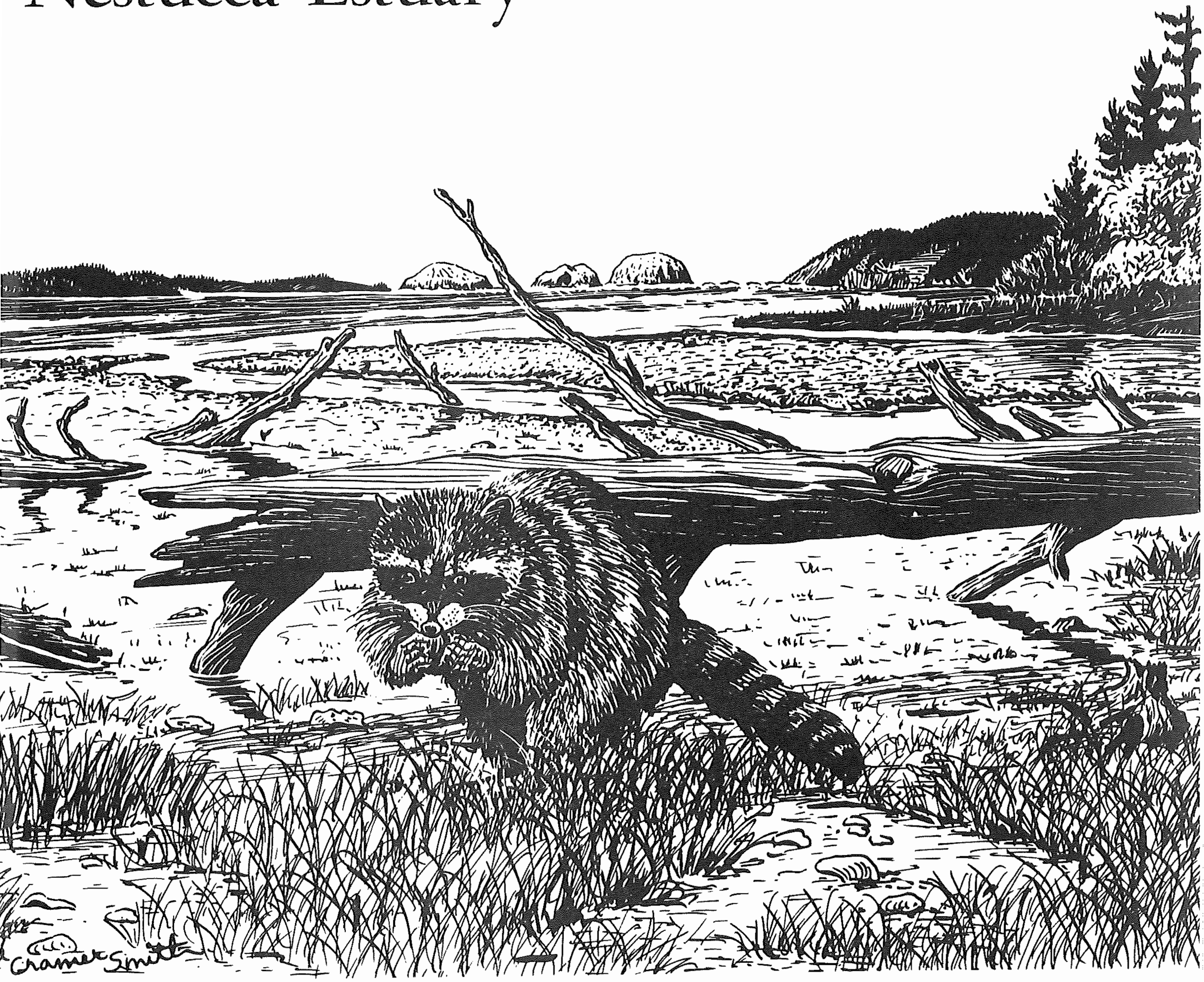
Natural Resources of Nestucca Estuary



ESTUARY INVENTORY REPORT

Vol. 2, No. 3

Prepared by
RESEARCH AND DEVELOPMENT SECTION
Oregon Department of Fish and Wildlife
for
Oregon Land Conservation and Development Commission

1979

FINAL REPORT

ESTUARY INVENTORY PROJECT

OREGON

PROJECT TITLE: Technical assistance to local planning staffs in fulfilling the requirements of the LCDC estuarine resources goal.

JOB TITLE: Natural resources of the Nestucca estuary.

PROJECT PERIOD: February 1978 - June 1979

Prepared by: Richard M. Starr

Oregon Department of Fish and Wildlife
506 S.W. Mill Street
P. O. Box 3503
Portland, Oregon 97208

The preparation of this document was financed in part by funds from the Oregon Land Conservation and Development Department and the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, U. S. Department of Commerce, and by the Oregon Department of Fish and Wildlife.

ACKNOWLEDGEMENTS

This report is the result of work by many people in the Oregon Department of Fish and Wildlife. Doug Daylor and Dave Heckeroth, district biologists, assisted in the habitat mapping phase and reviewed the draft report. Dale Snow of the Marine Region spent considerable time reviewing the draft report as did Jim Lauman of the Environmental Management Section. Special thanks go to Dan Bottom, Jim Lichatowich, and Al McGie who helped design the format of this report and reviewed the report for accuracy.

I am grateful to Margie Lamb and Jan Ehmke for typing and to Marita Loch for drafting the figures. My thanks to Phil Howell for editing the final drafts.

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 1977).

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 1977). 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.

CONTENTS

INTRODUCTION

The Nestucca estuary, located in southern Tillamook County, is relatively far from major urban centers, and the few unincorporated towns nearby are small (Table 1). Most of the land surrounding the estuary receives low intensity land use such as farming and recreation. Houses clustered around Pacific City and Woods (Fig. 1) comprise the major developments adjacent to the estuary. Most of the commercial, recreational, and residential activities in the area are associated with the ocean shorelands and dory fishing fleet, located west of Pacific City.

Table 1. Population centers around Nestucca estuary (Percy et al. 1974).

Name	General location	Approximate distance from estuary mouth (miles)	1970 population
Oreton	2 miles south of Nestucca Bay	--	rural
Pacific City	Nestucca River; east side	3.5	400
Woods	Nestucca River; north side	4.4	95
Cloverdale	Nestucca River; south side	9.0	no pop.
Meda	Little Nestucca River; south side	--	rural
Dolph	Little Nestucca River; north side	13.9	not listed
Hebo	Three Rivers	12.7	200

The Nestucca estuary will probably experience an increase in estuarine shoreland development as are other Oregon estuaries. As the population increases, additional demands will be placed on the natural resources of the Nestucca estuary. Visitor use of the area will increase, and land adjacent to the estuary will receive greater recreational and residental pressures. Careful planning is needed to conserve the natural resources of this small estuary, while providing for increasing demands. The Oregon Land Conservation and Development Commission (LCDC) has classified the Nestucca estuary as a conservation estuary, which is to be managed for long-term uses of its resources that do not require major alterations. This report summarizes physical and biological

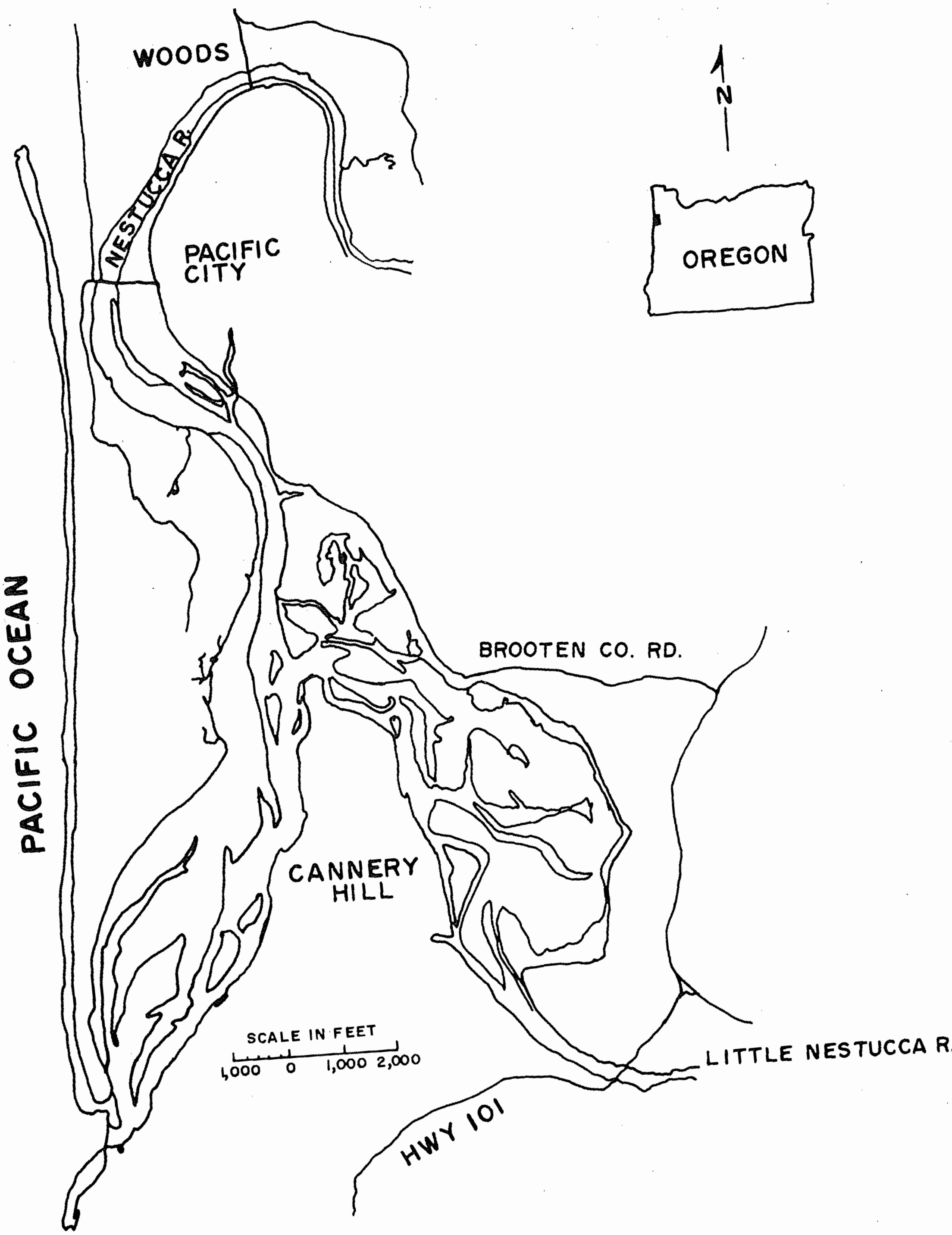


Fig. 1. Map of Nestucca estuary (Oregon Division of Lands [DSL] 1973).

characteristics of the Nestucca estuary and proposes recommendations for land and water use management.

THE NESTUCCA ESTUARINE SYSTEM

The Nestucca estuary has not been studied as much as have most other Oregon estuaries (Morgan and Holton 1977). Although only limited data are available, a general description of the estuarine system is helpful in understanding the relationships among the estuarine subsystems.

Description of the Area

Three different figures for surface area of the Nestucca estuary have been published (Table 2). The discrepancies are due to differences in tidal datums, upper limits of the riverine portion, and accuracy of the measurements. According to the Oregon Division of State Lands (DSL 1973), the Nestucca estuary covers 1,000 acres. Tidelands (area between mean low water [MLW] and mean high water [MHW]) represent about 58% (578 acres) of that area.

Table 2. Surface area of Nestucca estuary (Percy et al. 1974).

Reference	Surface area (acres)	Measured at	Tidelands		Submerged lands	
			Acres	Percent	Acres	Percent
Johnson 1972	1,022	HW				
Marriage 1958	1,149	a/				
DSL 1973	1,000	MHT	578	58	422	42
	422	MLT				

a/ *Specified by Marriage (1958) as the area affected by tidal action.*

Two major streams flow into the Nestucca estuary. The Nestucca River, 54.9 mi long, enters from the north, and the Little Nestucca River, 22.5 mi long, enters the estuary from the south (Fig. 1). The 259 mi^2 drainage basin of the Nestucca River has an average annual yield of 1.0×10^6 acre-feet of water (Oregon State Water Resources Board [OSWRB] 1974). The Little Nestucca River has a drainage basin of 59 mi^2 with an average annual yield of 2.3×10^5 acre-feet of water (OSWRB 1974).

Historical Changes

Major physical alterations to the Nestucca estuary have occurred along the Nestucca and Little Nestucca rivers. Large areas of tidal marsh were diked to provide pasture land. The condition of the dikes and vegetation suggests that the conversion took place many years ago. Diking of marshes reduced the intertidal area and the total surface area of the estuary and accelerated deposition of sediments on the flats. The sedimentation rate probably also increased when the drainage basin was logged. Sediment carried into the estuary would have settled in the marshes but was deposited on the flats because of the dikes.

Recent developments that also influence the estuary include small fills for residential purposes (DSL 1972), riprap and other bank stabilization measures, boat ramps, and docks. In addition, a sewage treatment plant under construction will discharge into the estuary. Effects of these developments are not easily determined because baseline data are lacking.

Physical Characteristics

Quantitative physical data are very limited for the Nestucca estuary. A climatological station at Cloverdale (river mile [RM] 9.0, measured from the mouth of the estuary) and a stream gage near Beaver (RM 15.5) provide the only data collected over an extended time period. Giger's (1972b) data give some indication of salinity, estuarine depths, and mixing characteristics but are insufficient to make reliable inferences. Information about tidal dynamics has not been gathered for this estuary and remains a major research need.

Tides and mixing characteristics

The mean tidal range at the entrance to the Nestucca estuary is 5.8 feet, and the spring tidal range is 7.6 feet (National Oceanic and Atmospheric Administration [NOAA] 1977). The mean tidal range multiplied by the mean surface area between MHW and MLW (DSL 1973) produces a tidal prism of 1.8×10^8 ft^3. Although this is a very crude estimate, it provides a basis for comparison among estuaries. From values reported by Johnson (1972) and computations from the tide tables, it is apparent that the Nestucca has considerably less salt water exchange than most other Oregon estuaries (Table 3).

Table 3. Nestucca estuary tidal prism compared with selected Oregon estuaries[a].

Estuary	Tidal Prism (ft^3)	Ratio of other estuaries to Nestucca estuary
Nestucca	1.8×10^8*	1.0
Tillamook	2.49×10^9	13.8
Coos	1.86×10^9	10.3
Umpqua	1.18×10^9	6.6
Yaquina	8.35×10^8	4.6
Alsea	5×10^8	2.8
Nehalem	4.28×10^8	2.4
Siletz	3.5×10^8	1.9
Netarts	3.3×10^8*	1.8
Siuslaw	2.76×10^8	1.5
Coquille	1.32×10^8	0.7
Sand Lake	8.2×10^7*	0.5

[a] *Values indicated by an asterisk (*) were calculated from DSL (1973). All others are from Johnson (1972).*

Although there are no published data on tidal dynamics, some extremely crude estimates of mixing characteristics can be obtained by the flow ratio method discussed by Simmons (1966). The flow ratio is the volume of fresh water which enters an estuary during a tidal cycle divided by the tidal prism. Results of the flow ratio analysis indicate that the estuary is well mixed in the spring, summer, and fall and partially mixed in winter (Table 4). These results represent averages since mean values were used in the computations.

Table 4. Mixing characteristics derived from flow ratio method (NOAA 1977; Simmons 1966; USGS 1977).

	Mean range at mouth (ft)	Mean daily flow (cfs)	Total freshwater input (ft^3)	Tidal prism on mean range (ft^3)	Flow ratio	Classification
Winter (Nov-Mar)	5.8	2052	4.7×10^7	1.8×10^8	0.26	Partially mixed
Spring (Apr-Jun)	5.8	500	1.2×10^7	1.8×10^8	0.07	Well mixed
Summer (July-Sept)	5.8	117	2.7×10^6	1.8×10^8	0.02	Well mixed
Fall (Oct)	5.8	304	7.0×10^6	1.8×10^8	0.04	Well mixed

Mixing classifications of the Nestucca estuary can also be determined by the salinity difference method described by Burt and McAlister (1959). The only salinity data suitable for this type of analysis (Giger 1972b) were collected on one winter day and one summer day, making generalizations for an entire season impossible. However, the salinity profiles for that winter day (Fig. 2) indicate the estuary was well mixed at high tide. During low tide the estuary was well mixed because it was almost entirely fresh water. In the summer salinity gradients were measured at high tide. From the mouth of the Nestucca River to RM 2.2, the estuary was well mixed; from RM 2.2 to 5.0, it was partially mixed; and above RM 5.0 it was well mixed. At low tide in the summer, the estuary was partially mixed.

River discharge

The Little Nestucca River does not have a stream gauge, but the Nestucca River has been monitored since 1964 (U.S. Geological Survey [USGS] 1977). The Nestucca River discharges an average of 7.48×10^5 acre-feet of water annually. The Little Nestucca River flow is estimated to be one-fourth that figure (OSWRB 1961). Although there is no stream gauging station near the head of

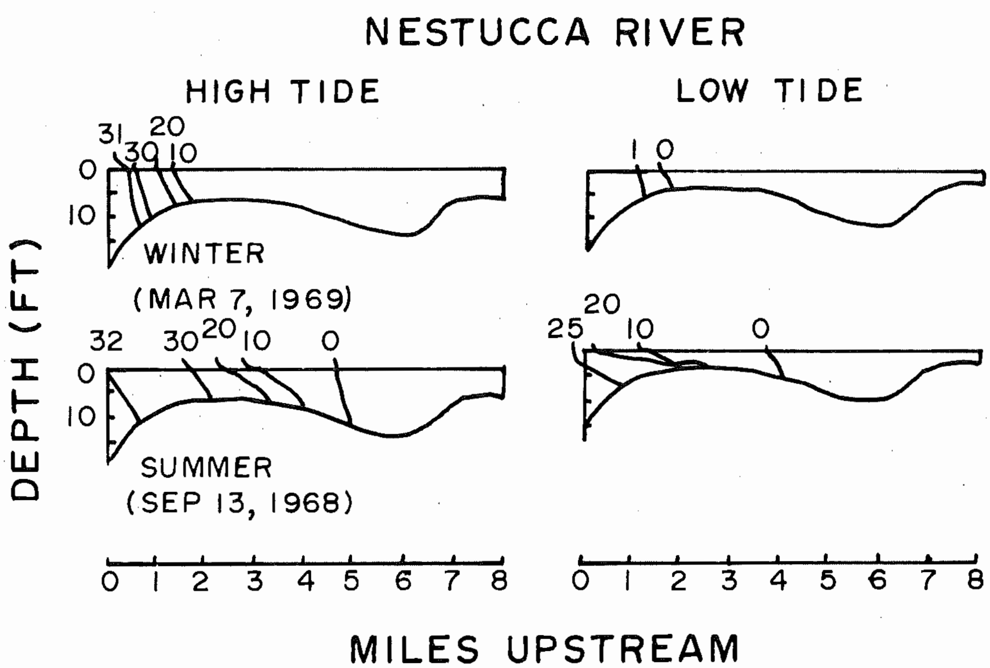


Fig. 2. Salinity gradients (in parts per thousand) from mouth of estuary to head of tide on the Nestucca River at moderately low and high tides during two seasonal periods (Giger 1972b).

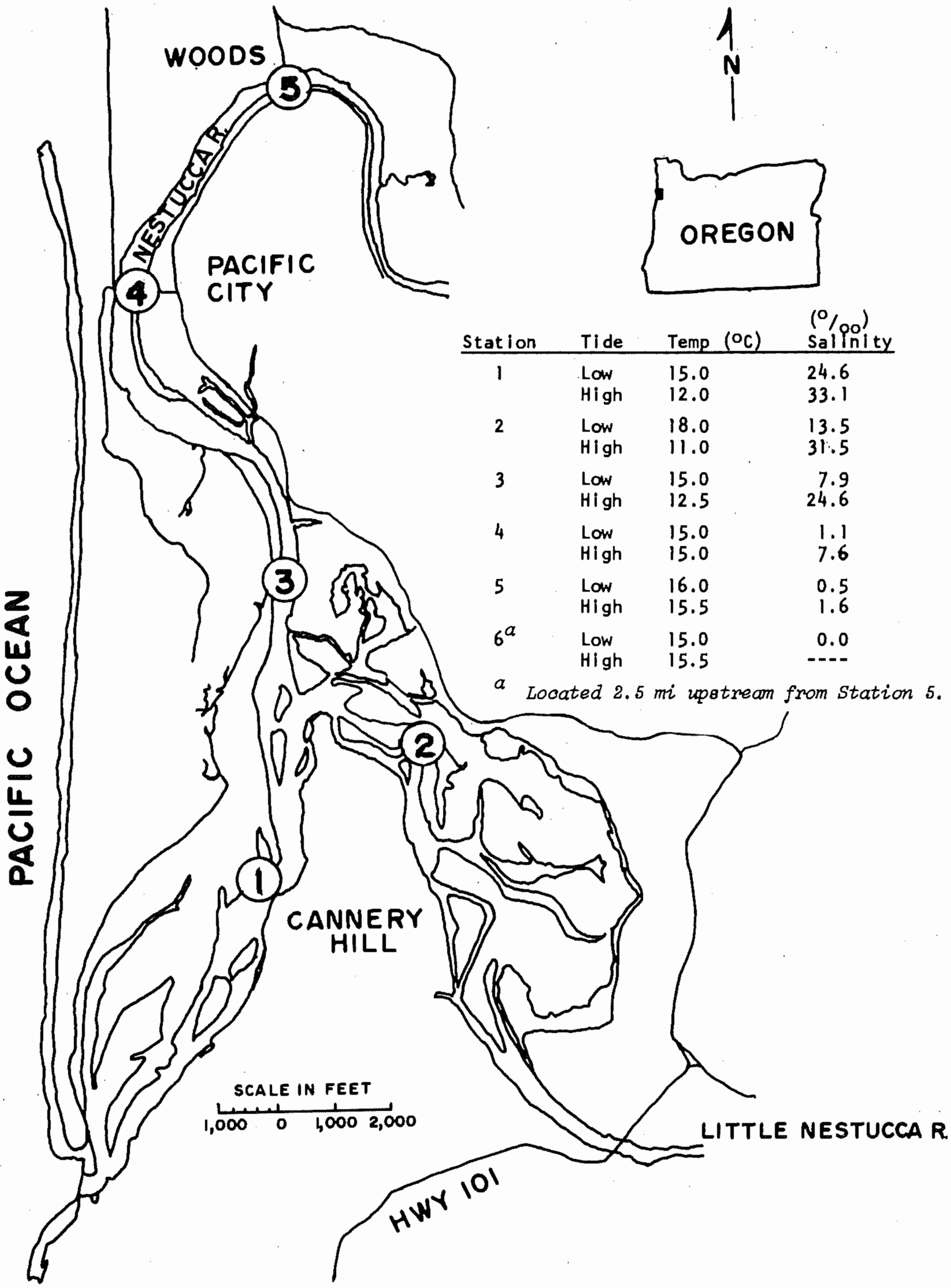
tide, values from the Nestucca River gauge near Beaver at RM 15.5 give an indication of seasonal fluctuations in flow. About 77% of the average annual yield occurs during November through March, and the period from December through February accounts for more than 50% of the average annual yield (OSWRB 1961). Mean monthly river discharge for the Nestucca River is about 2000 cfs from November through March. It falls below 250 cfs during July, August, and September.

Temperature

A few studies of river water temperature above the estuary are available (Skeesick and Gaumer 1970; USGS 1977), but only a few random measurements of estuarine water temperature have been recorded (Giger 1972a; Giger 1972b, Oregon Department of Environmental Quality [DEQ] 1978). River water entering the estuary is colder than the ocean water during winter, and warmer than ocean water during summer. Thus, the relative amounts of river and ocean water combined with the seasonal mixing characteristics greatly influence water temperatures. Water temperatures will be higher in shallow areas, during low tide (except in winter), and in the summer.

Chemical parameters

Giger (1972b) and the DEQ (1978) provide a few salinity measurements for the Nestucca River (Fig. 2, 3). Giger (1972b) observed higher salinities during high tide, near the mouth of the estuary, on the bottom, and during low stream flow. Salinities decreased upstream from the mouth, but decreased more slowly on the bottom. The limit of saline intrusion occurred between RM 4 and RM 5 in the summer and between RM 1.5 and RM 2.5 in the winter (Giger 1972b). The steep river gradient may limit the upriver intrusion of marine water.



Station	Tide	Temp (°C)	(‰) Salinity
1	Low	15.0	24.6
	High	12.0	33.1
2	Low	18.0	13.5
	High	11.0	31.5
3	Low	15.0	7.9
	High	12.5	24.6
4	Low	15.0	1.1
	High	15.0	7.6
5	Low	16.0	0.5
	High	15.5	1.6
6[a]	Low	15.0	0.0
	High	15.5	----

[a] *Located 2.5 mi upstream from Station 5.*

Fig. 3. Surface temperature and salinity at DEQ surveillance stations July 11, 1973 (DSL 1973; DEQ 1978).

A number of other chemical parameters have been monitored including dissolved oxygen, pH, turbidity, orthophosphates, nitrates, and pathogens (DEQ 1978). There appear to be no major water quality problems in the estuary; however, more data are needed to substantiate this hypothesis.

Biological Characteristics

Existing data for the Nestucca estuary are insufficient to correlate distribution and abundance of species with their habitats. Giger's (1972b) study is the only ecological study published. A shellfish survey and a brief angler catch survey represent the only other quantitative data recorded (Gaumer and Halstead 1976; Gaumer et al. 1973).

Plants

Plants are the energy source for the grazing and detritus food chains in an estuary. Important smaller plants such as phytoplankton and benthic micro-alage have not been studied, but Gaumer and Halstead (1976) mapped the distribution of green algae (*Enteromorpha* and *Ulva* spp.), brown algae (*Fucus* sp.), and eelgrass (*Zostera* sp.) in portions of the estuary. Jefferson (1975) and the Oregon Department of Fish and Wildlife (ODFW 1978) classified and mapped salt marshes in the Nestucca estuary (Fig. 4).

Invertebrates

ODFW surveys show an abundance of softshell (*Mya arenaria*) and baltic (*Macoma baltica*) clams in the estuary. A few irus (*Macoma irus*) clams were also reported (Gaumer and Halstead 1976). Ghost shrimp (*Callianassa californiensis*) and mud shrimp (*Upogebia pugettensis*) were found in the flats (Gaumer and Halstead 1976). Dungeness crabs (*Cancer magister*) have been caught in the lower estuary (Gaumer et al. 1973).

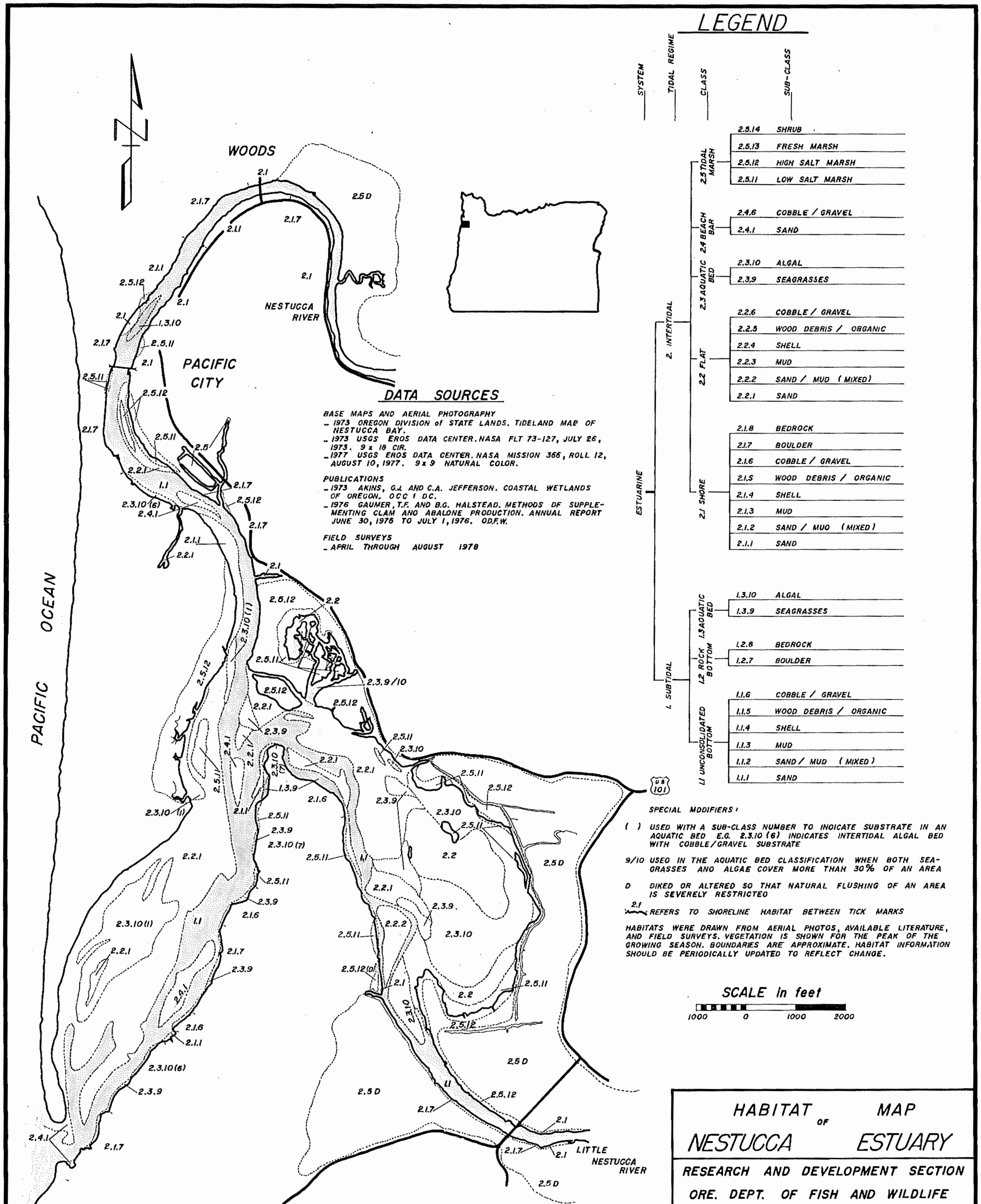


Fig. 4. Habitat map of Nestucca estuary (ODFW 1978).

Fish

There have been no comprehensive surveys of fish, but angler catch data indicate some of the important sport fish which use the estuary (Table 5). Anglers caught fewer species in the Nestucca estuary than in most other estuaries surveyed in 1971 (Gaumer et al. 1973). This may indicate a lower diversity of recreational species than is found in many Oregon estuaries, but it probably reflects a lack of fishing effort or insufficient sampling of anglers.

Table 5. Species harvested in Nestucca River estuary, March 1 through October 31, 1971 (Gaumer et al. 1973).

Common name	Local names	Scientific name
FISH		
Buffalo sculpin	Bullhead	*Enophrys bison*
Chinook salmon	King salmon, salmon	*Oncorhynchus tshawytscha*
Coho salmon	Silver salmon	*Oncorhynchus kisutch*
Cutthroat trout	Blueback, harvest trout, sea run	*Salmo clarki*
Pacific staghorn sculpin	Bullhead	*Leptocottus armatus*
Redtail surfperch		*Amphistichus rhodoterus*
Shiner perch	Shiner	*Cymatogaster aggregata*
Starry flounder		*Platichthys stellatus*
CRABS		
Dungeness crab	Market crab	*Cancer magister*
CLAMS		
Softshell clam	Mud clam, bay clam	*Mya arenaria*
MISCELLANEOUS INVERTEBRATES		
Ghost shrimp	Sand shrimp	*Callianassa californiensis*
Mud shrimp	Sand shrimp	*Upogebia pugettensis*

Giger (1972b) studied the movements of anadromous cutthroat trout (*Salmo clarki*) through the Nestucca estuary from 1965 to 1970. Cutthroat trout entered the estuary in mid to late July and to a lesser extent in late August.

The cutthroat trout moved quickly through the shallow lower estuary and through the summer concentrated in the deeper central section of tidewater. Temperature seemed to have a greater influence than salinity on distribution. Small fall freshets brought cooler water into the estuary, causing a shift in trout distribution to upper tidewater areas. Most fish moved upstream out of the estuary in the late fall following the first substantial rain. Thus, many adult cutthroat remained in the estuary 3 to 4 months or more (Giger 1972b). Juveniles inhabited the estuary during the spring and summer on their journey to the sea.

Fall chinook (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) entered the Nestucca estuary later than cutthroat trout but had similar upstream migration patterns (Giger 1972b). Other important salmonids utilizing the estuary include spring chinook salmon, chum salmon (*O. keta*), and summer and winter steelhead trout (*Salmo gairdneri*). Lauman et al. (1972) reported that more winter steelhead and fall chinook spawn in the Nestucca River than in any other streams in the north coast basin.

Salmon populations of the Nestucca and Little Nestucca rivers were probably larger a few decades ago, but steelhead runs are probably as great or greater due to hatchery supplementation (Heckeroth 1970). ODFW hatcheries produced about 48% of the winter steelhead, 95% of the summer steelhead, 50% of the spring chinook, 10% of the fall chinook, and 67% of the anadromous cutthroat trout caught in the Nestucca River in 1976 (ODFW 1977). Hatcheries produced about 83% of the winter steelhead and 67% of the anadromous cutthroat trout caught in the Little Nestucca River in 1976. Angler catch statistics indicate that the Nestucca River rivals the Siletz, Rogue, and Umpqua rivers for numbers of summer steelhead caught and is a close second to the Rogue River for numbers of winter steelhead caught (Table 6). Large numbers of fall chinook are also caught in the Nestucca River.

Table 6. Sport catch of summer-run steelhead in Oregon coastal streams, 1976-77 (ODFW 1976).

	Run year									
Stream	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
Coastal Tributaries										
Alsea River & Bay	225	153	159	154	154	128	126	129	198	140
Applegate River	646	305	543	480	291	274	124	953	388	8+
Drift Creek	0	14	21	10	19	17	8	4	23	26
Illinois River	122	71	38	189	69	41	62	150	120	97
Kilchis River	6	13	11	5	38	29	8	10	293	129
Miami River	0	0	0	10	4	0	8	8	19	20
Nehalem River	--	--	--	--	--	--	--	--	--	--
Nestucca River & Bay	1,503	3,733	2,947	3,599	3,666	4,223	2,611	6,688	5,458	2,479+
Nestucca River, Little	--	17	8	5	22	6	0	27	21	58
Rock Creek	1	41	46	53	72	149	30	0	0	0
Rogue River	4,161	2,756	4,490	4,334	6,242	3,659	1,943	6,939	4,290	2,791+
Salmon River	70	151	95	260	353	196	59	153	273	91
Siletz River & Bay	1,955	2,999	2,680	3,740	6,172	3,601	2,976	6,096	5,647	3,963
Smith River	20	18	11	22	17	24	0	15	6	0
Tillamook Bay	15	14	12	14	0	0	4	0	0	0
Tillamook River	0	10	21	1	3	13	7	53	6	3
Trask River	241	303	306	846	893	656	423	745	746	503+
Umpqua River & Bay	813	1,584	1,815	3,723	3,091	3,598	1,183	3,908	1,535	1,454
Umpqua River, N.F.	1,910	2,520	4,802	7,011	6,352	8,294	3,256	4,007	3,749	3,111
Umpqua River, S.F.	--	0	8	42	5	6	4	0	0	18
Wilson River	60	100	148	1,163	2,345	1,819	1,016	2,404	2,613	1,178+
Total	11,748	14,802	18,161	25,661	29,808	26,733	13,848	32,389	25,385	16,108+

Birds and mammals

The Nestucca estuary is located in the Pacific flyway and is important as a resting stop and wintering area for many waterfowl and shorebirds (Table 7). Wigeon (*Anas americana*) and pintail (*Anas acuta*) are the most abundant birds observed in winter (Batterson 1971). Batterson (1971) listed a few marine and terrestrial mammals which utilize the estuary (Table 7). The smaller terrestrial mammals are permanent residents and rely upon riparian and marsh vegetation.

Table 7. Birds and mammals found abundantly or occasionally on Nestucca estuary (Batterson 1971).

Waterfowl	Shorebirds	Other estuary birds
Whistling Swan	Wilson Snipe	Green Heron
Canada Goose	Hudsonian Curlew	Great Blue Heron
Dusky	Greater Yellowlegs	Baird's cormorant
Cackling	Lesser Yellowlegs	Brandt's cormorant
Lesser	Dowitcher	Black Guillemot
Whitefront Goose	Red-backed Sandpiper	Pied-billed Grebe
Snow Goose	Rock Sandpiper	Western Grebe
Mallard	Western Sandpiper	Horned Grebe
Pintail	Least Sandpiper	Eared Grebe
Wigeon - American	Red Phalarope	Common Loon
Wigeon - European (occasional)	Northern Phalarope	Red-throated Loon
Gadwall	Black Oystercatcher	Brown Pelican
Green-winged Teal	Semi Palmated Plover	Kingfisher
Cinnamon Teal	American Knot	Sora Rail
Blue-winged Teal	Spotted Sandpiper	Virginia Rail
Shoveler	Sanderling	Western Gull
Wood duck	Wandering Tattler	California Gull
Redhead	Killdeer	Ringbilled Gull
Canvasback	Snowy Plover	Glaucous-winged Gull
Scaup	Black-bellied Plover	Bonaparte's Gull
Lesser	Black Turnstone	Common Tern
Greater	Ruddy Turnstone	Forster's Tern
Ruddy Duck	Surf Bird	Artic Tern
Common Merganser		Common Egret
Red-breasted Merganser		
Hooded Merganser		
American Goldeneye		
Bufflehead		
American Scoter		
Surf Scoter		
White-winged Scoter		
Harlequin Duck		
Ring-necked Duck		
American Coot		

Estuary Mammals

Hair Seal	Beaver
Fur Seal	Muskrat
Seal lion	Meadow Mouse
Mink	Shrew
River Otter	

NESTUCCA ESTUARINE SUBSYSTEMS

The Nestucca estuary can be divided into a marine, a bay, and two riverine subsystems, based upon sediment size, habitats, and geographic location (Fig. 5). Physical and biological differences in each subsystem are due to the relative influences of ocean water, river water, and currents. Although the subsystems do not function independently, a separate discussion of each of the four subsystems is useful in developing management strategies.

Marine Subsystem

The marine subsystem is located in the lower portion of the estuary and extends from the mouth to RM 1.8 on the Nestucca River (Fig. 5). The diurnal salinity changes and the overwash of the spit in February 1978 indicate it is an area where ocean waters have a strong influence (Komar 1978). Depths in the marine subsystem are greater than in the bay subsystem. Approximately 70% of this subsystem is intertidal habitat with primarily a sand substrate (Table 8). The sand spit west of this subsystem is a state park, and Cannery Hill to the east is steep, relatively undeveloped land with a rocky shore.

Gaumer and Halstead (1976) reported some shrimp and a few softshell and baltic clams in the extensive sand flats of the marine subsystem. Crabs also occupy the sand habitats (Gaumer et al. 1973). Adult and juvenile anadromous fish pass through the marine subsystem. Juvenile fall chinook salmon may rear in this subsystem before entering the sea. In some estuaries juvenile fall chinook spend the entire summer in shallow water in the lower estuary prior to seaward migration (Reimers 1970).

A comprehensive inventory of fish habitats in the Nestucca estuary is lacking, but research in other estuaries suggests the cobble shore and subtidal habitats on the eastern margin of the marine subsystem may provide food and shelter for many species. In the Tillamook estuary, the lower estuary provided

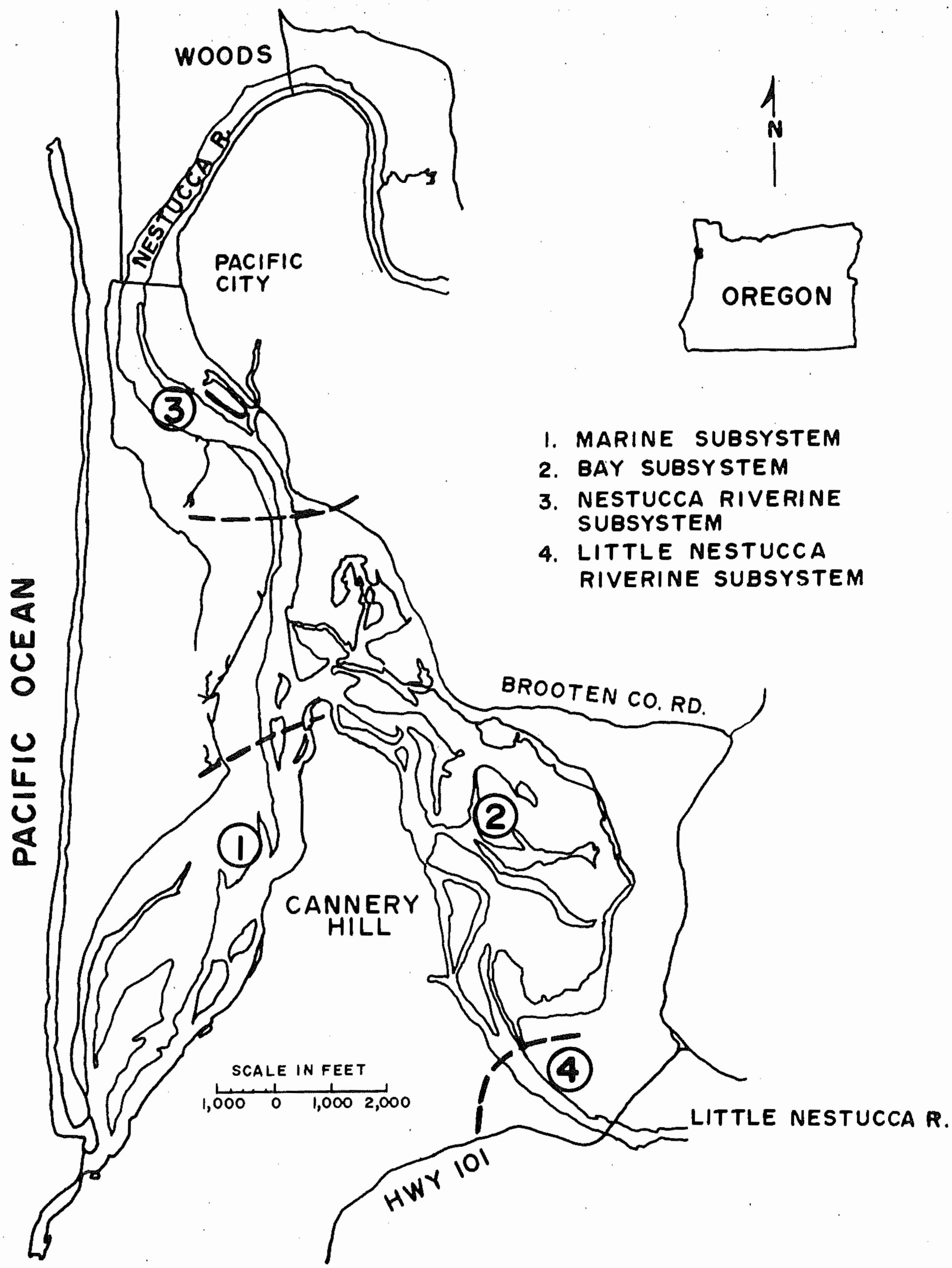


Fig. 5. Map of Nestucca estuary subsystems (Base map from DSL 1973).

the most productive and diverse catch per seine set over cobble substrates and eelgrass beds (Forsberg et al. 1977). Surveys also show dense accumulations of algae (*Ulva, Enteromorpha, Fucus* spp.) and eelgrass (*Zostera* sp.) attached to the cobble substrate in the Nestucca estuary (Gaumer and Halstead 1976).

Table 8. Estimated percentage of habitat surface area within Nestucca marine and bay subsystems.[a/]

Habitat	Marine Subsystem		Bay Subsystem	
Subtidal	30		15	
Unconsolidated bottom		29		14
Seagrass bed		*		1
Intertidal	70		85	
Sand Shore		*		*
Cobble/gravel shore		*		*
Rock shore		*		*
Sand flat		46		21
Sand/mud flat				3
Mud flat				3
Undifferentiated flat				10
Seagrass bed		*		2
Algal bed		18		21
Seagrass/algal bed				1
Beach/bar		5		
Low marsh		*		6
High marsh		*		16

[a/]*Values estimated from habitat map of Nestucca estuary (ODFW 1978).*
**Less than 1%.*

Management recommendations

The extensive shifting sand flats along the western side of this subsystem provide habitat for crabs, shrimp, and demersal fish. These large flats should be considered major tracts which require inclusion in a natural designation as described in the LCDC (1977) Estuarine Resources Goal. The channel is an important avenue for anadromous fish, and juvenile salmonids may rear in shallow areas of this subsystem. The algae and eelgrass covered rocky shores on the east side of the subsystem are extremely rare in mid-coast and north-coast estuaries and have high species diversity (Fig. 4; Bottom and Forsberg 1978). These habitats should be protected to ensure a diversity of habitats among all Oregon estuaries and within the Nestucca estuary according to the Overall Statement of the Estuarine Resources Goal (LCDC 1977).

Bay Subsystem

The bay subsystem is located between the marine subsystem and the Nestucca and Little Nestucca riverine subsystems (Fig. 5). It encompasses most of the major marshes and contains extensive flats where most of the fine, river borne sediments are deposited. It is a transition zone between salt and fresh waters and is shallower than either the marine or the riverine subsystems.

The habitats in the bay subsystem range from lower intertidal to extreme high water elevations. Eelgrass beds correspondingly graduate into algal beds, flats, low marshes, and high marshes. Intertidal marshes, flats, and aquatic beds account for approximately 83% of the surface area, although the bay subsystem contains a wide array of habitats (Table 8).

Extensive diking of marshlands between the bay and U.S. Highway 101 is the major alteration to the bay subsystem. The habitat map of the estuary (Fig. 4) shows that about 42% of the original surface area of the bay subsystem has been diked for pasture. Although the remaining marshes are not as extensive as in other estuaries, they are extremely diverse (Akins and Jefferson 1973). Most of the 222 acres of tidal marsh in the estuary are located in the bay subsystem. The only large undiked areas of high marsh occur along the shores of the Nestucca River, just south of its junction with the bay subsystem.

Softshell clams, baltic clams, and shrimp were observed on the flats of the bay by Gaumer and Halstead (1976). Adult softshell clams were usually found in moderate concentrations of 1 to $5/ft^2$, but softshell sets often occurred in concentrations greater than 5/ft^2. Baltic clams were also frequently found in concentrations greater than 5/ft^2 (Gaumer and Halstead 1976). Thus, the flats maintain clam populations despite higher elevations due to increased deposition of sediment from the heavily logged drainage basin.

Data are scarce concerning the occurrence of other species in the bay subsystem. Perch, flounder, salmon, and cutthroat trout have been caught by anglers (Gaumer et al. 1973). Migratory waterfowl and shorebirds rest and feed in large numbers in this subsystem (Table 7). Data collected from the Tillamook estuary and Puget Sound suggest that the eelgrass communities in the bay subsystem may contain many species of fish and invertebrates (Bottom and Forsberg 1978; Thayer and Phillips 1977).

Management recommendations

The bay subsystem contains the greatest diversity of habitats in the estuary. Most of the marshes, flats, and aquatic beds are located in this subsystem, and subtidal habitats comprise a small percentage of the total acreage. The remaining large expanses of salt marsh in the northern portion of the bay subsystem should be considered major tracts and protected accordingly. The diked marshes on the eastern margin of this subsystem are heavily grazed, but the drainage channels are still intact. Some of these marshes may be suitable for restoration. If the diked marshes are not restored, they should be retained for agriculture or some other low intensity use, since the area is used by migratory birds and small mammals.

The east side of the bay subsystem contains the largest tideflats in the estuary. Large eelgrass and algal beds occur on the tideflats. This entire area should be managed as major tracts. The west side of the bay subsystem along Cannery Hill is characterized by subtidal eelgrass beds and fringing low marsh. The slopes of the adjacent upland are steep and probably unsuitable for development. However, if the hill is developed for residential sites, erosion control measures should be required to prevent destruction of the eelgrass beds and low marshes. Development along this shoreline should not subject the eelgrass and marsh communities to increased siltation, excessive scouring, reduction of light, or pollutants.

Nestucca Riverine Subsystem

The Nestucca River subsystem (Fig. 5) extends from the boat ramp at about RM 2.4 to the head of tide at Cloverdale Bridge (RM 9.0). The estuary is deeper and narrower in this subsystem than in the bay subsystem. Available salinity data indicate that this subsystem is composed of brackish water during summer and fresh water during winter (Giger 1972b; DEQ 1978). Downstream from the town of Woods, altered and unaltered intertidal habitats occur with low sedge (*Carex* sp.) marshes interspersed among riprap and pilings. Small patches of algal bed and high marsh are also found. Riverine habitats upstream from Woods are primarily subtidal.

The Nestucca River subsystem is heavily used by recreational anglers, and angler use is expected to increase (Heckeroth 1970). Cutthroat trout, winter steelhead, and fall chinook are caught as they migrate upstream. Mammals such as beaver (*Castor canadensis*), river otter (*Lutra canadensis*), mink (*Mustela vison*), muskrat (*Ondatra zibethica*), and meadow mouse (*Zapus hudsonius*) are residents of the riparian habitats (Batterson 1971).

Much of the shoreline in the Nestucca River sybsystem has been altered by docks, bulkheads, pilings, and riprap. Docks, bulkheads, and pilings are located along the shoreline between Pacific City and Woods. Southeast of the airstrip, channels were dug many years ago in a high marsh to allow space for docks. The only fills in the estuary occur in this subsystem near Pacific City. These have been riprapped. Riprap has also been placed along the shoreline adjacent to the two boat ramps below Pacific City and along much of the shoreline in the upper stretches of tidewater. A nearly completed sewage treatment plant outfall near Woods completes the list of alterations in this area.

Little physical or biological data exist for the Nestucca River subsystem. However, the subsystem is an important transportation corridor for anadromous fish. Recreational angling is popular and has stimulated recreational and residential development on the stream banks.

Management recommendations

The entire Nestucca River corridor should be managed as a unit so that piecemeal destruction of shoreland habitats does not occur. Management decisions should be based on a stream management plan which incorporates the following recommendations.

New buildings should be constructed at a sufficient distance from the river so that bank stabilization measures are not required. Much of the land adjacent to the riverine portion of the estuary is in the floodway or floodway fringe, which is subject to high velocity flood waters that cause erosion. Riprap or bulkheads merely shift the erosional forces from one area to another. Where bank stabilization measures are necessary, gradually sloping, vegetated banks are an alternative to riprap that should be considered in the stream management plan. Such non-structural solutions to problems of erosion and flooding are encouraged by the implementation requirements of the Coastal Shorelands Goal (LCDC 1977).

To prevent the destruction of habitats of organisms which live in or use the estuary, riparian vegetation should be protected as suggested by the implementation requirements of the Coastal Shorelands Goal (LCDC 1977). Riparian vegetation retards erosion and provides cover for terrestrial animals using the river, shade for fish, and habitat for terrestrial insects which are consumed by fish. Riprap and bulkheads destroy riparian vegetation. Docks that become stranded on the bottom at low tide decimate benthic populations. Riparian vegetation and benthic habitats could be better protected if riprap, bulkheads, and docks were restricted on stretches of river where they are not already established. Thus, additional docks should be limited to the area between Pacific City and Woods. Public marinas could be established as an alternative to private docks. However, storage of boats on land should be encouraged as an alternative to storage on the water. The estuary currently has enough boat ramps to meet anticipated needs. This approach would help maintain a diversity of uses with some developed areas and some natural areas.

Little Nestucca Riverine Subsystem

The Little Nestucca River subsystem extends from the river's mouth at the southeastern end of the bay subsystem to the head of tide at Fall Creek (Fig. 5). Most of the land surrounding this portion of the estuary is within the 100 year flood plain. Habitats in this subsystem include low fringing marshes, intertidal shore, and subtidal habitats. Marshes are diked on both sides of the river, and some dikes are fortified with riprap. A boat ramp and the U.S. Highway 101 bridge have also altered the habitats of this subsystem. A new highway bridge will soon be constructed downstream from the present bridge.

Studies of physical and biological characteristics are lacking for the Little Nestucca River subsystem. Random observations of water temperature are the only physical data published (Skeesick and Gaumer 1970; Thompson and Fortune 1968; Lauman et al. 1972). Biological information specific to the Little Nestucca River consists of fish spawning counts and sport angling catch data. This subsystem is important as a transportation corridor for anadromous fish, especially winter steelhead and cutthroat trout. Extensive areas of diked marsh provide pasture for dairy cows. Many waterfowl rest and feed on the diked marshes in the winter when standing water is prevalent.

Management recommendations

The entire Little Nestucca River corridor should be managed as a unit. Recommendations concerning maintenance of riparian vegetation and bank stabilization for the Nestucca River subsystem apply to the Little Nestucca subsystem as well.

Shoreline development of this subsystem should be designed to minimize impacts on habitats and species downstream. Care should be taken to prevent a reduction of dissolved oxygen, which could stress fish; an increase in sedimentation, which could bury clam beds; an increase in scouring, which could destroy benthic populations; and an introduction of pollutants, which could adversely affect plants and animals. Since most of the land in the subsystem is in the flood plain, upstream from sensitive habitats including large tracts of tideflats and algal beds, additional structures should be kept to a minimum. Retaining low intensity uses in adjacent diked marshes would be beneficial to migratory birds which rest and feed in the area.

SUMMARY AND RESEARCH RECOMMENDATIONS

The Nestucca estuary is primarily used for recreational purposes. Fishing, hunting, bird watching, crabbing, clamming, boating, and sightseeing are becoming increasingly popular. Land around the estuary is receiving developmental pressure, and future development must be carefully planned to prevent degradation of the natural resources.

Scant physical and biological data are available to assess the impact of development activities in the Nestucca estuary. Quantitative research is needed to more accurately evaluate the relationships of resident organisms and their environment. A number of physical process and water quality data should be collected concurrently and correlated to season, river flow, and tidal stage. The DEQ maintains six water surveillance stations in the Nestucca estuary which should be used in a consistent, long term monitoring program. Additional salinity measurements are necessary to correlate distribution of freshwater, estuarine, and marine species with salinity distribution. Flushing, mixing, and circulation should be studied to predict the movement of pollutants introduced in the estuary. Sedimentation rates should be measured and water depths charted to determine the rate of increase in elevation of intertidal habitats. A study of the rate of increase in elevation of the large flats of the bay subsystem and related changes in clam populations is especially needed.

Basic biological surveys are a primary research need in the Nestucca estuary. Baseline surveys of plants, invertebrates, fish, birds, and mammals are needed to predict or evaluate changes due to estuarine alterations. Community composition, distribution, and abundance should be studied on a continuing basis to document critical periods in the life history of important recreational, commercial, and food web species; to identify important habitats and periods of residence of major adult and juvenile species; and to correlate studies from other estuaries to determine areas of greatest primary productivity. Predation and competition among juvenile salmonids should be studied, if aquaculture facilities are proposed for the Nestucca estuary.

Since comprehensive data are unavailable to assess developmental impacts, a diversity of habitats should be maintained to minimize the risks of irreversible changes (Bella 1978; LCDC 1977). Habitats in the marine subsystem such as the large sand flat, the rocky intertidal and subtidal areas near Cannery Hill, and the aquatic beds should be protected, since they are important habitats where diverse species rest, nest, rear, and feed. The flats, aquatic beds, and marshes of the bay subsystem should be protected as major tracts. The riparian vegetation in the riverine subsystems should also be protected as suggested by the implementation requirements of the Coastal Shorelands Goal (LCDC 1977). The channels in the estuary should remain free of structures which would hinder fish passage. Dredging new channels should be prohibited, since the estuary is a conservation estuary (LCDC 1977).

Some development of the estuary may be desirable to enhance recreational opportunities. Suitable sites for docks and marinas are located along the riprapped shoreline near Pacific City and Woods. Storage of boats on land should be encouraged as an alternative to docks and marinas which would occupy estuarine surface area.

REFERENCES CITED

Akins, G. J. and C. A. Jefferson. 1973. Coastal wetlands of Oregon. Oreg. Coastal Conser. Dev. Comm. Florence. 190 pp.

Batterson, W. M. 1971. Nestucca Bay, conflicts in estuary use. Oreg. Game Comm. Special Rep.

Bella, D. A. 1978. Environment, technology, and future generations. Water Resources Research Institute, Oreg. State Univ., Corvallis. 36 pp.

Bottom, D. and B. Forsberg. 1978. The fishes of Tillamook Bay. Oreg. Dep. Fish Wildl. 56 pp.

Burt, W. V. and B. Mcalister. 1959. Recent studies in the hydrography of Oregon estuaries. Fish Comm. Oreg. Res. Briefs. 7(1):14-27.

Forsberg, B. O., J. A. Johnson, and S. M. Klug. 1977. Identification, distribution, and notes on food habits of fish and shellfish in Tillamook bay, Oregon. Oreg. Dep. Fish Wildl. 117 pp.

Gaumer, T., D. Demory, and L. Osis. 1973. 1971 Nestucca River estuary resource use study. Fish Comm. Oreg. 24 pp.

Gaumer, T. F., and B. G. Halstead. 1976. Methods of supplementing clam and abalone production. Annual Report July 1, 1975 to June 30, 1976. Oreg. Dep. Fish Wildl.

Giger, R. D. 1972b. Ecology and management of coastal cutthroat trout in Oregon. Oreg. Game Comm. Fish. Res. Rep. No. 6.

Giger, R. D. 1972b. Some estuarine factors influencing ascent of anadromous cutthroat trout in Oregon. Pages 18-29 in Proceedings 2nd Annual Technical Conference on Estuaries of the Pacific Northwest, March 16 and 17, 1972. Oreg. State Univ., Corvallis.

Heckeroth, D. N. 1970. Fishery resource data, Tillamook district estuaries. Oreg. Game Comm. Special Rep.

Jefferson, C. A. 1975. Plant communities and succession in Oregon salt marshes. PhD. Thesis, Oreg. State Univ., Corvallis. 192 pp.

Johnson, J. W. 1972. Tidal inlets on the California, Oregon, and Washington coasts. Hydraulic Engineering Laboratory HEL 24-12, Univ. of Calif., Berkeley. 156 pp.

Komar, P. D. 1978. Wave conditions on the Oregon coast during the winter of 1977-78 and the resulting erosion of Nestucca spit. Shore and Beach October 1978.

Lauman, J., A. K. Smith, and K. E.Thompson. 1972. Supplement to the fish and wildlife resources of the North Coast basin, Oregon, and their water requirements, April, 1968. Oreg. Game Comm. 52 pp.

Marriage, L. D. 1958. The bay clams of Oregon. Condensed from Fish Comm. Oreg. Contrib. No. 20, The bay clams of Oregon, their economic importance, relative abundance, and general distribution, May 1954.

Morgan, J. B. and R. L. Holton. 1977. A bibliography of estuarine research in Oregon. Oregon Estuarine Research Council, Pub. No. 1. Oreg. State Univ., Corvallis. 141 pp.

National Oceanic and Atmospheric Administration. 1977. Tide tables, high and low water predictions, 1978, west coast of North and South America including the Hawaiian Islands. U.S. Department of Commerce.

Oregon Department of Environmental Quality. 1978. STORET retrieval data. Unpub. Water Quality Data (computer printout).

Oregon Department of Fish and Wildlife. 1976 annual report, fisheries. Portland. 137 pp.

Oregon Department of Fish and Wildlife. 1977. Unpublished catch and release data.

Oregon Department of Fish and Wildlife. 1978. Habitat map of Nestucca estuary. Res. and Dev. Sect. Unpub.

Oregon Division of State Lands. 1972. Inventory of filled lands in Nestucca estuary. Salem.

Oregon Division of State Lands. 1973. Oregon estuaries. Salem.

Oregon Land Conservation and Development Commission. 1977. Statewide planning goals and guidelines. Salem.

Oregon State Water Resources Board. 1961. North Coast basin. Salem. 142 pp.

Oregon State Water Resources Board. 1974. Freshwater resources of the Oregon coastal zone. Oreg. Coastal Conser. Dev. Comm. Florence. 76 pp.

Percy, K. L., D. A. Bella, C. Sutterlin, and P. C. Klingeman. 1974. Descriptions and information sources for Oregon's estuaries. Sea Grant College Program, Oreg. State Univ., Corvallis. 194 pp.

Reimers, P. E. 1970. Growth and abundance of juvenile fall chinook salmon in Sixes River estuary, 1969. Fish Comm. Oreg. Coastal Rivers Invest. Inf. Rep. 70-4. 29 pp.

Simmons, H. B. 1966. Field experience in estuaries. Chapter 16 of Estuary and Coastline Hydrodynamics, A. T. Ippen ed. McGraw Hill, New York.

Skeesick, D. G. and T. F. Gaumer. 1970. Potential hatchery sites on Oregon coastal streams. Fish Comm. Oreg. 68 pp.

Thayer, G. W. and R. C. Phillips. 1977. Importance of eelgrass beds in Puget Sound. Marine Fisheries Review. 39(11):18-22.

Thompson, K. E. and J. D. Fortune. 1968. The fish and wildlife resources of the North Coast basin, Oregon, and their water requirements. Oreg. Game Comm. 102 pp.

U. S. Geological Survey. 1977. Water resources data for Oregon, water year 1977.