	7/3/1979	Irrigation	0.01
55419	Surface	11/14/1980	Domestic	0.01
9829	Groundwater	7/14/1982	Municipal	2.7
39233	Surface	10/14/1983	Fish	0.25
permit #51437	Surface	1/6/1992	Domestic	0.005

Certificate number refers to the number on file with the Oregon Water Resources Department for each water right. When a certificate number was not available a permit number is indicated. Application Character refers the type of water right (groundwater, surfacewater or reservoir). Rate: surface water rights are in cubic feet per second (cfs), ground water rights are in gallons per minute (gpm).

9. Hydrology

The hydrology assessment summarizes statistics on precipitation, stream flows, and human uses at a landscape scale (e.g., logging, development, agriculture) that could affect stream flows. The Netarts Watershed has no gages on any of the streams so no flow information is available. The closest certified weather station is in the city of Tillamook, which is approximately 5 miles to the northeast of the center of the Netarts Watershed. Rainfall in Tillamook is approximately 90 inches/year; the 30 year range is 61.2 to 109.3 inches/year. Annual precipitation ranges from a low of 90 inches/year in the north end of the watershed to 110 inches/year in the highest elevations of the southern portion of the watershed according to the state precipitation map.

Peak flows in the streams are generally in December and January and the lowest flows occur most often in September, but may also occur in August or October. Extreme 24 hour precipitation has been recorded as high as 5.22 inches, but averages 3.24 inches over 30 years.

Human uses that affect hydrology at the subwatershed scale include forestry timber harvest, forest road density, agriculture and urban development. The following table ranks the subwatersheds for their degree of development in each of these areas where applicable; there is no agriculture to rate. Apart from possible effects on peak flows from forest roads, human uses probably have no current significant effect on hydrology in the Netarts watershed. The following factors support this theory: there has been no large scale timber harvest in the watershed recently and most of the forest is reaching hydrologic maturity (i.e., it is $\geq$30 years of age); the more recent timber harvesting activities have been non-industrial forest landowners, harvesting primarily to convert land to non-forest uses such as subdivisions and homes; a low percentage of the watershed is affected by development and there is a low percentage of impervious surfaces within developed areas; and there is no significant agriculture located in the watershed.

Table 9-1. Summary Of Ranked Subwatersheds Within Each Activity Category For The Netarts Watershed

Subwatershed	Timber Harvest	Forest Road Density	Urban Development
Fall Creek	-	2	-
Hodgdon Creek	2	8	3
O'Hara Creek	4	5	2
Rice Creek	1	3	1
North Bay	3	9	-
Yager Creek	-	1	-
Wee Willy	-	4	-
Whiskey Creek	-	2	-
Austin Creek	-	6	-
South Bay	-	5	-
Jackson Creek	-	3	-

A rank of 1 indicates the highest intensity of human activity is in that subwatershed, and the activity is less intense as the rank number gets higher.

10. Watershed Condition Synthesis

The goal of this chapter is to synthesize and assess resource condition and fish use of the watershed. Resource issues that were raised by residents were taken into account during the assessment and synthesis. Those resource issues voiced most often by local citizens of the Netarts Watershed were:

- the decline in fish populations,
- the turbidity in Rice Creek from a headwater landslide,
- culverts that block fish passage or mute tidal flows to saltmarshes,
- current development impacts to streams (Hodgdon, O'Hara, Rice),
- the green crab invasion and colonization of the bay, and
- potential future logging impacts to streams.

A summary form is used to organize all of the stream reaches into one of four categories. The four categories are:

1. habitat areas that are relatively intact and need to be protected,
2. habitat areas where restoration is feasible with changes in land use activities or at reasonable cost,
3. habitat areas that could be restored but the cost would be high and the probability of success is low, and
4. habitat areas where restoration is not technically feasible due to stream alteration, degradation, or sociopolitical limitations.

Within each of the four categories are subcategories based on CHTs for important habitat, potential habitat, limited habitat, and habitat not typically utilized by salmonids. A further subdivision of the habitat is into areas that are currently utilized by fish and those areas that aren't currently utilized. The results of the synthesis are presented below for the entire watershed.

Table 10-1. Habitat Areas For Potential Protection And Restoration In The Netarts Watershed

1. Intact Habitat Needing Protection

	Important Hab.	Potential Hab.	Limited Hab.
Fish Use	Lower Whiskey, Lower Crown Zellerbach	Lower Jackson, Northbay Marsh (600)	Upper Whiskey, Upper Jackson
Unknown Fish Use	Upper O'Hara	Lower O'Hara, Lower Rice Creek, Midbay Marshes (800, 900) , Northbay Marsh (500)	Lower Austin

2. Restoration Is Feasible

	Important Hab.	Potential Hab.	Limited Hab.
Fish Use	Northbay (600), Lower Unnamed (1400), Upper Fall	Lower Fall, Lower Hodgdon, Jackson Marsh	
Unknown Fish Use	Northbay (500)	Lower Midbay (800, 900), Lower Southbay (1100), Yager Marsh	

3. Poor Chance For Restoration or 4. Not Feasible To Restore

	Important Hab.	Potential Hab.	Limited Hab.
Fish Use	Upper Rice		
Unknown Fish Use			

All listings are creeks unless specifically labeled as marshes.
Marsh indicates a saltmarsh at the outlet of the creek to the bay, except for the freshwater marsh on the North Fork of Jackson Creek.
Lower indicates the lower reach(es) of the creek while upper indicates the upper reach(es) of the creek.

Specific restoration projects include:

1. Restore healthy chum, cutthroat and steelhead runs to Whiskey and Jackson Creeks. This would allow stray fish from Whiskey and Jackson Creeks to recolonize the other streams with good quality habitat that is not currently utilized.
2. Replace or modify culvert draining Yager Reservoir into Yager saltmarsh. Currently the Reservoir supports a freshwater marsh, but no fish can access this habitat from downstream. Modifying the culvert would open up this rearing habitat to fish use. Replacing the culvert with a larger one would also increase sediment scour and lower the rate of infilling of the marsh. Either action would convert the freshwater marsh to saltmarsh.
3. Replace or modify culverts on Crown Zellerbach Creek and Jackson Creek to improve fish migration and maximize habitat utilization.
4. Plant willows along the lowest reach of Fall Creek. This consists of inserting willow cuttings into the riprap on the engineered bank.
5. Plant riparian vegetation to stabilize the small landslide and shade the stream channel on the lowest reach of O'Hara Creek.
6. Introduce beaver at the head of the habitat area (low gradient reach) on Rice Creek and build a settling pond above the freshwater marsh on the North Fork of Whiskey Creek. These creeks have turbidity that affects the habitat quality below the sediment source. Building a settling pond and vegetating it with cattails or introducing beaver to build natural settling ponds would reduce the turbidity downstream and in the case of the beaver also enhance the salmonid habitat values.

Monitoring and Information Gathering Projects include:

1. Conduct stream habitat surveys on Jackson, lower Austin, lower Crown Zellerbach (1300), Whiskey, Yager, lower Northbay (600), Rice, O'Hara, Hodgdon and Fall Creeks. Conduct habitat surveys to determine the habitat quality, and the length of usable habitat to the first natural fish migration barrier.
2. Conduct fish presence surveys of all perennial creeks in the watershed to determine the species present and the extent of habitat use.
3. Conduct temperature monitoring of all creeks that have fish use to determine if temperatures are within the preferred range for the species present.
4. Conduct turbidity monitoring on Rice Creek and North Fork of Whiskey Creek to determine if they should be 303(d) listed and remediation work done. Possible remediation work would be a vegetated settling basin or beaver introduction above the habitat but below the sediment source (see #5 above).
5. Conduct a survey of the on-site septic systems to determine if any are failing. The County Health Department will train volunteers and provide information and coordination for a septic survey.

11. Acronyms

CHT	Channel Habitat Type
cfs	cubic feet per second
DOGAMI	Department of Geology and Mining Industries
gpm	gallons per minute
GWEB	Governor's Watershed Enhancement Board
LWD	large woody debris
ODEQ	Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
OWRD	Oregon Water Resource Department
TBNEP	Tillamook Bay National Estuary Project
TCWRC	Tillamook Coastal Watershed Resource Center
USGS	US Geological Service
303d list	State list of water quality impaired streams submitted biannually to the EPA

Channel Habitat Types

MH	moderate gradient headwater in open v-shape valley
MM	moderate gradient, moderately confined between terraces
SV	steep v-shape headwater channel
VH	very steep v-shape headwater channel
WC	connected wetlands in flat landforms or depressions

12. Appendices

Appendix 1. Summary of published records of salmonid fish distribution in Netarts Watershed. See Appendix 2 for complete references.

Salmonid fish species	*Location in the watershed*	*Source*
Chum	Whiskey Creek	1998 ODFW Spawning Survey
	Whiskey Creek, Jackson Cr., Crown Z. Cr.	1992 ODFW Spawning Survey
	Jackson Creek	Pearcy et al, 1989
	Whiskey Creek, Jackson Creek	Berry, 1974
	No location specified	Lauman et al, 1972
	Some tributaries, notably Whiskey Creek	Heckeroth, 1970
	Whiskey Creek and Jackson Creek	OR Fish Commission Spawning Surveys
Coho	Either Whiskey Creek and/or Jackson Creeks (doesn't specify)	Pearcy et al, 1989
	Caught in estuary	Gaumer et al, 1974
	No location specified	Lauman et al, 1972
	"in streams"	Heckeroth, 1970
	Whiskey Creek and Jackson Creek	OR Fish Commission Spawning Surveys
Steelhead (winter)	Either Whiskey Creek and/or Jackson Creek (doesn't specify)	Pearcy et al, 1989
	"in streams"	Heckeroth, 1970
	Netarts Bay tributaries	Oregon Game Commission, 1958
Cutthroat Trout	Either Whiskey Creek and/or Jackson Creeks (doesn't specify)	Pearcy et al, 1989
	Whiskey Creek & Jackson Creek	Stout et al, 1976
	Caught in estuary	Gaumer et al, 1974
	No location specified	Lauman et al, 1972
	"in streams"	Heckeroth, 1970
	Jackson Creek & Netarts Bay tributaries	Oregon Game Commission, 1958
Chinook	Only 1 fish found in bay	Stout et al, 1976
	Whiskey Creek: very few found, probably strays from other creeks	Stout et al, 1972
	Whiskey Creek	OR Fish Commission Spawning Surveys

Appendix 2. Annotated bibliography of relevant sources for Netarts Watershed listed according to subject. The list was compiled by the Netarts Watershed Council.

Research and Scientific Studies

These references are located at the Tillamook Coastal Watershed Resource Center or with the Netarts Watershed Council and are available for review or checkout.

Resource Inventories

Kreag, R.A., ed. 1979. *Natural Resources of Netarts Estuary.* Portland: Oregon Department of Fish & Wildlife. 45 pp., maps.

This report is an estuary inventory project which summarizes the biological and physical characteristics of Netarts Estuary. It contains data on the Netarts Estuarine System and the marine and bay subsystems. The report also provides research recommendations to assist in land use planning decisions concerning the estuary. Along with the Stout Report, 1976, it is currently the most comprehensive inventory of the resources of Netarts Bay.

Stout, H., ed. 1976. *The Natural Resources and Human Utilization of Netarts Bay, Oregon.* Corvallis: Oregon State University. 247 pp., maps.

This study is an interdisciplinary survey of Netarts Bay by a group of students from Oregon State University (OSU) and Portland State University (PSU). It includes: a survey of the benthic fauna; a quantification and evaluation of eelgrass beds; an analysis of sediments; an evaluation of the chemistry of the sea water; surveys of the distribution and abundance of the major fin fish; an evaluation of the avian, mammalian, reptilian, and amphibian wildlife; a quantification of human activities within the estuary and watershed; and a survey of human attitudes concerning the conservation and development of Netarts Bay.

Fisheries

Berry, R.L. 1974. *Status of the Native Chum Salmon Run in Selected Coastal Streams of Oregon, 1973.* Coastal Rivers Investigation Report 74-5. Portland: Fish Commission of Oregon. 15 pp., tables.

This report presents data collected from chum salmon spawning surveys in tributary streams of the Tillamook and Nestucca Bays in 1973. It also compares these counts to data dating back to 1948.

Gaumer, T., D. Demory, and L. Osis. 1974. *1971 Netarts Bay Estuary Resource Use Study.* Portland: Fish Commission of Oregon. 28 pp., maps, tables.

This report summarizes the results of a comprehensive study of the recreational use of fish and shellfish in Netarts Bay. During the study, 7,827 boat, shore, tideflat, and scuba resource users were interviewed to estimate catch and effort values and angler origin. Anadromous sport fisheries were not included in this study.

Lannan, J.E. 1975. *Netarts Bay Chum Salmon Hatchery: an experiment in ocean ranching.* Corvallis: Oregon Sea Grant Program, Oregon State University. 28 pp., illustrations.

This report describes the Netarts Bay Chum Salmon Hatchery (now the privately-owned Whiskey Creek Hatchery), a demonstration project by Oregon State University to test the technology of producing chum salmon through extensive aquaculture. The booklet explains the background information on the project and the concepts, facilities, and methods employed at the Netarts Bay Chum Salmon Hatchery.

Pearcy, W.G., and C.D. Wilson. 1985. *The utilization of Netarts Bay by juvenile chum salmon.* Corvallis: Oregon State University, Sea Grant Program. 62 pp., tables, graphs.

This report investigates the utilization of Netarts Estuary by hatchery and wild chum salmon, the residence time of chum salmon in the bay, and the size at which the fish emigrated from the bay in 1984 and 1985. Results from the 1986 field season are summarized in a successive report.

Pearcy, W.G., and A.W. Chung. 1986. *The utilization of Netarts Bay by juvenile chum salmon.* Corvallis: Oregon State University, Sea Grant Program. 50 pp., tables, graphs.

This report investigates the utilization of Netarts Estuary by hatchery and wild chum salmon, the residence time of chum salmon in the bay, and the size at which the fish emigrated from the bay in 1986. This report emphasizes the feeding ecology of juvenile chum salmon. Results from the 1984-85 field seasons are summarized in a previous report.

Pearcy, W.G., C.D. Wilson, A.W. Chung, and J.W. Chapman. 1989. *Residence Times, Distribution, and Production of Juvenile Chum Salmon, Oncorhynchus keta, in Netarts Bay, Oregon.* Fishery Bulletin 87:553-568.

This scientific paper is based on the two previous Sea Grant reports by Pearcy et al. It discusses the downstream movement, distribution, abundance, residence time, growth, and production of juvenile chum salmon in Netarts Bay to evaluate the capacity of estuaries to produce chum salmon.

Project correspondance and stream surveys for Jackson Creek dating back to 1949. Provided by the Oregon Department of Fish & Wildlife, Tillamook District Office.

Project correspondance and stream surveys for Whiskey Creek dating back to 1952. Provided by the Oregon Department of Fish & Wildlife, Tillamook District Office.

Wildlife

Brown, R.F., and B.R. Mate. 1983. *Abundance, Movements, and Feeding Habits of Harbor Seals, Phoca Vitulina, at Netarts and Tillamook Bays, Oregon.* Fishery Bulletin 81:291-301.

This scientific study addresses the seasonal abundance of harbor seals hauling out in Netarts and Tillamook Bays, the movement of radio-tagged harbor seals between Netarts and Tillamook Bays, the level of predation on returning chum salmon by harbor seals near the Whisky Creek hatchery, and other food items of harbor seals using Netarts Bay.

Jewett, S.G. 1914. *Bird Notes from Netarts Bay, Oregon.* The Condor XVI: p.107-115.

This article describes the birds recorded at Netarts Bay and along the beach to Cape Meares during four site visits by the Oregon Fish and Game Commission in 1912 and 1913. The list of 51 birds identified contains water and shorebirds only. Each specimen's locality and description is documented in this article.

Geology

Peterson, C.D., and M.E Darienzo. 1988. *Coastal neotonic field trip guide for Netarts Bay, Oregon.* Oregon Geology 50:9/10. Portland: Oregon Department of Geology and Mineral Industries. 8 pp.

This scientific article summarizes the geologic evidence of episodic abrupt coastal subsidence that is recorded in the late Holocene salt marshes and in uplifted Pleistocene terrace deposits of Netarts Bay.

Peterson, C.D., and M.E. Darienzo. 1993. *Field trip guide to Cascadia paleoseismic evidence along the northern Oregon coast: Evidence of subduction zone seismicity in the central Cascadia margin.* Oregon Geology 55:5. Portland: Oregon Department of Geology and Mineral Industries. 16 pp.

This scientific article describes geologic evidence of subduction zone seismicity on the northern half of the Oregon coastline.

Schlickler, H.G., et al. 1972. *Environmental Geology of the Coastal Region of Tillamook and Clatsop Counties, Oregon.* Portland: Oregon Department of Geology and Mineral Industries. 164 pp., tables, maps, photographs.

This report provides information on the geology of the coastal zone, engineering characteristics of the bedrock and unconsolidated deposits, and geologic hazards. Engineering problems related to these geologic factors have been analyzed, and the information is intended to serve as a guide for those in the planning stages of development and assist in the development of intelligent zoning ordinances. Located at the Tillamook County Library.

Archeology

Newman, T. M. 1959. *Tillamook Prehistory and Its Relations to the Northwest Coast Culture Area.* Eugene: University of Oregon Department of Anthropology. 55 pp., maps.

This Ph.D. thesis was the first report on intensive archeological research in the northern Pacific coast. It describes, in detail, archeological materials derived from excavations on Netarts Sand Spit and makes conclusions about the emergence of the Tillamook as a distinct culture.

Water Quality

Boley, S. L., and L. S. Slotta. 1974. *Relevant Data Concerning Proposed Discharges of Domestic Waste into Netarts Bay, Oregon.* Corvallis: OSU Sea Grant Program. 24 pp., tables, charts, maps.

This report is a study to determine the best means of discharging domestic wastes collected from Netarts and Oceanside (prior to the Netarts Sewage Treatment Plant). It presents data collected in the summer of 1971, and makes analyses and recommendations for a sewage treatment plant that discharges domestic waste in the open ocean west of Oceanside. It also makes recommendations on a discharge schedule that would take advantage of natural tidal flushing processes if domestic waste was to be discharged in Netarts Bay.

Department of Agriculture, Shellfish Program. *Shellfish Growing Area Evaluation* (1995 - Triannual Report); *Netarts Bay Management Plan for Commercial Shellfish Harvesting* (1989); *Oyster Plat Production Annual Reports* (1990-1994).

These studies from the Department of Agriculture report water quality data (fecal coliform levels) from 8 commercial shellfish management areas in Netarts Bay (map included). The *Oyster Plat Production Reports* compare oyster production in Netarts Bay to Coos, Tillamook, Umpqua, and Yaquina Bays. The management plan describes conditions for closure of shellfish growing and harvesting. The data in these reports are not for publication.

Glanzman, C. F., et al. 1971. *Tidal Hydraulics, Flushing Characteristics and Water Quality of Netarts Bay.* Corvallis: Oregon State University. 103 pp., tables, charts, maps.

This baseline study provides data on the physical characteristics, tidal hydraulics, flushing characteristics, sediment load, dispersion studies, and water quality of Netarts Bay in 1969 and 1970. The report also provides concise conclusions about its findings and makes recommendations on the most desirable means of domestic waste disposal (prior to the Netarts Sewage Treatment Plant).

Coastal Natural Hazards

Good, J. W., and S. S. Ridlington, eds. 1992. *Coastal Natural Hazards: Science, Engineering, and Public Policy.* Corvallis: Oregon Sea Grant, OSU. 162 pp., photographs, tables, graphs, illustrations.

This book is a collection of 14 papers delivered at the October 1991 "Coastal Natural Hazards" conference in Newport, Oregon. For the most part, the papers are written in nontechnical language, and are therefore useful reference materials for coastal residents, property owners, planners, policy makers, and coastal managers, as well as engineers and scientists.

Oregon Sea Grant Program. 1994. *Improving Natural Hazards Management on the Oregon Coast.* Corvallis: Oregon State University. 128 pp.

This is the final report of the Coastal Natural Hazards Policy Working Group, formed in March 1992. It identifies 23 coastal natural hazard issues under the subjects of hazard assessment, shore protection, land use, and disaster preparedness and response. The report also summarizes the findings of the Policy Working Group for each issue, makes 79 specific recommendations for dealing with the issues, and suggests actions needed to implement each recommendation.

Additional Research and Scientific Studies

These references are **not** located Tillamook Coastal Watershed Resource Center. They can be checked out through an ***interlibrary loan*** at the Tillamook County Library from the libraries specified below.

Akins, G. J., and C. A. Jefferson. 1973. *Coastal Wetlands of Oregon.* Florence, Oregon: Oregon Coastal Conservation & Development Commission. 159 pp.
Located at Oregon State University; Coos County Library Service District; Southern Oregon State Library; Western Oregon State College; and US Army Corps of Engineers; Portland District.

Beals, H. K., and H. Steele. 1981. *Chinese porcelains from site 35-TI-1, Netarts sand spit, Tillamook County, Oregon.* Eugene: University of Oregon. (University of Oregon anthropological papers; no. 23.) 37 pp., maps.
Located at University of Oregon and Oregon State University.

Bella, D. A. and P. C. Klingman. 1973. *General Planning Methodology for Oregon's Estuarine Natural Resources.* Corvallis: Oregon State University. 113 pp.
Located at Oregon State University (Hatfield Marine Science Center).

Boas, F.. 1965. *Notes on the Tillamook.* New York: Kraus Reprint.
Located at Oregon State University.

Bonacker, G. L., R. C. Martin, and R. E. Fenkel. 1979. *Preserve Analysis: Netarts Sand Spit.* Salem: Oregon Natural Preserves Advisory Committee. Presented to the State Land Board. 56 pp., maps, tables.
Located at Oregon State University (Hatfield Marine Science Center) *uncatalogued-not for circulation*.

Bottom, D.L., P.J. Howell, and J.D. Rodgers. 1985. *The effects of stream alterations on salmon and trout habitat in Oregon.* Portland: Oregon Department of Fish & Wildlife.
Located at Oregon State Library, Salem; Oregon State University; and Southern Oregon State Library.

Breese, W. P., and R. E. Malouf. 1975. *Hatchery Manual for the Pacific Oyster.* Corvallis: Oregon Sea Grant Program, Oregon State University. 22 pp., illustrations.
Located at Oregon State University (Hatfield Marine Science Center).

Canter, L. W., and R.C. Knox. 1985. *Septic Tank System Effects on Ground Water Quality.* Michigan: Lewis Publishers, Inc. 336 pp., tables, figures.
Located at Oregon State University (Hatfield Marine Science Center).

Cortright, R., J. Weber, and R. Bailey. 1987. *The Oregon Estuary Plan Book.* Salem: Oregon Department of Land Conservation and Development.
Located at Oregon State University; University of Oregon; and 22 other Oregon libraries.

Gaumer, T. F. 1977. *Oregon Bay Clam Distribution, Abundance, Planting Sites and Effects of Harvest.* Annual Report; July 1, 1976 to September 30, 1977. Oregon Department of Fish & Wildlife. 38 pp., maps, tables. (Includes distributions of clams, substrate material, and eelgrass beds in Netarts Bay.)
Located at Oregon State University (Hatfield Marine Science Center) *uncatalogued-not for circulation*.

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Hunger, A. A. 1966. *Distribution of Foraminifera, Netarts Bay, Oregon.* Corvallis: Oregon State University. 112 pp., M.S. thesis.
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Located at Oregon State University.

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Located at Oregon State University.

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Located at Multanomah County Library.

Liverman, M. C. 1981. *Multivariate analysis of a tidal marsh ecosystem at Netarts Spit, Tillamook County, Oregon.* Corvallis: Oregon State University. 88 pp., M.S. thesis.
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Morgan, J. B., and R. L. Holton. 1977. *A compendium of current research management programs concerning Oregon's estuaries.* Corvallis: Oregon State University.
Located at Oregon State University; Lewis & Clark College, Portland; and US Army Corps of Engineers; Portland District.

Oregon Department of Fish & Wildlife. 1988 - . *Life history and persistence of anadromous salmonid stocks in relation to stream habitats and watershed classification.* Portland: Oregon Department of Fish & Wildlife. Annual progress reports.
Located at Linfield College, McMinnville; University of Oregon; Southern Oregon State Library; Western Oregon State College; and Oregon State Library, Salem.

Oregon Division of State Lands. 1983. *Administrative Rules for Estuarine Mitigation in Oregon Estuaries, Draft.* Salem: Oregon Division of State Lands.
Located at Oregon Department of Fish & Wildlife, Tillamook District Office.

Percy, K. L., et al. 1974. *Descriptions and Information Sources for Oregon Estuaries.* Corvallis: Oregon Sea Grant Program, Oregon State University.
Located at Oregon State University; University of Oregon; and 34 other Oregon libraries.

Ratti, F. D. 1977. *Reproduction and growth of the Pacific basket-cockle, Clinocardium nuttallii Conrad, from intertidal and subtidal environments of Netarts Bay.* Corvallis: Oregon State University. 105 pp., M.S. thesis.
Located at Oregon State University (Hatfield Marine Science Center).

Robert E. Meyers Engineers, Inc. 1975. *Amendment to Environmental Impact Statement, Netarts-Oceanside Sanitary District.* Beaverton, Oregon: Robert E. Meyers Engineers, Inc.
Located at Oregon State University (Hatfield Marine Science Center) *uncatalogued-not for circulation*.

Squire, D. R. 1971. *The Japanese Oyster Drill, Ocenebra Japonica, in Netarts Bay, Oregon.* Corvallis: Oregon State University. 65 pp., M.S. thesis.
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United States Environmental Protection Agency. 1978. *Nutrient Dynamics Study, Data Set, Netarts Bay Study, 1978.* Corvallis: Corvallis Enivronmental Research Laboratory, U.S. Environmental Protection Agency.
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United States Environmental Protection Agency. 1974. *Final Environmental Impact Statement for Proposed Sewerage Facilities, Netarts-Oceanside Sanitary District.* Seattle: U.S. Environmental Protection Agency. 40 pp., tables, figures.
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Whiting, M. C. 1983. *Distributional Patterns and Taxonomic Structure of Diatom Assemblages in Netarts Bay, Oregon.* Corvallis: Oregon State University. 138 pp., Ph.D. thesis.
Located at Oregon State University.

Wilsey & Ham, Inc. 1974. *Estuarine Resources of the Oregon Coast.* Florence, Oregon: Oregon Coastal Conservation & Development Commission.
Located at Oregon Department of Fish & Wildlife, Tillamook District Office and Oregon State University (Hatfield Marine Science Center).

Zimmerman, S. T. 1972. *Seasonal succession of zooplankton populations in two dissimilar marine empbayments on the Oregon coast.* Corvallis: Oregon State University. 212 pp., Ph.D. thesis. (Comparison of Netarts and Yaquina Bay zooplankton populations, with species list. Descriptions of the physical factors and classifications of Yaquina and Netarts Bays.)
Located at Oregon State University (Hatfield Marine Science Center).

Community of Netarts

Hawkins, Bill, ed. 1994. *General History of the Town of Netarts, Tillamook County, Oregon.* Netarts, Oregon: Netarts Steering Committee. 24 pp., black and white photographs.
This is a concise, but comprehensive description of the history of Netarts from the 1400's to 1994. The chronology contains an 1859 Bureau of Land Management map of Netarts, as well as 33 photographs of early Netarts residents, Cape Meares Lighthouse and its caretakers, and the first developments in Netarts, Happy Camp, and Oceanside. Located at the Tillamook Coastal Watershed Resource Center (TCWRC).

Netarts Steering Committee. 1994. *Netarts Community Vision Statement.* Netarts, Oregon: Netarts Steering Committee. 5 pp.
The *Netarts Community Vision Statement* was initiated by the Netarts Vision Committee and created by the people of Netarts. It illustrates the common values, priorities, and expectations held by the people of Netarts and describes the kind of community Netarts would like to be in the year 2015. It is intended to be used in the planning and decision making process to achieve the community's desired future. Located at the Tillamook Coastal Watershed Resource Center (TCWRC).

Netarts Steering Committee. 1994. *Netarts Community Questionnaire*, and *Netarts Community Survey Results.* Netarts, Oregon: Netarts Steering Committee.

The community questionnaire and survey results reflect the opinions of the citizens of Netarts regarding their community and lifestyle, the conservation and development of Netarts Bay, and community structure and funding issues. Located at the Tillamook Coastal Watershed Resource Center (TCWRC).

Land Use Planning

Beasley, Chuck (prepared by). 1995. *Inventory of Parcels in Netarts Water District within Community Growth Boundary*. Tillamook County Department of Community Development.

This inventory includes data on tax lots, owners, number of dwelling units, possible additional dwellings, acreage, and water connections for each lot. These data are for tax lots within the service area inside the Community Growth Boundary of Netarts.

Oregon Department of Environmental Quality and Oregon Department of Land Conservation and Development. *Coastal Nonpoint Pollution Control Program*, summary, overview, briefing notes, and guidance management measures.

These are pieces of information on Oregon's Coastal Nonpoint Pollution Control Program. This program specifically addresses nonpoint source pollution problems that arise in coastal watersheds and is directly applicable in Tillamook County. This information is very useful reference material, particularly the management measures.

Oregon Department of Environmental Quality and Oregon Department of Land Conservation and Development. 1994. *Nonpoint Source Pollution Control Guidebook for Local Government.*

This report is a comprehensive guide for communities to use in addressing the problem of nonpoint source (NPS) pollution and NPS pollution prevention. The guidebook is clearly organized and written and includes information on: the NPS pollution problem, control measures, implementation approaches, the role of local governments, coordination and monitoring of projects, public involvement, state and federal authorities, legal background, and specifically addresses all major sources of NPS pollution.

Oregon Department of Forestry. 1994. *Oregon Forest Practice Rules and Statutes*. Salem: Oregon Department of Forestry. 130 pp.

This handbook provides all of the forest practice rules and statutes in Oregon, including general administrative rules, rules on water protection, reforestation, and using chemicals on forest lands.

Oregon Department of Land Conservation and Development. *Oregon's Statewide Planning Goals - Goals 16-18: Estuarine Resources (Goal 16), Coastal Shorelands (Goal 17), Beaches and Dunes (Goal 18).* From the Tillamook County Comprehensive Plan.

Goals 16, 17, and 18 are three of Oregon's 19 statewide planning goals, which constitute the framework for a statewide program of land-use planning. These goals address the coastal resources of Oregon and are included in the Tillamook County Comprehensive Plan.

Oregon Division of State Lands. 1972. *An Inventory of Filled Lands in Netarts Bay Estuary.* Salem: Oregon Division of State Lands. 14 pp., maps.

This report presents the location, extent, ownership, history, and use of filled lands in Netarts Bay in 1972. At that time, the boat launch and parking area were the only filled lands. It also provides a glossary of terms pertaining to tidelands and tidal boundaries.

Oregon Natural Heritage Program. 1977. *Site Reports of Netarts Bay, Netarts Spit, and Cape Lookout* from *Oregon Natural Areas, Tillamook County Data Summary*. Portland: The Nature Conservancy. 10 pp.

These site reports provide descriptions, natural elements, ecological significance, and management/use considerations of Netarts Bay, Netarts Spit, and Cape Lookout. These sites were proposed as Oregon Natural Areas by the Oregon Natural Heritage Program in 1977. The entire document provides introductory materials to the Oregon Natural Heritage Program, natural area needs, an inventory of natural areas, and Oregon land protection programs. Entire document located in the Tillamook County Community Development archives.

Parks Master Planning Unit. 1981. *Cape Lookout State Park Master Plan.* Salem: Oregon State Parks & Recreation Division. 7 chapters, maps.

This report is the first printing of the Cape Lookout State Park master plan adopted in January 1981. It contains site evaluations, land use proposals, and development plans for Cape Lookout State Park. It also describes the resource attractions which are most vital to protect and areas where recreation developments are possible (which have likely been developed since the publishing of this plan).

Tillamook County Board of County Commissioners. *Tillamook County Land Use Ordinance.*

This government document is the ordinance regulating the use of land and structures in Tillamook County, and the zones established for that purpose. The sections most pertinent to land use and development around Netarts Bay are:

- Section 3.050: Water Dependent Development Zone;
- Section 3.085: Beach and Dune Overlay Zone;
- Section 3.090: Shoreland Overlay Zone;
- Section 3.092: Freshwater Wetlands Overlay Zone;
- Section 3.100: Estuary Zones;
- Section 3.102: Estuary Natural Zone;
- Section 3.082: Estuary Conservation Zone;
- Section 3.120: Review of Regulated Activities;
- Section 3.140: Estuary Development Standards;
- Section 4.070: Development Requirements for Geologic Hazard Areas;
- Section 4.080: Requirements for Protection of Water Quality and Streambank Stabilization.

History

Boge, Lila V. Cooper. 1975. *Tillamook History.* (Sequel to Tillamook Memories.) Tillamook: Tillamook County Pioneer Association. 262 pp., black & white photographs.

As described by the author, this compilation of material deals with "Human Interest Tillamook History." It is a mixed bag of photographs, records, diaries, letters, observations, articles, and stories of turn-of-the-century-life in Tillamook County. Located at the Tillamook County Library.

Cotton, Samuel J. 1915. *Stories of Nehalem.* Chicago: M.A. Donahue & Company. 147 pp.

Located at the Tillamook County Library.

DeVoto, Bernard, ed. 1953. *The Journals of Lewis and Clark.* Cambridge, Massachusetts: The Riverside Press. 504 pp.

This book contains edited versions of the journals of Lewis and Clark as they traveled from St. Louis to the Pacific coast. Much of the second half of the book describes their explorations in Oregon and Washington. Located at the Tillamook County Library.

Jacobs, Elizabeth, recorder. 1959. *Nehalem Tillamook Tales.* Eugene: University of Oregon. 216 pp.

This book is a collection of Nehalem Tillamook Salish myths and anecdotes dictated to the recorder by Mrs. Clara Pearcy, a speaker of Nehalem and resident of Garibaldi, in 1934. Located at the Tillamook County Library.

Sauter, John, and Bruce Johnson. 1974. *Tillamook Indians of the Oregon Coast.* Portland: Binfords & Mort Publishers. 196 pp., black & white photographs.

This book explores the prehistory of the Tillamook Indians of the Oregon Coast through information gathered from early diaries, archeological reports, original journals of explorers, and interviews with native descendants. The researched text is supplemented with 150 photographs of bone and stone artifacts. Located at the Tillamook County Library.

Vaughn, Warren N. Unpublished. *The Early History of Tillamook County.* 91 pp.

This is a detailed account of one of the first white men to settle in Tillamook County. It covers an approximate time period of 1852 to the 1890's, and colorfully describes many events and stories that took place in and around Netarts during that time. The original journal is located at the Oregon Historic Society.