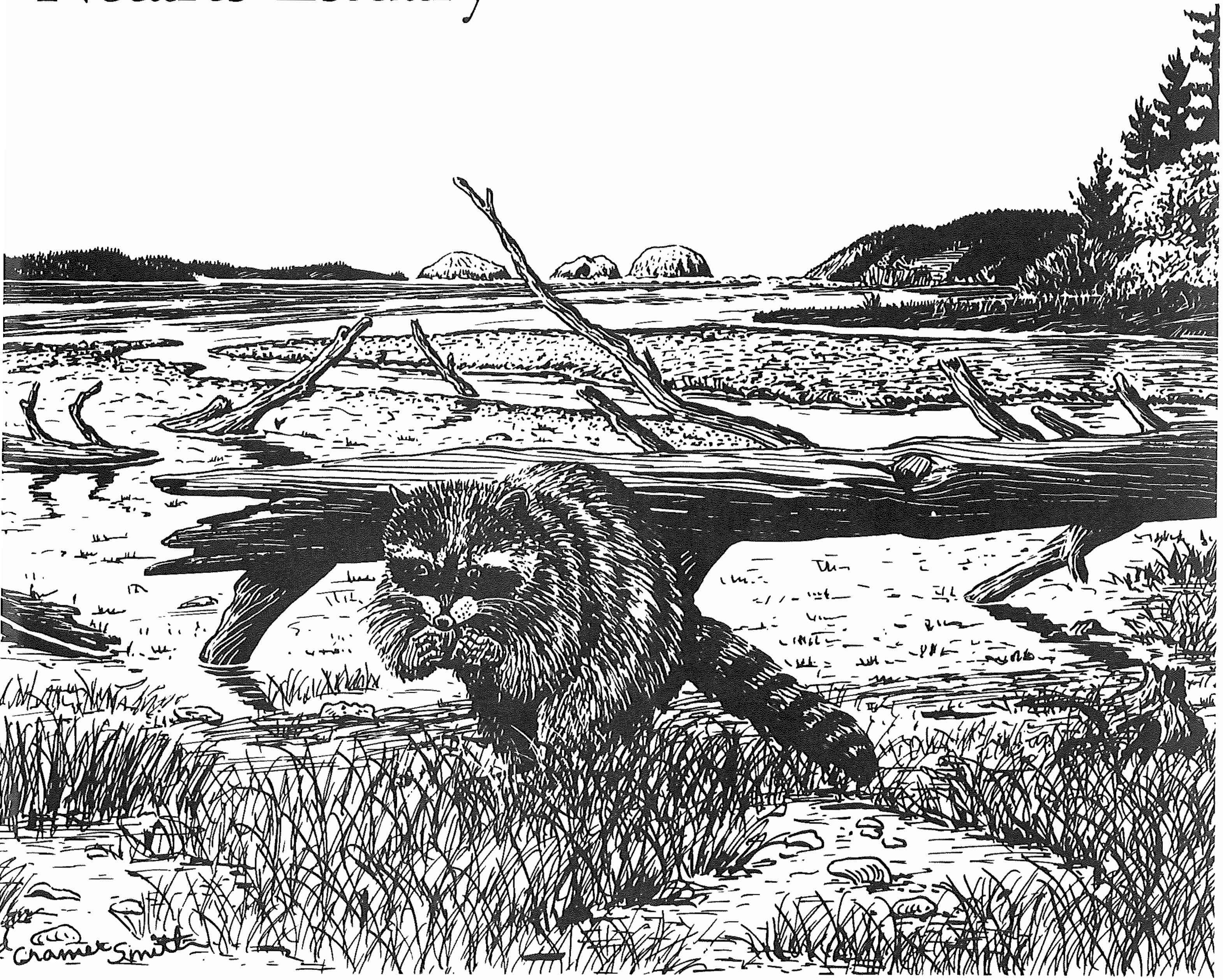
Natural Resources of Netarts Estuary



ESTUARY INVENTORY REPORT

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PREFACE

This report is one of a series prepared by the Oregon Department of Fish and Wildlife (ODFW) which summarizes the physical and biological data for selected Oregon estuaries. The reports are intended to assist coastal planners and resource managers in Oregon in fulfilling the inventory and comprehensive plan requirements of the Land Conservation and Development Commission's Estuarine Resources Goal (LCDC 1977b).

A focal point of these reports is a habitat classification system for Oregon estuaries. The organization and terminology of this system are explained in volume 1 of the report series entitled "Habitat Classification and Inventory Methods for the Management of Oregon Estuaries."

Each estuary report includes some general management and research recommendations. In many cases ODFW has emphasized particular estuarine habitats or features that should be protected in local comprehensive plans. Such protection could be achieved by appropriate management unit designations or by specific restrictions placed on activities within a given management unit. In some instances ODFW has identified those tideflats or vegetated habitats in the estuary that should be considered "major tracts", which must be included in a natural management unit as required by the Estuarine Resources Goal (LCDC 1977b). However, the reports have not suggested specific boundaries for the management units in the estuary. Instead, they provide planners and resource managers with available physical and biological information which can be combined with social and economic data to make specific planning and management decisions.

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THE NETARTS ESTUARINE SYSTEM

Description of the Area

Netarts estuary is located between Tillamook Bay and Sand Lake estuaries in Tillamook County. It has the smallest drainage area (15 mi^2) of the 21 major estuaries in Oregon. Netarts and Sand Lake are the only bar-built estuaries in the state (Wilsey and Ham, Inc. 1974). The shallow bay, which lies between a 4.5 mile-long spit and a narrow slope facing west, is shaped like an open lagoon, uncomplicated by sloughs, inlets, islands or bends (Fig. 1). The estuary has extensive seagrass beds, clam beds, and tideflats.

The unincorporated communities of Netarts and Oceanside, whose populations total about 1,100, are at the northern end of the estuary (Fig. 1), and most of the development in the estuary has occurred along the northern and eastern shores. However, Cape Lookout State Park at the southern end attracts many campers and visitors. The Oregon Land Conservation and Development Commission (LCDC 1977a) classified Netarts as a conservation estuary which is to "be managed for long-term uses of renewable resources that do not require major alterations."

Historical Changes

Like many Oregon estuaries with larger drainages, Netarts Bay was exposed to heavy siltation as a result of extensive logging between 1951 and 1971 (Stout 1976). Glanzman et al. (1971) estimated the volume of the bay at mean high water (MHW) had decreased by 10% between 1957 and 1969. The sedimentation rate has probably decreased since then. Logging activity has declined and the sediment transport in the creeks is now low (phone conversation, January 26, 1979 with David Heckeroth, Oregon Department of Fish and Wildlife [ODFW], Tillamook District).

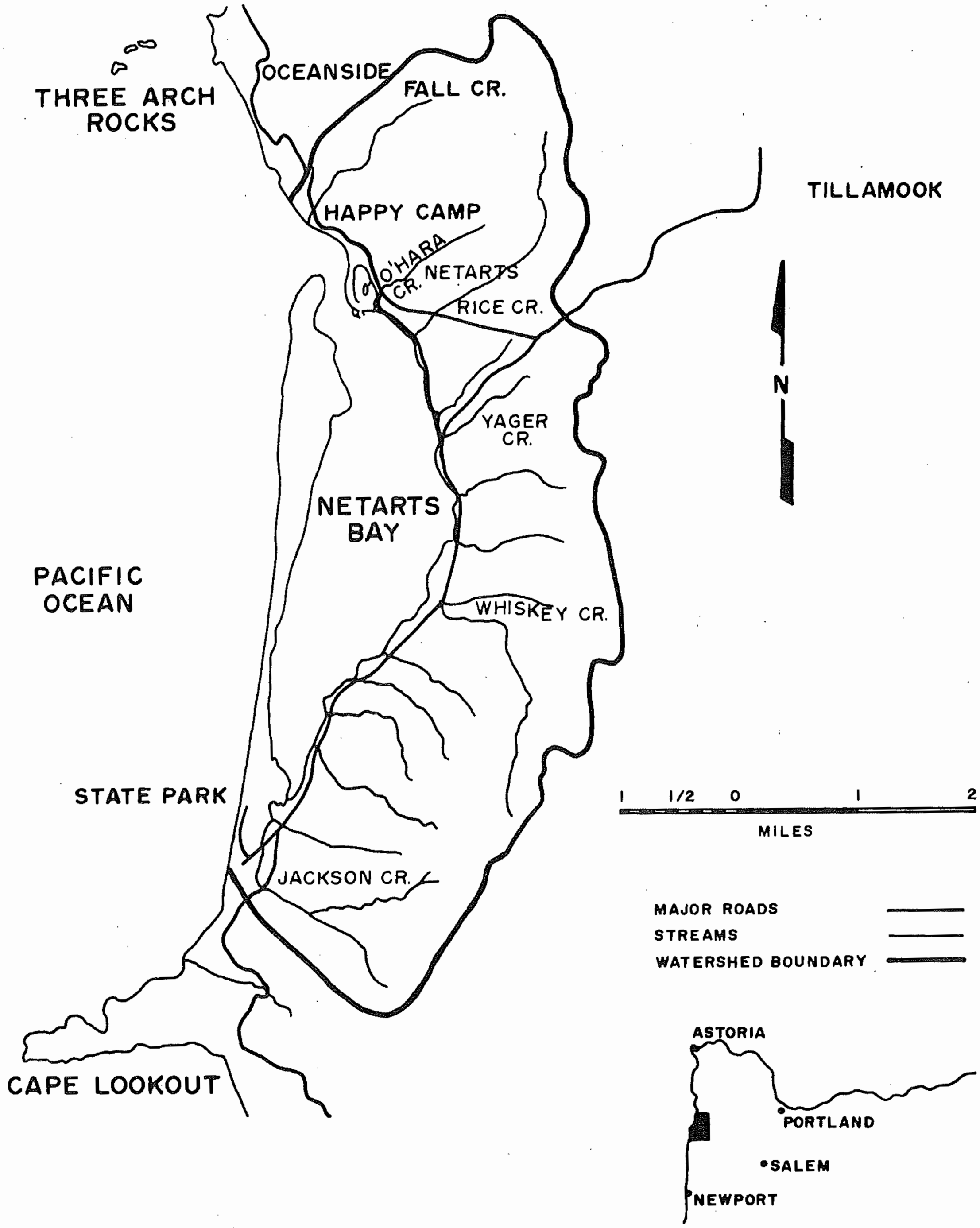


Fig. 1. Vicinity map of Netarts Bay (U.S. Geological Survey (USGS) topographic map).

Construction of the road along the eastern shore altered the estuary in several ways. The northern portion was built on fill, which was heavily riprapped (Stout 1976). This development has eliminated riparian vegetation and halted natural shoreline erosion. The fill follows the edge of flats and crosses several small marshes associated with creeks draining into the estuary. Although all of the creeks have culverts, the size of the culvert openings restricts tidal flushing of marshes and flats east of the road. Rice Creek (Fig. 1) is an exception. The mouth of the creek has been dredged and developed to provide access to the bay for small boats.

Drainage in the upper (southern) end of the estuary has been altered several times. At the turn of the century, farmers constructed small dikes and tide boxes in the marsh to drain areas for livestock grazing (Stout 1976). When ownership of the marsh changed to the Division of State Parks, the alterations were no longer maintained, and the marsh has essentially reverted to its former drainage pattern. Freshwater flow into the marsh has also been changed. Prior to 1960, Jackson Creek was diverted from a nearby ocean outflow into the main marsh channel in an attempt to increase freshwater flow into the estuary (Dicken et al. 1961). Park development involved additional diversions of Jackson Creek. The effect of these modifications to Jackson Creek on estuarine habitats has not been determined. However, most of Jackson Creek once again drains directly into the ocean.

In 1961 Tillamook County constructed a boat basin near the mouth of Netarts Bay. Environmental impacts of the marina design and location were not considered. Unfortunately, the marina was located on one of the most productive and accessible clam beds in the estuary, and the project destroyed an estimated 20,000 clams (Fish Commission of Oregon 1962). The construction involved dredging the basin and filling five acres for the parking area and rubble mound breakwater surrounding the marina. The breakwater altered the estuary's circulation pattern, causing the position of the channel near the mouth to shift and erosion of the head of the spit (Stout 1976).

The Yager Creek area (Fig. 1) was subdivided for residential development at about this same time. A high tidal marsh was diked, apparently to create a lake view for residents. However, the shallow reservoir dries up during the summer (Stout 1976), leaving neither a beautiful lake nor a productive tidal marsh.

Stout (1976) provides a detailed account of the historical development of the Netarts watershed.

Physical Characteristics

The physical dimensions, tidal action, water chemistry, and sediments of Netarts estuary have been studied more thoroughly than most Oregon estuaries (Hunger 1966; Glanzman et al. 1971; Zimmerman 1972; Stout 1976). The studies demonstrate the strong interrelationships among areas of the estuary due to its simple shape and well mixed waters. Sediments and water chemistry are more stable throughout the year in Netarts than in estuaries with major freshwater tributaries. Ocean water strongly influences water conditions within the estuary.

Physical dimensions

The surface area of Netarts Bay is 3.9 mi^2 at MHW (Glanzman et al. 1971), making it the sixth largest estuary in Oregon. The inclusion of marshes increases the total estuarine surface area to approximately 4.2 mi^2. Only about 12% of the estuary is subtidal, but approximately half is deeper than mean tide level (4.46 ft above mean lower low water [MLLW]). These deeper intertidal and subtidal areas are where most eelgrass beds and many clam species are concentrated. The volume of the estuary at MHW is 44.5×10^7 ft^3

and the tidal prism (volume between MHW and MLW) is 33.2×10^7 ft^3 (Glanzman et al. 1971), which ranks ninth among Oregon estuaries.

Drainage basin and freshwater inflow

The small Netarts drainage basin contains 13 minor creeks located along the eastern shore (Fig. 1). No point in the watershed is farther than 2.25 mi from the estuary. The watershed is primarily marine terrace and mountain scarp, with some stabilized dunes at the northern end.

The Netarts sand spit is part of a short beach located between Maxwell Point to the north and Cape Lookout to the south. Although no creeks arise from the spit, it probably contains substantial subsurface freshwater. The occurrence of the rush *Scirpus americanus* and the sedge *Carex obnupta* in marshes along the spit are evidence of freshwater seepage into the bay (Jefferson 1975; Frenkel et al. 1978).

Whiskey Creek is the only tributary where water flow has been recorded. Glanzman et al. (1971) estimated the average monthly freshwater inflow (Table 1) to Netarts estuary from precipitation data and estimates of runoff. The inflow of freshwater is small compared with the volume of ocean water in the estuary (Table 2).

Table 1. Average freshwater inflow to Netarts estuary (Glanzman et al. 1971).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Inflow (cfs)	200	174	147	91	50	25	8	5	13	59	152	229

Table 2. Comparison of ocean water and freshwater volumes in Netarts estuary (Glanzman et al. 1971).

	Volume (ft3/tidal cycle)
Ocean water	
5 ft. tidal range	250,000,000
between MLW and HHW	330,000,000
9 ft tidal range	430,000,000
Fresh water	
August	223,000
December	10,200,000

Tides and currents

A predominant feature of Netarts estuary is the strong influence of ocean water. Glanzman et al. (1971) found the tidal wave was significantly dampened as it moved up the bay. A temporary tidal gauge near the boat basin (Schooner in Table 3) recorded tidal ranges approximately 81% of the ocean levels. Further up the bay at Whiskey Creek, the ranges were only 75% of ocean levels. Mean tidal levels are listed in Table 3.

Table 3. Tidal observations July 16-August 3, 1970 (Glanzman et al. 1971).

	Schooner	Whiskey Creek	Schooner to Whiskey Creek
MHHW elevation[a]	7.66 ft	7.81 ft	
MHW	6.59 ft	6.50 ft	
MTL	3.78 Ft	4.09 ft	
MLW	0.97 ft	1.67 ft	
MLLW	-0.25 ft	-	
Mean Tidal Range	5.62 ft	4.83 ft	
Ebbing period for mean tidal range	405 min.	410 min.	
Flooding period for mean tidal range	340 min.	335 min.	
Avg. time lag of high or low water			47 min.
Avg. chocking coefficient			86%

[a]*MHHW - Mean Higher High Water*
MHW - Mean High Water
MTL - Mean Tide Level
MLW - Mean Low Water
MLLW - Mean Lower Low water
Elevations are expressed above MLLW at Tillamook, which is 3.41 feet below mean sea level.

High and low water in Netarts occurred later than at Newport (Glanzman et al. 1971). High tides were normally 40 minutes later, while low tides were delayed up to 1.8 hours due to the friction of the shallow bottom on the ebbing flow. Measurements of current in the channel demonstrated the effect. Currents near the bottom were normally 25% slower than upper currents.

Glanzman et al. (1971) reported that the ebbing tide primarily flowed through the main channel rather than across the flats. Drainage from the flats was nearly perpendicular to the channel in most places. Summer ocean currents usually carried the outflow from the estuary south along the spit. The effects of winter ocean currents on the outflow were not determined.

Strong tidal currents keep the mouth open throughout the year. The currents have also caused frequent shifting of channels in the estuary, especially the main channel. Most of the shifting has been in the upper and lower ends of the estuary. Changes in channel location did not correspond to any observed physical or biological processes but appeared to be random (Glanzman et al. 1971).

Mixing and salinity

The large volume of ocean water entering Netarts Bay is usually completely mixed with the small and diffuse freshwater inflow, and salinities generally approach ocean levels. On two occasions Zimmerman (1972) detected partial mixing in the middle of the estuary during heavy rain. Surface and bottom salinities differed by 10.2 and 7.2 parts per thousand (ppt) on those occasions. Mixing estuarine waters is enhanced by wave action and currents in the bay.

Mean monthly salinities at the county boat basin ranged from 27.42 to 32.66 ppt during 1960 to 1963 with no seasonal pattern (Hunger 1966). Zimmerman (1972) measured salinity at three stations and Glanzman et al. (1971) at five stations, and they occasionally found a gradient of about 2.5 ppt between the mouth and upper bay. During offshore upwelling, the salinity of ocean water off the mouth of Netarts is higher than normal, but when the Columbia River plume is near shore, salinity is lower than normal. These oceanic variations have a corresponding effect on salinity in the estuary.

Temperature

The temperature of the ocean off Netarts remains fairly constant at 46-48 F (Glanzman et al. 1971). However, estuarine water temperatures vary seasonally due to the influence of air temperatures and solar radiation on shallow bay areas. Monthly mean temperatures at the county boat basin illustrate these variations (Table 4). Stout (1976) and the U.S. Environmental Protection Agency (EPA 1978) found water temperatures in the summer exceeding 68 F in the flats, eelgrass beds, and high marsh of the upper bay.

Table 4. Seasonal average and range of monthly mean water temperature at the Tillamook County boat basin, Netarts Bay 1960-1963 (Hunger 1966).

	Ave. temp. (F)	Range of monthly mean temp (F)
Dec-Mar	49	46-53
Apr-May	54	51-58
June-Sept	58	53-62
Oct-Nov	53	51-57

Water quality and flushing

The water quality of Netarts Bay is nearly pristine. Measurements of dissolved oxygen, biochemical oxygen demand, coliform bacteria, organic carbon, nitrogen, and phosphorus have been well within legal limits (Glanzman et al. 1971; Oregon Department of Environmental Quality [DEQ] 1978). Occasionally fecal coliform are detected, indicating probable septic tank failures in the watershed. However, contamination is minimal when compared with other monitored estuaries (Glanzman et al. 1971). Sewage treatment facilities, discharging directly into the ocean, are being constructed at Oceanside to protect the water quality of Netarts estuary and reduce the use of septic tanks.

The excellent water quality in Netarts is particularly important in maintaining the bay's extensive shellfish beds. Glanzman et al. (1971) noted that the addition of nutrients to the upper bay from inadequately treated wastes or land drainage could cause the muddy sediments to begin decomposing anaerobically, resulting in low dissolved oxygen and high sulfide levels, which would adversely affect the benthic invertebrates.

The water quality of Netarts bay is enhanced by the rapid exchange of water with the ocean. During average tidal cycles most (75-88%) of the water in the estuary is exchanged. Flushing time, even during the summer when fresh water inflow is negligible, required less than 2.5 days (Zimmerman 1972; Stout 1976).

Sediments

There have been four quantitative surveys of surface sediments throughout the estuary (Hunger 1966; two by Glanzman et al. 1971; Stout 1976). The three surveys made in the summer all recorded similar sediment grain sizes (mean size, sorting, skewness and kurtosis) and percentages of carbon (organic and carbonate). Stout (1976) emphasized the similar sediment data obtained from the studies in a nine year period attests to the seasonal stability of the physical processes in Netarts Bay and its watershed. An extensive qualitative sediment survey was conducted by Gaumer et al. (1978) in association with several years of clam surveys. Gaumer's substrate classification coincides with the other studies and provides many sample locations.

Glanzman et al. (1971) found coarser surface sediments in October following extreme high tides (spring tides). They postulated that the additional fresh-water flow in winter could also create this moderate scouring effect. Coarser estuarine sediment was also found where ocean waters breached the spit in 1939 (Stout 1976). There is no record of another breach since 1940, and the breached section is now densely vegetated. Sand and cobble in the estuary are derived from the ocean and beach, while silt is transported by watershed tributaries.

Stout (1976) identified four general sediment realms (Fig. 2) based on predominant grain sizes, carbon content, and the local energy of tidal currents.

1. The mouth and northern part of the main channel are consistently high energy environments characterized by well sorted sand and some gravel in the channel.
2. The upper main channel, northern flats, and the western perimeter of the flats adjacent to the sand spit contain fine grain sands and are variable moderate or low energy environments which lack a source of silt.
3. The dense eelgrass beds in the mid-upper bay contain fine grained sands mixed with silt which is trapped by the vegetation despite moderate tidal currents.
4. The head of the bay and the eastern edge of the flats (including eelgrass beds north to Yager Creek) consist of very fine sand and silt sediments. This area has slow currents and is the closest to the creek mouths which carry silt from the watershed.

The study also showed a strong inverse relationship between grain size and organic carbon content. High organic carbon concentrations in the mid and upper bay reflected the lower energy environment and the proximity of estuarine and terrestrial sources of carbon.

Biological Characteristics

The phytoplankton and animal species found in Netarts estuary are generally

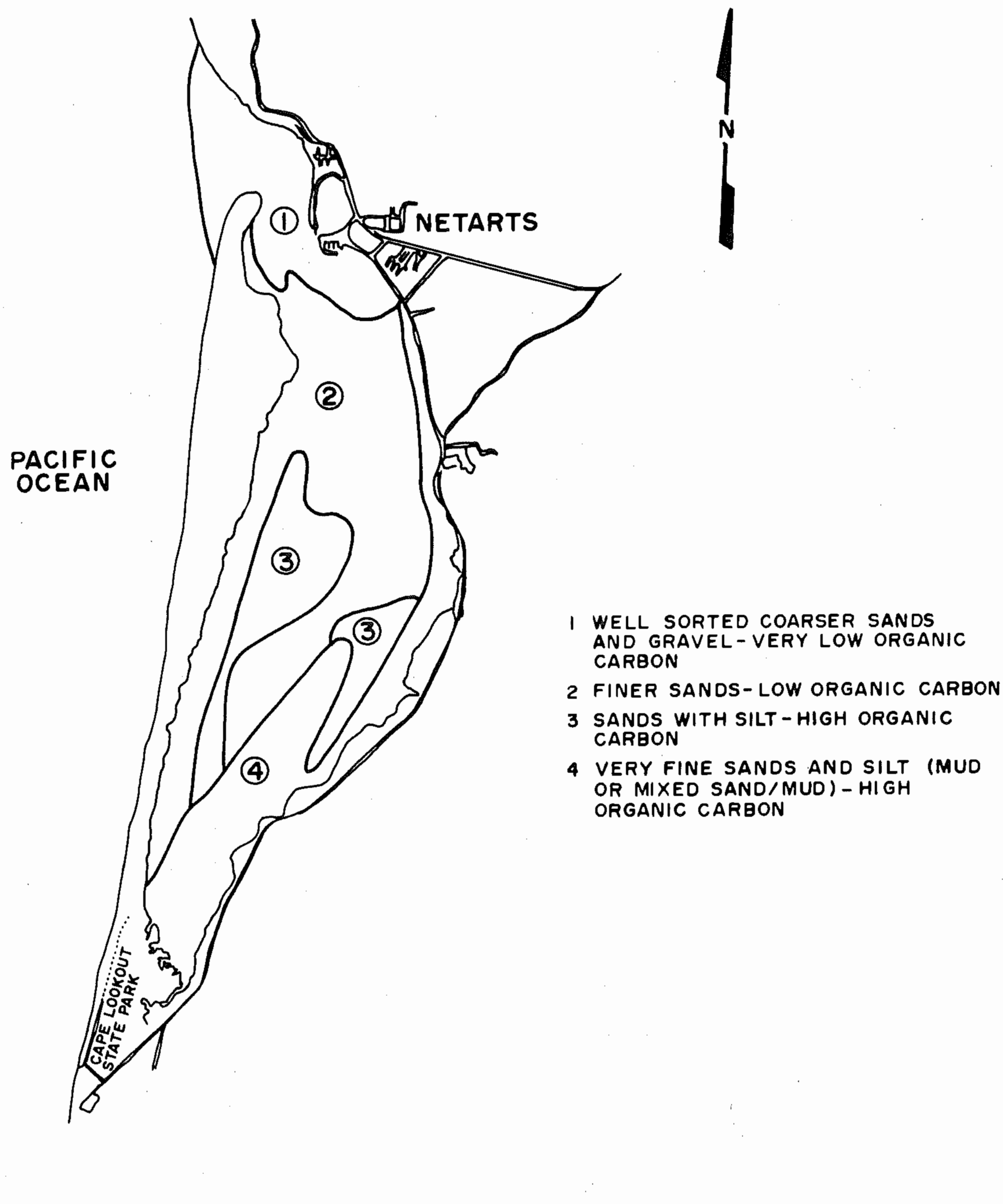


Fig. 2. Generalized sediment realms of Netarts estuary (Stout 1976; Hunger 1966).

discussed in this section, while their distribution and relationships to specific habitat types are discussed in the subsystems section that follows. Biological data for Netarts estuary is relatively comprehensive, especially when compared with data available for other Oregon estuaries.

Plankton

Plankton are small floating or drifting plants (phytoplankton) and animals (zooplankton). They respond to changes in the physical and chemical characteristics of the water. Because of their small size or limited mobility, the vertical distribution of plankton is controlled largely by water currents. Phytoplankton are microscopic algae that probably account for a large portion of the primary productivity of estuaries. Specht (1974) found that low dissolved nitrogen concentration in the water of Netarts Bay during summer limited the productivity of two common phytoplankton species. Eight other Oregon estuaries studied also showed this trend.

Netarts is one of the few Oregon estuaries where zooplankton populations have been studied. Zimmerman (1972) compared the zooplankton of Yaquina and Netarts estuaries. Zooplankton were divided into two categories: holoplankton, that remain planktonic throughout their life cycle (e.g. copepods), and meroplankton, that metamorphose into benthic or free swimming species (larval barnacles, clams, and crabs). Meroplankton were more abundant and diverse in Netarts than in Yaquina, reflecting the dense and diverse populations of benthic invertebrates in Netarts bay. Meroplankton were most abundant in the spring and summer. Holoplankton were most abundant during fall and least abundant in winter. Netarts' holoplankton were associated with ocean populations of zooplankton with the exception of *Eurytemora americana*, which is strictly estuarine and found only at the head of the bay. Throughout the year zooplankton were most abundant near the mouth of the estuary. Although differences in

Netarts and Yaquina zooplankton populations were documented, the same 16 species of holoplankton and types of meroplankton were most abundant in these two estuaries and also Alsea estuary (Table 5).

Seasonal cycles of zooplankton populations are often associated with seasonal fluctuations in the phytoplankton community. The seasonality of zooplankton influences the feeding behavior of larger animals. Bottom and Forsberg (1978) found that the diet of several estuarine fish species in Tillamook was composed predominantly of zooplankton throughout the year or during particular seasons.

Water quality and circulation patterns are probably important factors in zooplankton distribution and community composition. Information concerning other factors influencing composition and species distribution is lacking. Consequently, the impact of development or other activities in the estuary on zooplankton cannot be easily predicted.

Benthic invertebrates

Hunger (1966) completed an extensive survey of the distribution and abundance of foraminifera, a microscopic invertebrate, in the sediment of Netarts estuary. He mapped the areal distribution of foraminiferal standing crop in Netarts Bay (Fig. 3) and found a strong relationship between habitats and abundance.

There are a great variety of larger benthic invertebrates in Netarts. Clams, oysters, mussels, snails, barnacles, shrimp, and crabs are among the most familiar. Many less familiar species of worms and small crustaceans also inhabit the sediments of the estuary. Live sand dollars (*Dendraster excentricus*), which are not a typical bay resident, have also been found there (Stout 1976).

There are many highly productive clam beds in Netarts. The estuary contains the greatest diversity of clam species of any Oregon estuary, including

Table 5. Comparison of the relative importance of the dominant zooplankton of Yaquina, Netarts, and Alsea bays (Zimmerman 1972).

Species	Holoplankton	Meroplankton	Yaquina Bay		Netarts Bay		Alsea Bay	
			% of all animals[a]	Rank	% of all animals	Rank	% of all animals	Rank
Acartia clausi	x		63.1	1	46.1	1	39.9	1
Pseudocalanus minutus	x		8.4	2	6.0	3.5	8.1	3
Barnacle nauplii and cyprids		x	8.2	3	6.8	2	15.1	2
Acartia tonas	x		7.5	4	1.8	11	0.5	13
Oithona similis	x		2.3	5	4.5	6	3.4	6
Paracalanus parvus	x		1.6	6	6.0	3.5	2.0	9
Acartia longiremis	x		1.5	7	4.6	5	5.2	4
Eurytemora americana	x		1.0	8	0.7	16	2.7	7
Pelecypod veligers		x	0.9	9	3.5	7	4.3	5
Crab zoea		x	0.6	10	1.9	10	0.2	16
Centropages abdominalis	x		0.5	11	1.0	12	1.2	11
Larvacea and larval ascidacea		x	0.4	12.5	2.0	9	2.7	7
Calanus finmarchicus	x		0.4	12.5	0.8	14	0.6	12
Corycaeus anglicus	x		0.3	14.5	1.0	12	0.5	13
Marine Cladocera		x	0.3	14.5	3.2	8	1.7	10
Ctenocalanus vanus and *Clausocalanus* sp.	x		0.2	16	0.8	14	0.4	15

[a]*Percentage of all animals collected from October 1969 through September 1970.*

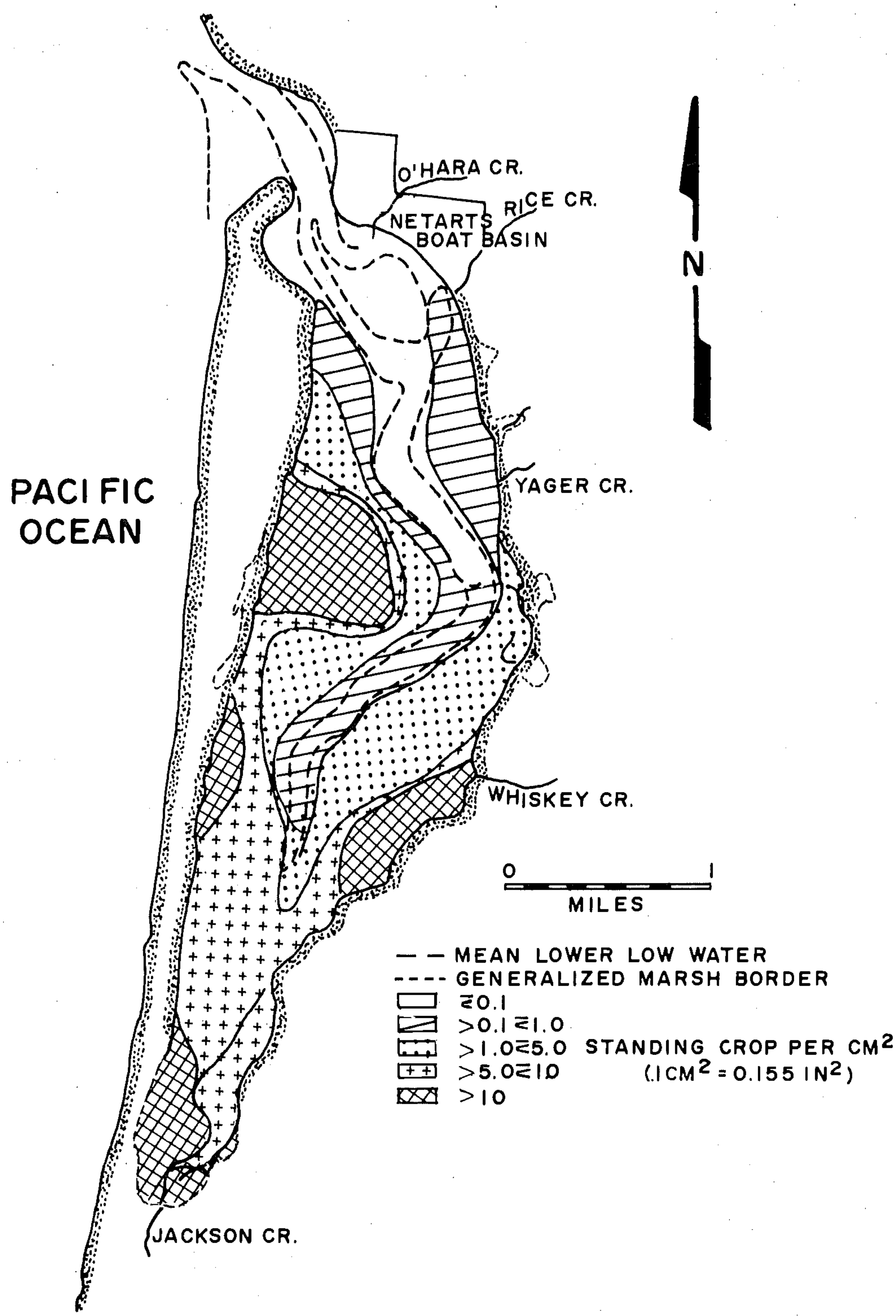


Fig. 3. Areal distribution of foraminiferal standing crop (Hunger 1966).

three species not found elsewhere in Oregon (conversation, January 22, 1979, with C. Dale Snow and Thomas Gaumer, ODFW, Newport). Gaumer et al. (1978) surveyed the clam distribution in Netarts estuary between 1973 and 1978. The survey covered both subtidal and intertidal areas throughout most of the estuary. Clam beds were individually mapped for 13 species. Shrimp beds, sediment composition, and vegetation were also identified. A composite map of all clam beds surveyed with at least one clam/ft^2 is shown in Fig. 4. Twenty-three species of clams, oysters, and mussels have been reported from Netarts (Table 6). Many species are widely distributed and most clam beds in Fig. 4 contain more than one species.

Stout (1976) investigated smaller benthic invertebrates by examining 8 in deep core samples from stations throughout the bay. All animals in each sample were identified and counted. Seven different clusters of the 20 most abundant species were identified. These invertebrates included worms, small clams, and crustaceans. Feeding, reproduction, and habitat associations were discussed for many species, and the distributions of some species were mapped. Shrimp were widespread in Netarts Bay but were not generally collected because their burrows are deeper than 8 in. Stout (1976) mapped the general locations of three species of shrimp. A composite map of shrimp distribution in the estuary, adapted from Stout (1976) and Gaumer et al. (1978) is shown in Fig. 5.

Oysters were once commercially harvested in Netarts Bay. The Pacific oyster was grown in the bay for several years. However, a carniverous snail, the Japanese oyster drill (*Ocenebra japonica*), was introduced with the oyster spat and heavily preyed upon the oysters. Strict management controls were placed on the export of oyster shell from Netarts to avoid the spread of the snail to other oyster grounds. Efforts to eliminate the oyster drill have not been successful, although existing oyster plats are no longer actively cultured in Netarts. The drill now feeds primarily upon cockles.

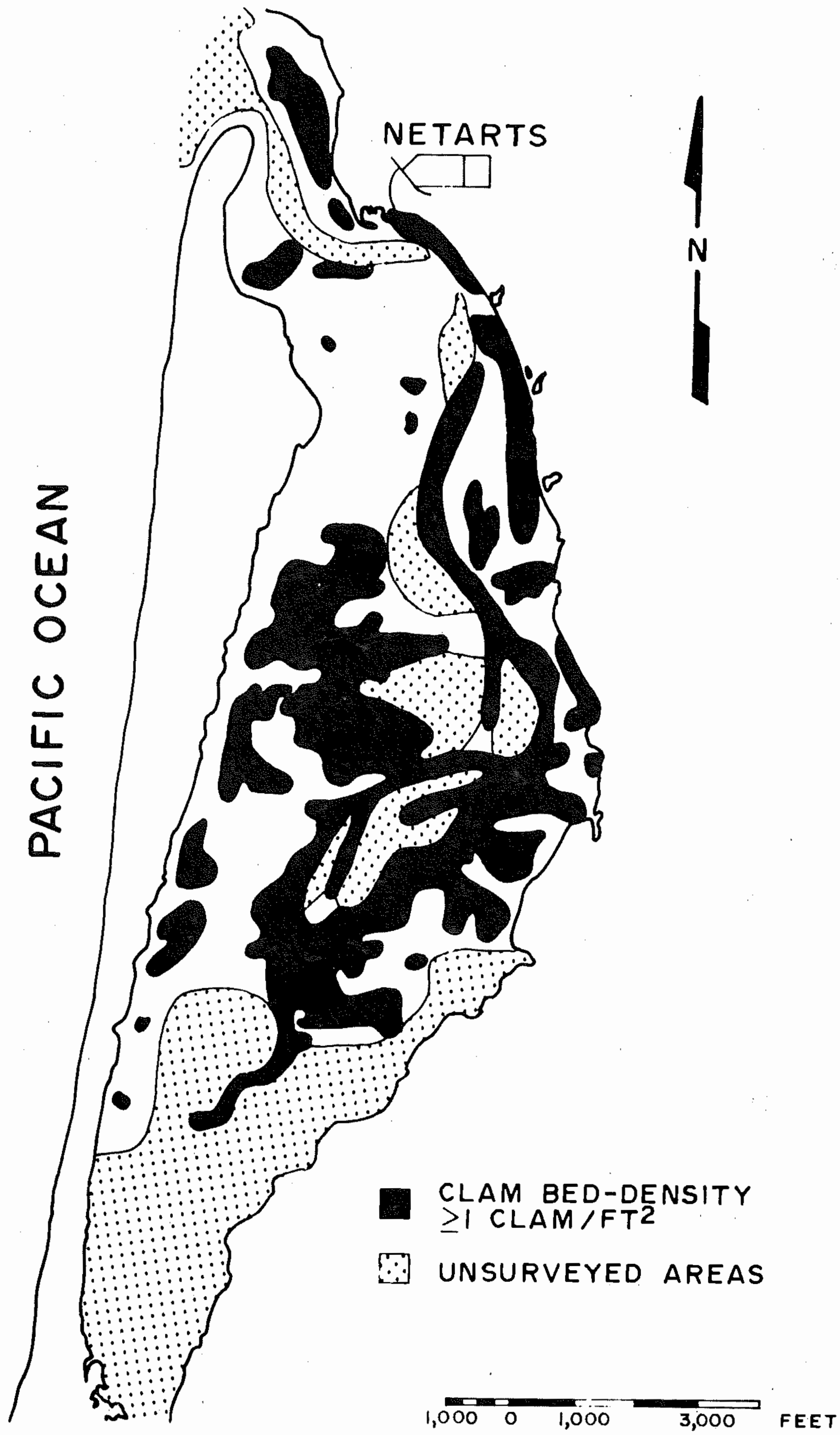


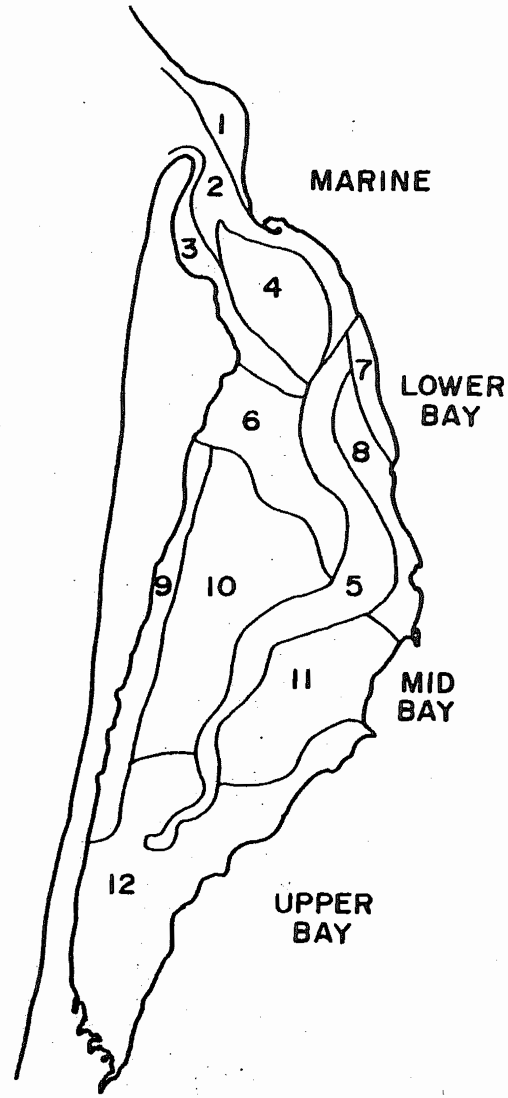
Fig. 4. Clam beds of Netarts estuary (Gaumer et al. 1978).

Table 6. Species and distribution of clams and oysters in Netarts estuary.

Common Name	Scientific Name	General Distribution[a]
Gaper clam	*Tresus capax, Tresus nuttallii*	1, 2, 5, 7, 8, 10, 11
Cockle	*Clinocardium nuttallii*	3, 4, 5, 6, 9, 10, 11
Butter clam	*Saxidomus giganteus*	2, 8, 9, 10, 11
Native littleneck	*Protothaca staminea*	7, 8, 9, 10, 11
Thin shell littleneck	*Protothaca tenerrima*	marine, lower bay
Manila littleneck	*Tapes semidecussata*	9, 10, 11
Baltic macoma	*Macoma balthica*	3*, 4*, 6*, 8, 10*, 11
Irus macoma	*Macoma irus*	11
Bent-nose macoma	*Macoma nasuta*	8, 9, 10*, 11
Sand macoma	*Macoma secta*	marine, lower bay
Bodega tellin	*Tellina bodegensis*	4
California softshell	*Cryptomya californica*	3*, 7*, 9, 10*, 11
Softshell	*Mya arenaria*	3, 6, 8, 10, 11
Piddock	*Zirfaea pilsbryi* and *Penitella penita*	2, 5, 7
Razor clam	*Siliqua patula*	marine
Geoduc	*Panope generosa*	mid bay
Ringed lucina	*Lucinoma annulata*	mid bay
Sea mussel	*Mytilus californianus*	marine
Bay mussel	*Mytilus edulis*	marine
Native oyster	*Ostrea lurida*	mid and upper bay (may be locally extinct)
Pacific oyster	*Crassostrea gigas*	mid and upper bay

[a]*Locations are from Gaumer et al. (1978) except for those followed by asterisk (*), which are from Stout (1976). Area 12 was not surveyed by Gaumer et al. (1978).*

Descriptive distributions are for rare and less abundant species based on communication with C. Dale Snow and Thomas Gaumer, ODFW, Newport.



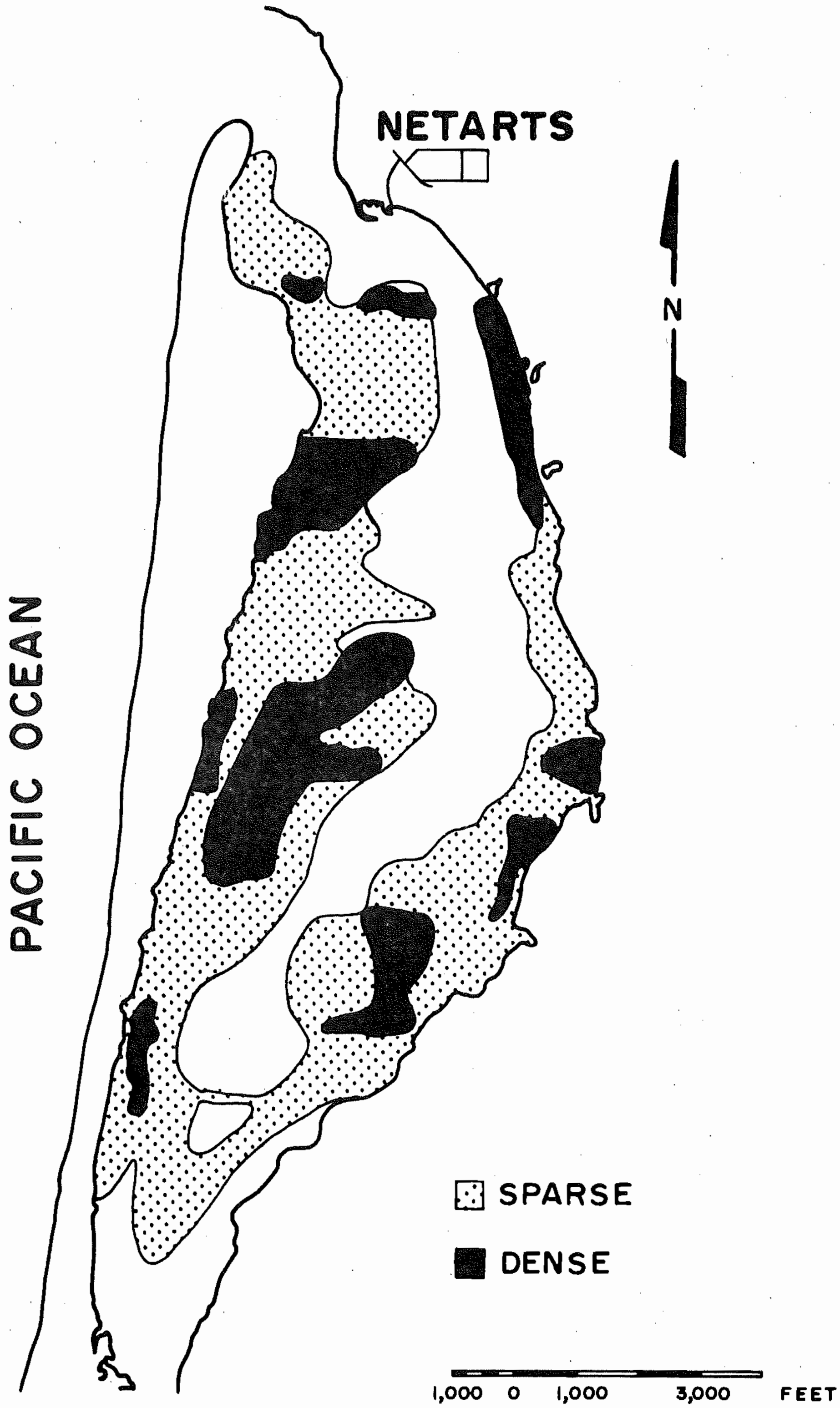


Fig. 5. Distribution of mud and ghost shrimp in Netarts Bay (Gaumer et al. 1978; Stout 1976).

Gaumer et al. (1974) estimated that sport anglers caught several thousand Dungeness crab (*Cancer magister*) and red rock crabs (*Cancer productus*) in the summer of 1971. That figure exceeded the fish harvest. A limited amount of commercial crabbing also occurs. There are no surveys of the distribution, seasonal abundance, or movement of crabs in the estuary.

Fish

The occurrence and distribution of fish species in Netarts estuary was studied by Stout (1976) in the summer of 1975. A variety of netting and trapping techniques were used. Gaumer et al. (1974) surveyed the hook and line catch of sport fishermen in the summer of 1971. The results of the two reports vary significantly. Stout (1976) suggested the difference in species composition and abundance was due to the differences among sampling methods used and the locations surveyed. Larger and faster swimming fish, such as adult rockfish and perch, can usually avoid nets and traps but will take bait. The two surveys tend to complement each other by including the smaller species that fishermen overlook and the larger fish that netting and trapping techniques miss. Some species were caught in similar proportions during both studies. The known fish species of Netarts are listed in Table 7. Relative abundance and observed habitat associations of fish are further discussed in the subsystem section of this report.

The composition and abundance of fish species in Netarts Bay during winter have not been studied. Surveys of several other Oregon estuaries show a dramatic reduction in numbers and kinds of fish during winter (Bottom and Forsberg 1978). This may also occur in Netarts estuary, although high salinities during winter could continue to attract some marine fish species that leave estuaries with high freshwater inflow.

Table 7. Fish species recorded in Netarts Bay (Stout 1976; Gaumer et al. 1974; Lauman et al. 1972).

FAMILY Common name	Scientific Name
PETROMYZONTIDAE	
Pacific lamprey	*Lampetra tridentatus*
Western brook lamprey	*Lampetra richardsoni*
ENGRAULIDAE	
Northern anchovy	*Engraulis mordax*
SALMONIDAE	
Chum salmon	*Oncorhynchus keta*
Coho salmon	*Oncorhynchus kisutch*
Chinook salmon	*Oncorhynchus tshawytscha*
Cutthroat trout	*Salmo clarki*
Steelhead (rainbow) trout	*Salmo gairdneri*
OSMERIDAE	
Whitebait smelt	*Allosmerus elongatus*
Surf smelt	*Hypomesus pretiosus*
ATHERINIDAE	
Topsmelt	*Atherinops affinis*
Jacksmelt	*Atherinopsis californiensis*
GADIDAE	
Pacific tomcod	*Microgadus proximus*
GASTEROSTEIDAE	
Threespine stickleback	*Gasterosteus aculeatus*
SYNGNATHIDAE	
Bay pipefish	*Syngnathus grisiolineatus*
EMBIOTOCIDAE	
Redtail surfperch	*Amphistichus rhodoterus*
Shiner perch	*Cymatogaster aggregata*
Striped seaperch	*Embiotoca lateralis*
Walleye surfperch	*Hyperprosopon argenteum*
Silver surfperch	*Hyperprosopon ellipticum*
White seaperch	*Phanerodon furcatus*
Pile perch	*Rhacochilus vacca*
STICHAEIDAE	
High cockscomb	*Anoplarchus purpurescens*
Snake prickleback	*Lumpenus sagitta*
PHOLIDAE	
Penpoint gunnel	*Apodichthys flavidus*
Saddleback gunnel	*Pholis ornata*

Table 7 (continued)

FAMILY Common name	Scientific name
ANARHICHADIDAE	
Wolf-eel	*Anarrhichthys ocellatus*
AMMODYTIDAE	
Pacific sandlance	*Ammodytes hexapterus*
SCORPAENIDAE	
Copper rockfish	*Sebastes caurinus*
Black rockfish	*Sebastes melanops*
HEXAGRAMMIDAE	
Kelp greenling	*Hexagrammos decagrammus*
Rock greenling	*Hexagrammos lagocephalus*
Whitespotted greenling	*Hexagrammos stelleri*
Lingcod	*Ophiodon elongatus*
COTTIDAE	
Padded sculpin	*Artedius fenestrailis*
Scalyhead sculpin	*Artedius harringtoni*
Sharpnose sculpin	*Clinocottus acuticeps*
Mosshead sculpin	*Clinocottus globiceps*
Prickly sculpin	*Cottus asper*
Buffalo sculpin	*Enophrys bison*
Red Irish lord	*Hemilepidotus hemilepidotus*
Brown Irish lord	*Hemilepidotus spinosus*
Pacific staghorn sculpin	*Leptocottus armatus*
Tidepool sculpin	*Oligocottus maculosus*
Fluffy sculpin	*Oligocottus snyderi*
Cabezon	*Scorpaenichthys marmoratus*
AGONIDAE	
Tubenose poacher	*Pallasina barbata*
Pricklebreast poacher	*Stellerina xyosterna*
BOTHIDAE	
Pacific sanddab	*Citharichthys sordidus*
Speckled sanddab	*Citharichthys stigmaeus*
PLEURONECTIDAE	
English sole	*Parophrys vetulus*
Starry flounder	*Platichthys stellatus*
Sand sole	*Psettichthys melanostictus*

Chum salmon were commercially netted in Netarts until 1957, when most commercial fishing in Oregon estuaries was banned. Coho salmon and cutthroat and steelhead trout also spawn in the tributaries (Lauman et al. 1972). Although the spawning area is limited by the small size of the creeks and has been further reduced due to logging, the runs of these fish are relatively large. There is little fishing pressure in the estuary and creeks, which probably contributes to their reproductive success (Heckeroth 1970). Oregon State University has an aquaculture research facility at the mouth of Whiskey Creek. Chum salmon are raised there using native fish for brood stock. During years of high chum returns, surplus eggs have been sold to private hatcheries in Sand Lake and Siuslaw estuaries (Cummings and Korn 1975; conversation, November 15, 1978, with James Lannon, OSU Department of Fisheries, Newport). The chum runs are presently larger than would be expected from natural spawning. Nearby tributaries, such as Jackson Creek, have also had larger chum returns, which have probably been increased by hatchery strays. Pink salmon (*Oncorhynchus gorbusca*), which are not native to Oregon estuaries, were experimentally released for four years from the Whiskey Creek Hatchery, but there were no returns. Adult chinook salmon are occasionally caught in the bay, but they are considered strays and are not known to spawn in the tributaries.

Birds and Mammals

Stout (1976) counted birds and mammals during the summer of 1975 at various tidal stages.[1/] Gulls comprised about half of the birds seen at high and low tides. Small shorebirds were also common and became more abundant in late summer. A few larger water birds, such as great blue herons, cormorants, and brown pelicans, were also observed in the estuary. Terrestrial species

[1/] The quantitative analyses of bird densities and abundance in Stout (1976) are inconsistent with the text and difficult to interpret. These data should be used cautiously.

including crows, swallows, sparrows, blackbirds, and starlings were commonly seen over the marshes, water, and exposed flats (Stout 1976).

Numerous ducks and geese use Netarts estuary during the winter. Although Stout (1976) primarily saw mallards during the summer, 24 species of ducks are normally present during winter (Akins and Jefferson 1973). Other notable wintering birds include the whistling swan and several species of geese, including black brant. Winter populations of black brant may be larger at Netarts than anywhere else on the Oregon coast. As many as 2,000 brant have been counted at one time (unpublished data, Douglas Taylor, ODFW, Tillamook District). Brant feed almost exclusively on eelgrass, and they flock to the large eelgrass beds in Netarts. The brant and duck populations in Netarts attract many waterfowl hunters in the winter.

While surveying birds, Stout (1976) also recorded harbor seals and raccoons, which were feeding along the tideflats. A few vagrant shrews, which were caught by traps in the marsh, were the only other mammals observed. The effect of people and dogs on the birds and mammals was also noted. In general, people did not disturb the birds except on the day of heaviest clamming, when many birds left the northern end of the bay. The density of harbor seals, however, was inversely related to the number of people present. The seals were observed leaving the bay at minus low tides. Bruce Mate and Robin Brown of OSU are currently studying the population size, feeding, and resting of harbor seals in Netarts Bay and the movement of seals between estuaries. About 50-70 seals are commonly found in the bay and more than 120 seals have been observed at one time. The seals haul out and rest on sandy intertidal areas near deeper sections of the main channel (conversation, April 16, 1979, with Robin Brown, OSU School of Oceanography, Corvallis).

NETARTS ESTUARINE SUBSYSTEMS

Netarts estuary can be divided into two subsystems (Fig. 6): a marine subsystem near the mouth, characterized by strong currents and coarse sediments; and a bay subsystem, which has extensive intertidal areas, weaker currents, and finer sediments. Within the two subsystems four types of habitat are predominant: subtidal, unconsolidated bottom; intertidal flats; eelgrass beds; and tidal marsh (Fig. 7). About 12% of the estuary is subtidal (below extreme low water). Unvegetated or sparsely vegetated flats cover about 40% of Netarts estuary, and eelgrass beds cover about 35%. Tidal marshes, comprising only 8% of the estuary, are less extensive than in many estuaries.

Marine Subsystem

The marine subsystem is generally a deeper and less vegetated portion of Netarts Bay (Fig. 6). It includes approximately the lower 20% of the estuary. Ocean swells, waves, and strong tidal currents make this a higher energy zone than the bay subsystem. Consequently, sediments are coarse and well sorted (Fig. 2). Salinity is consistently at or near ocean level, and temperatures rarely exceed 57 F. The marine subsystem is the focal point of recreational boating, crabbing, fishing, and clamming in Netarts estuary.

Habitats

Three habitat types-- sand bottom, sand flat, and sand beach/bar-- comprise 86% of the total marine subsystem (Table 8). The size and shape of the sandy habitats fluctuate with seasonal and yearly variations in ocean and estuarine currents. Other less extensive habitats are shown in Fig. 8 and listed in Table 8.

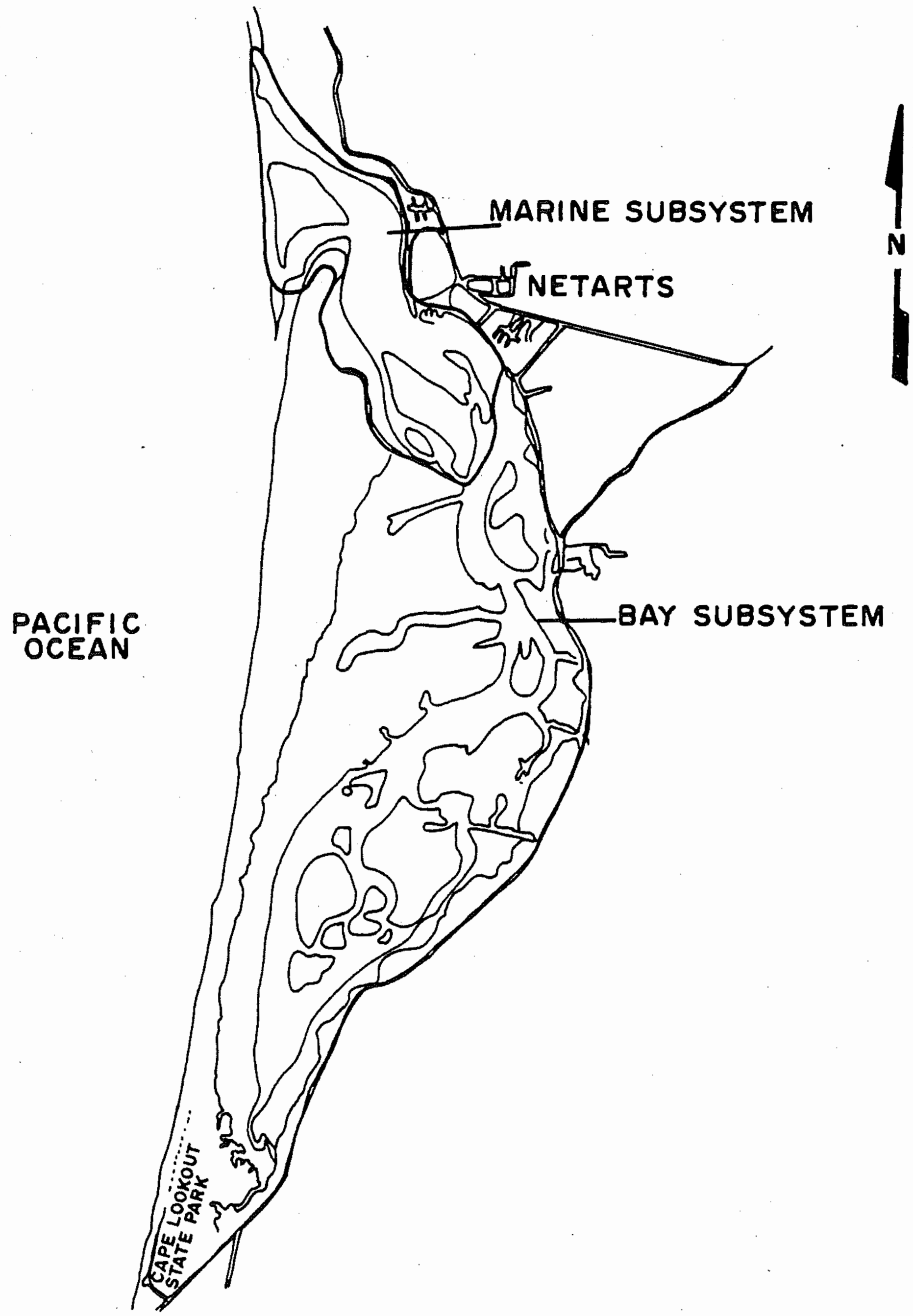


Fig. 6. Subsystems of Netarts estuary (base map from DSL 1972).

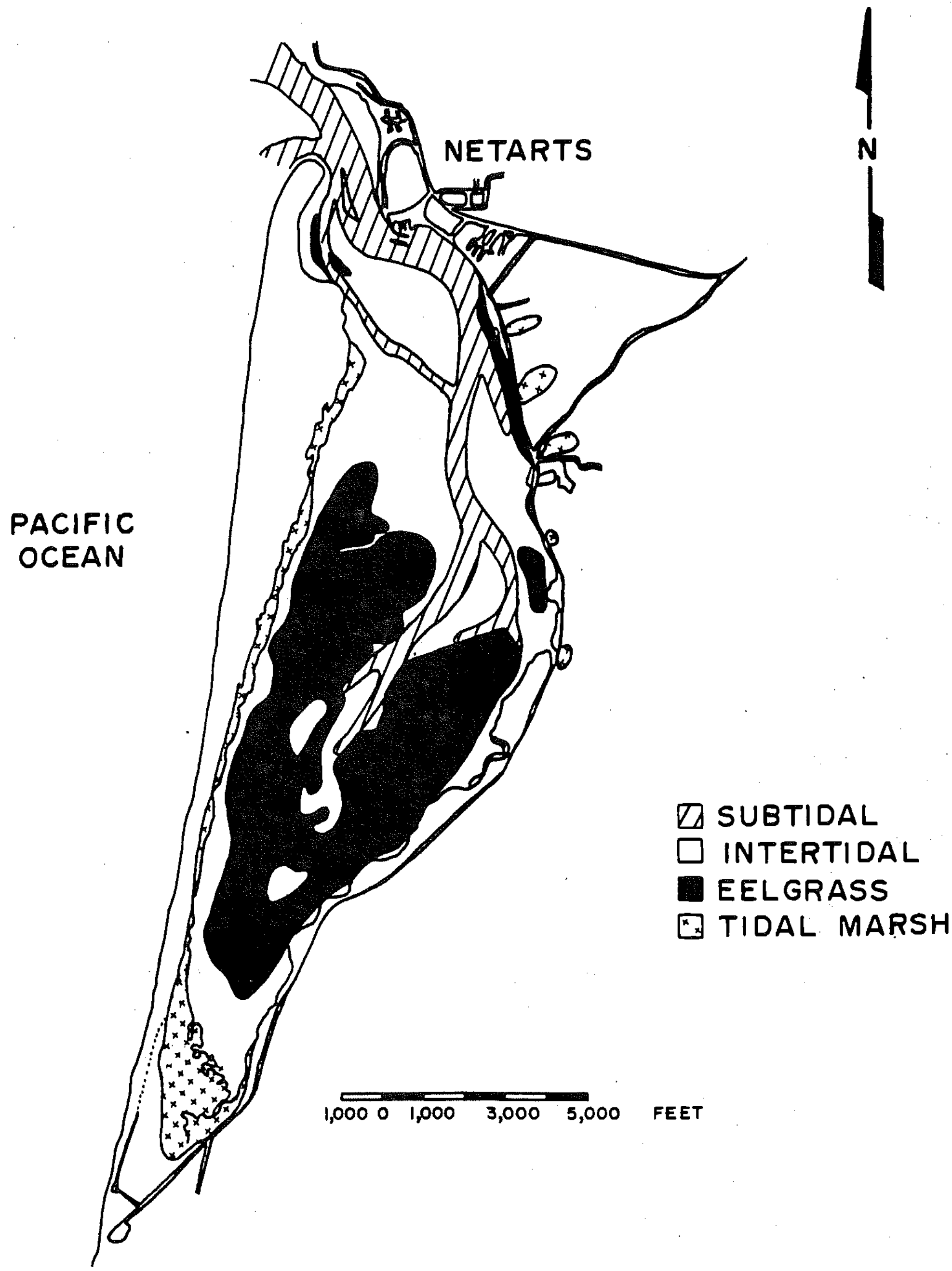


Fig. 7. Generalized habitats of Netarts estuary (ODFW 1978).

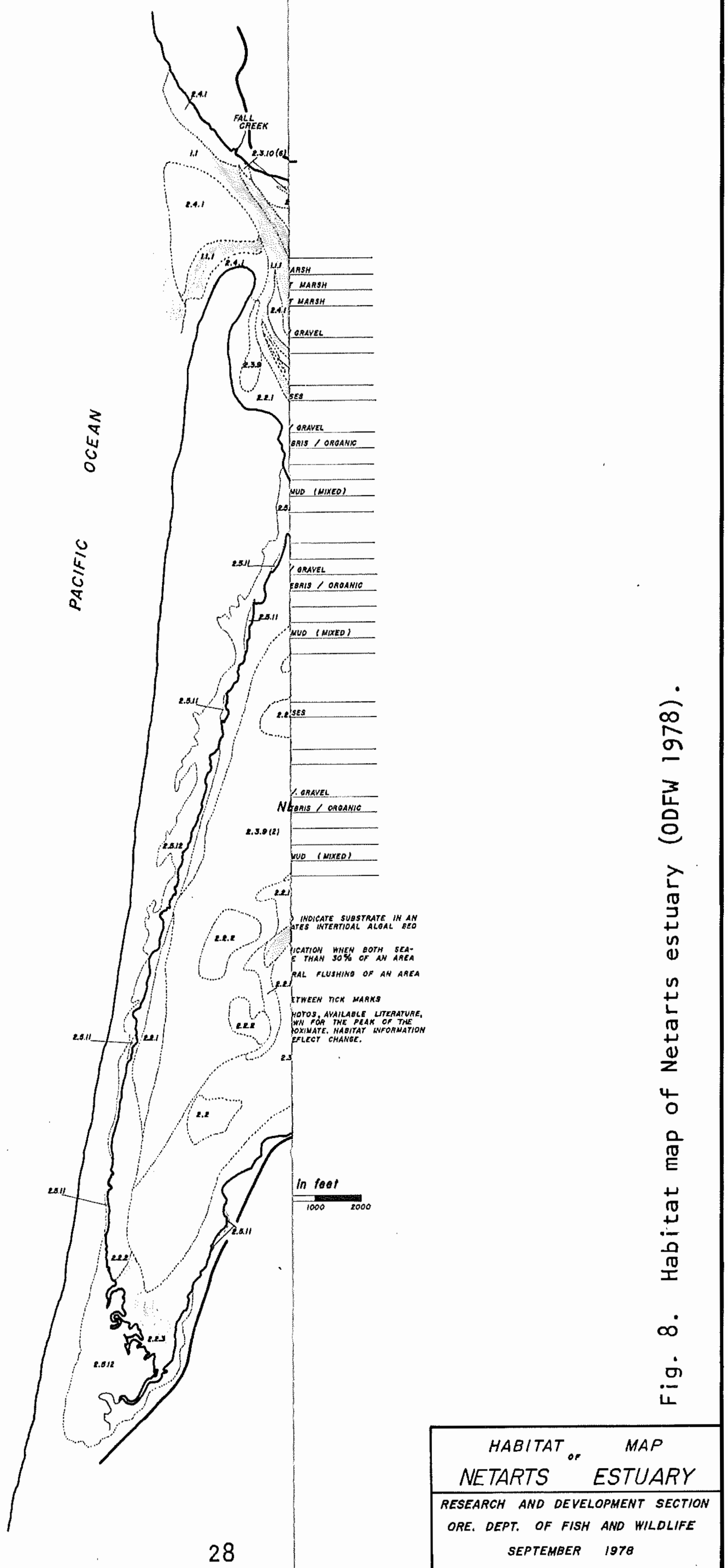


Fig. 8. Habitat map of Netarts estuary (ODFW 1978).

Table 8. Approximate percentage of habitat types within Netarts estuary and its subsystems (estimated from ODFW 1978).

Habitat type	Approximate percentage of surface area		
	Marine subsystem	Bay subsystem	Entire estuary
Subtidal	34	7	12
Sand bottom	27	7	11
Cobble/gravel bottom	7	0	1
Mud bottom	*	0	*
Seagrass	*	0	*
Intertidal	66	93	88
Shore	*	0	*
Flats	40	40	40
Diked flats	0	*	*
Beach/bar	19	0	4
Seagrass beds	3	43	35
Algal beds	4	*	1
Tidal marsh	0	10	8

* less than 1%.

Subtidal habitats and species

Subtidal habitat is 34% of the marine subsystem, compared to only 7% of the bay subsystem. Most of the subtidal area has a sand substrate. Gaumer et al. (1978) also found the northern side of the channel had a surface layer of cobble and gravel, which contained many shell fragments and a sparse attachment of green and brown algal species. The algae was not visible during a habitat field survey in the spring of 1978, indicating the algae may die back or be stripped off during the winter.

The only other subtidal habitats in the marine subsystem are the mud bottom of the boat basin and a small seagrass bed just outside of the boat basin. Slotta and Noble (1977) tested the sediment quality in the boat basin and found that it was not excessively polluted compared with other marinas in Oregon estuaries. However, volatile solids and sulfides were more prevalent in the Netarts marina samples than in several of the others tested. The seagrass bed probably contains the eelgrass *Zostera marina*, which is the prevalent species in the rest of the estuary (Stout 1976).

Zimmerman (1972) found a greater density of zooplankton throughout the year at a station in the channel of the marine subsystem than at two other stations located in the channel further up the bay. However, living foraminifera were nearly absent from the marine subsystem. Dense beds of gaper clams were found within the subtidal cobble/gravel habitat and the area just outside of the boat basin. Butter clams were found subtidally near the mouth, and piddocks were sparsely distributed in the channel south of the boat basin (Table 6).

Many species of fish in Netarts appear to remain in subtidal areas (Table 9). However, the intertidal habitats were not extensively surveyed. Most species preferring deeper habitats were found in both the marine and bay subsystems. Kelp greenling was the prevalent species in the channel. Juveniles were caught in sampling trawls, while adults were caught by hook and line (Stout 1976; Gaumer et al. 1974). Striped seaperch, adult shiner perch, pile perch, and black rockfish are also abundant in the channel. Rock greenling and red Irish lord were less abundant and found only in the marine subtidal areas. Surf smelt were only found in the marine subsystem but were located intertidally as well as subtidally. The marine subtidal habitat appears to be the primary location for more fish species than any other habitat in the estuary (Stout 1976; Gaumer et al. 1974).

Intertidal habitats and species

Nearly 2/3 of the marine subsystem is intertidal. Most of the substrate is sand containing little organic material (Fig. 2). Over half of the intertidal habitat is sand flat. Three sand flats are located at Happy Camp, south of the boat basin in the center of the bay, and adjacent to the spit (Fig. 8). Another major intertidal habitat is beach/bar. Three beach/bar habitats are located at the end of the spit, at the mouth, and just inside the spit (Fig. 8).

Table 9. General abundance and habitat associations of fish in Netarts estuary during summer (Gaumer et al. 1974; Stout 1976).[a]

		PRIMARY HABITAT ASSOCIATIONS[c]							
		Marine Subsystem			Bay Subsystem				
			Intertidal			Intertidal			
	Abundance[b]	Subtidal	Sand	Rock/ algal bed	Subtidal	Sand	Mixed or mud	Eelgrass	No observed preference
Threespine stickleback	A		X				X	X	
Bay pipefish	A							X	
Shiner perch	A	X			X		X	X	
Striped seaperch	A	X			X				
Pile perch	A	X			X				
Black rockfish	A	X			X				
Kelp greenling	A	X			X				
Pacific staghorn sculpin	A	X	X		X	X	X	X	
English sole	A	X	X		X	X			
Surf smelt	C	X	X						
Redtail surfperch	C	X			X				
Walleye surfperch	C	X			X				
Silver surfperch	C				X				
White surfperch	C				X				
Snake prickleback	C				X				
Saddleback gunnel	C	X	X					X	
Pacific sandlance	C	X				X			
Copper rockfish	C	X			X				
Rock greenling	C	X							
Lingcod	C	X			X				
Sharpnose sculpin	C			X					
Buffalo sculpin	C	X			X				
Red Irish lord	C	X							
Tidepool sculpin	C			X				X	
Cabezon	C	X							
Speckled sanddab	C	X			X				
Starry flounder	C	O			X	O		X	
Northern anchovy	O	X							
Chum salmon	O								O
Cutthroat trout	O								O
Steelhead trout	O								O

Table 9 (continued).

	Abundance[b]	PRIMARY HABITAT ASSOCIATIONS[c] Marine Subsystem Sub-tidal	Marine Subsystem Intertidal Sand	Marine Subsystem Intertidal Rock/ algal bed	Bay Subsystem Sub-tidal	Bay Subsystem Intertidal Sand	Bay Subsystem Intertidal Mixed or mud	Bay Subsystem Intertidal Eel-grass	No observed preference
Jacksmelt	O								O
Whitespotted greenling	O	X							
Pacific lamprey	U								O
Westernbrook lamprey	U								O
Coho salmon	U								O
Chinook salmon	U								O
Whitebait smelt	U	O							
Topsmelt	U							O	
Pacific tomcod	U	O			O				
High cockscomb	U			O					
Penpoint gunnel	U	X							
Wolf-eel	U	O							
Padded sculpin	U	O							
Scalyhead sculpin	U	O							
Mosshead sculpin	U				O				
Prickly sculpin	U						O		
Brown Irish lord	U	O							
Fluffy sculpin	U			O					
Tubenose poacher	U				O				
Pricklebreast poacher	U	O							
Pacific sanddab	U	X			X				
Sand sole	U	O							

[a]*Sampling gear included otter trawl, beach seine, dip net, and hook and line.*

[b]*A-Abundant, numerous in Netarts during one or more seasons.*
C-Common, moderate numbers during one or more seasons.
O-Occasional, moderate to large numbers in the bay for short periods of time.
U-Uncommon, occurring either regularly in low numbers or as marine, anadromous, or freshwater strays.

[c]*X --> 5 observations.*
O --≤ 5 observations.

There are also two small intertidal eelgrass beds near the spit, an algal bed on the cobble/gravel flat at Happy Camp, and a short cobble/gravel shore between the boat basin and Happy Camp. The remaining shore south of the boat basin to Rice Creek is riprap.

One benthic invertebrate community dominated by a sandy tube worm (*Pygospio elegans*) and amphipods of the genus *Eohaustorius* was found throughout the sand flats and eelgrass west of the channel (Stout 1976). Many ghost shrimp were also located in that area. Gaumer et al. (1978) and Stout (1976) found five species of clams on the marine sand flats (Table 6, location 6). Three other less abundant species (razor clam, sand macoma, and thin shell littleneck) are also likely to occur on those flats. Five of the more abundant fish species were taken over sandy intertidal areas: English sole, Pacific staghorn sculpin, threespine stickleback, surf smelt, and saddleback gunnel (Table 9).

Benthic invertebrates were not sampled by Stout (1976) in the Happy Camp area or the beach/bar habitats. The beach/bar habitat is directly exposed to ocean waves and probably has biological characteristics similar to ocean beaches. The algal bed at Happy Camp contains many gaper clams and the area is popular for clamming (Gaumer et al. 1974). Gaumer started a monthly sampling of the gaper population at Happy Camp during 1978 and 1979. One unexpected result of the sampling has been the discovery of young of the year of several clam species that have not been found in the area as adults (conversation, Feb. 15, 1979, with Anne Geiger, ODFW, Newport).

The survey of fish in the rocky intertidal habitat and algal beds was limited to dipnetting near the boat basin. The tidepool sculpin occurred in all of the samples (Stout 1976). Other fish, particularly perch, rockfish, greenling, and sculpin may use the algal bed during high tide.

Management recommendations

The marine subsystem is the focal point of much of the recreational activity in the estuary. The boat basin provides a sufficient amount of good boating access, considering the limited amount of subtidal area within the bay suitable for boating. There is relatively little primary productivity by attached algae and eelgrass in this subsystem. Therefore, recreational activities probably have fewer potentially detrimental effects in this subsystem than in the bay subsystem.

Netarts has few of the major alterations found in other estuaries of its size. The classification of Netarts as a conservation estuary (LCDC 1977a) was intended to protect the estuary from new major alterations, while permitting use and harvest of its resources. Water-dependent recreational activities should continue to be focused in the marine subsystem. At the same time the activities permitted should not threaten productive habitats and the clam, crab, and fish populations that depend on them.

The estuary should be protected from sewage, toxic chemicals, and potential contaminants of fish and shellfish, which provide food and recreation. Dredging should be avoided except in the boat basin to maintain productive habitats and water quality. Dredged materials from the boat basin should be deposited at upland disposal sites.

Although there is currently little need for expansion of boating facilities at the basin, any new facilities should be located at or near the existing boat basin to minimize disturbance of clam beds and habitats. Since the estuary is only suited for smaller boats, which are not difficult to move, storage of boats on the water should be prohibited. In order to accommodate present and future needs at the boat basin, much of the shoreland nearby should be limited to development for water-dependent recreation.

Bay Subsystem

The bay subsystem includes approximately 80% of the estuary. More than 90% of the bay subsystem is intertidal. Drainage courses in the upper (southern) portion are poorly defined and subject to shifting. Much of the area is lower intertidal, between extreme low water and MLW. Temperature measurements by Stout (1976) and EPA (1978) showed that higher intertidal areas are frequently as warm as 80 F in the summer, while deeper areas seldom exceed 65 F. Evaporation may raise salinities higher than ocean levels (EPA 1978).

The present recreational activities associated with the bay subsystem include clamming, crabbing, and fishing, which are generally concentrated in the northern half of the subsystem, and waterfowl hunting, which takes place along the spit. Wildlife observation is a popular activity at Cape Lookout State Park.

Habitats

The bay subsystem habitats are predominantly eelgrass beds (43%) and flats (40%). Other habitats include the subtidal sand bottom, tidal marsh, and a small algal bed (Table 8).

Subtidal habitats and species

The subtidal habitat extends from the subsystem boundary in the north to just south of Whiskey Creek (Fig. 7). Most of the habitat is confined to the main channel, which carries the bulk of tidal flow. The channel is not connected subtidally to any of the small tributaries of the bay subsystem. The substrate is primarily sand mixed with a small amount of silt and shell fragments (Gaumer et al. 1978). Little vegetation grows in the channel.

The channel contained a very small number of foraminifera (Fig. 3) and small benthic invertebrates (Stout 1976). It is one of the few areas of the bay where burrowing shrimp are noticeably absent (Fig. 5). Five types of clams are found in the channel (Table 6, locations 5 and 7). The cockle is the most prevalent species. Although the cockle population is less dense subtidally than intertidally, Ratti (1977) found that subtidal cockles grow significantly faster than intertidal cockles. The subtidal population mainly consisted of larger adults, while the intertidal cockle beds contained numerous young clams. As previously discussed in the marine subsystem section, the subtidal habitat is important for many fish species (Table 7). Three species of fish (silver surfperch, white seaperch, and snake prickleback) were abundant only in the subtidal habitats of the bay subsystem.

Intertidal eelgrass habitats and species

Over 40% of the bay subsystem is eelgrass bed (Fig. 7). The eelgrass beds are not uniformly dense. The density of eelgrass coverage varies from approximatley 30% to nearly 100%. Green macroalgae (*Enteromorpha* sp.) grows sparsely among the eelgrass, and two species of microalgae grow on the blades of eelgrass (Stout 1976). Netarts Bay is the only Oregon estuary where eelgrass productivity has been measured. Stout (1976) compared the density and growth of eelgrass from deeper intertidal areas that seldom drain completely (eelgrass lakes) and shallower areas with more drainage. The shallow eelgrass beds were generally less dense and had a smaller percentage of total biomass in the leaves than the deeper beds (Table 10). The annual productivity measurement of 304 grams/meter^2 dry weight was within the range of eelgrass productivity that has been measured in California, Washington, and Alaska (Stout 1976).

Table 10. Comparison of eelgrass beds in shallow and deep intertidal areas in Netarts estuary.

	Shallow intertidal beds	Deep intertidal beds
Turions (shoots)/ft^2	62	98
Percentage of reproductive turions	17	21
Percentage of total biomass in roots	46	29
Percentage of total biomass in leaves	54	71
Standing crop (grams/meter^2)[a]	288	466
Acreage	397.7	434.7

[a]*Metric units are given because no standard English unit is used in productivity measurement.*

Eelgrass influences sediment composition by reducing local currents, which permits silt and dead organic matter to settle. Eelgrass plays a major role in the phosphorus and sulfur cycles in estuarine water and sediment, and thus contributes to the water quality of the estuary. Disturbance of the sediment in eelgrass beds through extensive clamming or dredging can inhibit growth of eelgrass (Phillips 1972; Stout 1976; Waddel 1964).

Eelgrass beds in Netarts estuary contained a great number and diversity of benthic invertebrates (Stout 1976). The mud shrimp *Upogebia pugettensis* was the most abundant animal in the deeper eelgrass beds. Other crustaceans and worms were also numerous. Gaumer et al. (1978) found 10 species of clams in the bay eelgrass beds (Table 6, locations 10 and 11), more species than in any other habitat type. Most of the clamming in the bay subsystem takes place north of Whiskey Creek. The ODFW maintains a shellfish reserve, stretching across the estuary from south of Whiskey Creek (Fig. 1). The area includes eelgrass and tideflat habitats. It is set aside for research and is closed to recreational clamming. The ODFW has experimentally planted Manila littleneck (steamer) clams in the reserve. The program, which appears successful, may provide a new, fast growing, harvestable species in the future (Gaumer et al. 1978).

Five small fish species commonly inhabit the bay subsystem eelgrass beds (Table 9). Although these species make a minor contribution to the fishery, they provide food for larger fish and birds (Bottom and Forsberg 1978; conversation, August 15, 1978 with Range Bayer, OSU Marine Science Center, Newport).

Habitats and species of intertidal flats

Tide flats with little or no vegetation comprise 40% of the bay subsystem. Flats west of the channel and north of the eelgrass beds have a sand substrate. The sand flat adjacent to the spit is higher than the eelgrass beds (Fig. 7). The southern end of the bay rapidly grades from sand to mixed sand and mud, to an almost pure mud (Stout 1976). Flats along the eastern shore have a mud substrate. The few unvegetated areas in the center of the bay are either sand or mixed sand and mud, depending on the velocity of tidal currents that flow over the area (Fig. 8).

The animal communities associated with flats differ from site to site. Major factors affecting the communities appear to be substrate, elevation, and water current. For example, foraminifera populations are most dense in the higher, sandy areas with little current; moderately dense in the mud or mixed sand and mud of the eastern shore; and the lowest near or in the main tidal channel (Fig. 3).

The northwestern sand flat (Fig. 8) contained an abundant group of small invertebrates, including three of the most numerous species sampled in the estuary -- a sandy tube worm *Pygospio elegans*, a tube dwelling crustacean *Leptochelia dubia*, and the amphipod *Corophium brevis*. However, these species were not abundant near the spit (Stout 1976). Shrimp were not numerous in that sand flat (Fig. 5), but there was a large, dense cockle bed. Softshell and Baltic macoma clams were also found sparsely distributed through the northern sand flat (Table 6, location 6). The Sand flat along the spit was primarily inhabited by sand shrimp. Small California softshell clams were found in the sand shrimp tubes, while other invertebrates, except butter and native littleneck clams, were nearly absent from the flat.

The mudflats of the upper bay and eastern shore have not been surveyed for clams or other benthic invertebrates due to the difficult access on the soft mud. The soft mud also limits recreational use of the area, which remains essentially undisturbed. Further north where the eastern shore is sandier, there were several clam beds and many shrimp (Fig. 4 and Table 6, location 8; Fig. 5) but few of the smaller benthic invertebrates.

The flats near the main tidal channel contain cockle and gaper clam beds but lack shrimp beds (Gaumer et al. 1978). Concentrations of other invertebrates near the channel were spotty (Stout 1976).

Two fish species (juvenile English sole and Pacific sand lance) showed a preference for sand flat habitat. The ubiquitous Pacific staghorn sculpin was found over all types of flats, while the young shiner perch and three spine stickleback preferred the sand/mud and mud flats (Table 9). These small fish were often abundant, but few other species were found over the flats of the bay subsystem. Harbor seals haul out and rest on the flats near the channel.

Tidal marsh habitats and species

The few marshes in Netarts estuary are all located in the bay subsystem. A fringe marsh along the spit contains both high and low marsh. The major marsh at the head of the bay is entirely high marsh. Both marshes are within the boundaries of Cape Lookout State Park. Other small marshes fringe the eastern shore or are located east of the highway (Fig. 8).

The marsh at the head of the bay contains both mature and immature high marsh plant communities (Akins and Jefferson 1973). Mature high marshes have a diverse association of plants. Stout (1976) includes a discussion of the Netarts marsh communities based on Jefferson (1975). The EPA in cooperation with OSU is presently studying marshes of Cape Lookout park. The research includes studies of marsh plant transition zones between upland, marsh, and flat; primary productivity of emergent plants and micro and macro algal plants in the marsh; and the fish and invertebrates (including insects) found in the marsh channels, vegetated substrate, and among the vegetation. Although parts of the marsh were once diked for livestock use, it was not entirely cut off from the estuarine system and now appears to be returning to its former state (Stout 1976).

Small high marshes east of the highway have been reduced by the road base fill. Small culverts through the road retard the flushing of the marshes, which may result in additional sedimentation. An important function of marshes is filtering nutrients and sediments from water flowing into the estuary. Although the marshes east of the highway are small, they probably trap silt and other pollutants that would otherwise enter the estuary. These marshes also provide wildlife habitat, although they may be less important in this regard than larger marshes that are better flushed and more isolated.

Management Recommendations

The main developments in the bay subsystem are located along the northern half of the eastern shore. Access for small boats is available at Rice Creek, and the riprapped shore provides access for clamming and fishing. Any future water-dependent or water-related development on the bay subsystem shorelands should be limited to this area to avoid disturbance of the upper bay which should remain natural and because of its proximity to recreational use areas and existing shoreline alterations. Structures (e.g. pilings, rafts) should be allowed in the lower subsystem only where they are essential for water-dependent activities. Any such structures should be designed and located so that they do not obstruct recreational activities or change tidal currents enough to cause erosion or alter the sediment regime and associated benthic communities.

The northern part of the bay subsystem is popular for clamming. Present harvest levels have not appeared to reduce populations of the major clam species. Access to these clamming areas should be maintained, and harvest regulations should be reviewed when necessary to allow the optimum sustainable yield.

Much of the marsh, flats, eelgrass beds, and riparian vegetation in the mid to upper bay has been undisturbed by human activity. Present uses are largely limited to scientific research, wildlife observation, hunting and occasional fishing and clamming. The area contains the largest tracts of eelgrass and marsh in the estuary. The undisturbed flats and eelgrass habitats contain major clam beds, shrimp beds, and large concentrations of other benthic invertebrates. Numerous small fish also congregate in the mid to upper bay. Birds feed on the abundant plants and animals of this area. The large flock of black brant that overwinter in Netarts feed on the eelgrass. Maintenance of healthy eelgrass beds is crucial to retaining the brant flock in Netarts.

Because of its productive and undisturbed habitats, the mid to upper bay should remain natural as directed in the Estuarine Resources Planning Goal (Comprehensive Plan Requirements LCDC 1977b). New uses of the area should be restricted to water-dependent activities which require minimal disturbance of the area and which are strictly managed to protect the vegetation, clam beds, and wildlife. The standing crop of eelgrass and marsh plants should not be significantly reduced. Clam beds should be protected from pollution, siltation, physical destruction, and overharvest. Birds and harbor seals should be protected from excessive noise, traffic, and harassment. Activities permitted in the mid to upper bay should be monitored to ensure that the habitats, flora, and fauna are being adequately protected.

Shoreland development around the mid to upper bay should be low density, and an adequate fringe of riparian vegetation should be required to prevent erosion and provide a buffer between shoreland activity and the estuary. The State Parks Division should maintain a buffer between major parking, camping, and picnicking facilities and the marsh and spit. Observation decks or elevated walks for nature study may be desirable to control public use and avoid trampling of the marsh. However, direct pedestrian access to the upper bay mudflats and eelgrass beds, which may cause significant disturbance to the area, should not be developed.

Logging in the watershed and development around the bay subsystem should incorporate measures to control erosion and prevent the excessive siltation observed in the past.

The small marshes east of the highway should be conserved to protect their ecological contributions to the estuary. Additional filling of the marshes should be prohibited. Restoration and enhancement of these marshes could be achieved by installing larger culverts through the base fill of the highway to improve flushing and by removing the dike that created Yager "lake".

SUMMARY AND RESEARCH RECOMMENDATIONS

Netarts estuary is a medium-sized estuary with a very small drainage basin. The shallow, lagoon-shaped estuary contains extensive eelgrass beds, clam beds, and shrimp beds but relatively little marshland. The estuary can be divided into a small marine subsystem and a larger bay subsystem. The marine subsystem habitats are predominantly unvegetated and sandy. Bay subsystem habitats are shallower and consist primarily of eelgrass beds and flats.

There are relatively few alterations within the bay itself; however, shoreline alteration and shoreline development are extensive on the northern and eastern shores. The major activities in Netarts Bay are water-dependent recreation, aquaculture, commercial clamming and crabbing, and estuarine research. The southern half of the bay is essentially undisturbed and provides much of the primary productivity of the estuary. Development and high intensity recreational use areas should be concentrated in northern portions of the estuary and along the northeastern shore. The upper bay should be managed to protect the tideflat, eelgrass, and marsh habitats and associated communities.

Netarts estuary has been the subject of many research projects because of its rich diversity of plants and animals and its uncomplicated and unaltered physical nature. Little additional baseline information is needed for most land use planning decisions concerning the estuary. Netarts and Sand Lake are the only bar built estuaries in Oregon. Consequently, the results of many of the research projects conducted in Netarts may not be immediately applicable to other estuaries. State agencies and universities should give higher priority to research in estuaries with larger drainage basins on which information is greatly needed to assess the impacts of major alterations that have occurred or are pending. The only gaps in basic information for Netarts estuary are the distribution and abundance of birds and fish in the estuary during winter and the benthic invertebrates of the upper-bay mud flat. Studies of clams, oysters, eelgrass, black brant, and other important species in Netarts may also be valuable for managing those resources.

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