Natural Resources of Coquille 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.

CONTENTS

THE COQUILLE ESTUARINE SYSTEM

Description of the Area

The Coquille estuary is in southern Coos County. The estuary is long and narrow and meanders through the Coquille valley (Fig. 1). Three cities are located on the shores of this estuary. Bandon (population about 2,000) is at the mouth, Coquille (population about 4,500) and Myrtle Point (population about 2,500) are at the upper end of the estuary. The Port of Bandon serves the lower estuary and the Port of Coquille River encompasses much of the upper estuary. The estuary has historically been the hub of agriculture, navigation, commerce, recreation, and fisheries in the Coquille valley. It has also been the principal route of waste disposal.

The Oregon Land Conservation and Development Commission (LCDC 1977a) classified the Coquille estuary as a Shallow Draft Development Estuary. It has jetties and a short section of channel which is maintained to a depth of 13 ft for navigation by the U.S. Army Corps of Engineers (USACE), Portland District. Development estuaries are managed to provide for navigation and other water-dependent uses while protecting the estuarine productivity, habitat diversity, unique features, and water quality (LCDC 1977b).

Tidal influence extends up the Coquille River for 41 miles, a tidewater distance which is exceeded only by the Columbia estuary (Table 1). The estuary's drainage basin covers 1,058 mi^2, which is the largest drainage area of an estuary arising entirely from the Oregon coastal mountains (Table 1). Because of the riverine nature of the estuary, river mile (RM) designations shown in Fig. 1 and listed by the Pacific Northwest River Basins Commission (PNRBC 1968) are used to describe locations in the estuary.

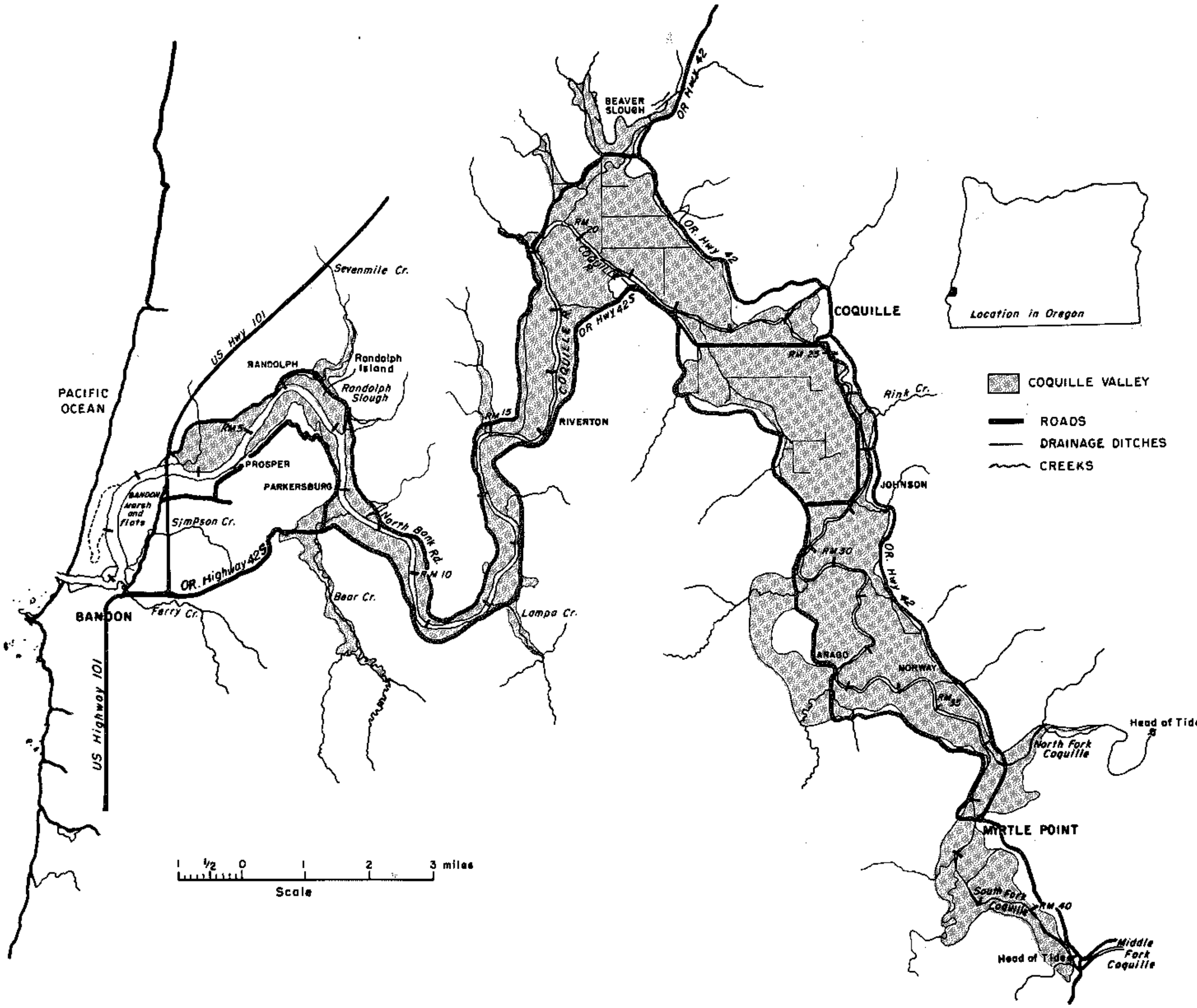


Fig. 1. Coquille estuary, valley and vicinity with river mile designations (U.S. Geological Survey [USGS] topographic maps).

Table 1. Tidal extents and drainage areas of Oregon estuaries.[a]

Estuary	Tributary	Approximate head of tide (Miles from mouth of estuary)	Drainage area (Square miles)
Columbia		144	258,000
Necanicum		3	87
Nehalem		13	847
Tillamook			540
	Kilchis	11	61
	Wilson	12	67
	Trask	15	193
	Tillamook	17	176
Netarts		7	14
Sand Lake		4.5	17
Nestucca			322
	Nestucca	8.6	259
	Little Nestucca	5.3	59
Salmon		4.3	75
Siletz			373
	Siletz	24.6	308
Yaquina		24.2	253
Alsea		15.0	474
Siuslaw		23	773
Umpqua			4,560
	Umpqua	27.1	4,560
	Smith	35	347
Coos			605
	Coos	32	415
	Millicoma	34	151
Coquille			1,058
	North Fork	41	289
	South Fork	41	598
Sixes		2.5	129
Elk		1.5	94
Rogue		4.5	5,100
Pistol		1	106
Chetco		3.5	359
Winchuck		>1	70

[a] *Head of tide from Division of State Lands (DSL) Tideland Maps, USACE Environmental Statements and Oregon Department of Fish and Wildlife (ODFW) stream surveys. Drainage area from PNRBC (1968).*

Very little research has been conducted on the Coquille estuary. Reimers et al. (1978) are conducting a study of fall chinook salmon, which is the only research to date that has involved the entire length of the estuary. Many of the conclusions in this report about the physical characteristics, habitats, and species of the Coquille are based on limited data.

Historical Changes

There is a rich pioneer history connected with white settlement of the Coquille valley and Bandon. At the turn of the century the economy of the area was booming with agriculture, logging, mining, saw mills, dairies, a woolen mill, ship yards, and fish processing plants (English and Skibinski 1973). Many early activities, particularly those involving agricultural development, were accompanied by substantial alterations of the estuary. There is no precise record of what the Coquille estuary was like prior to development, but it now is probably one of the most altered estuaries on the Oregon coast.

The main channel of the Coquille was once flanked by tidal marshes that occupied a large portion of the Coquille valley. Extensive diking and drainage of those marshes began in the mid 1800s for agricultural land reclamation. By 1870 most of the marshes were converted to farm land (English and Skibinski 1973). Presently only 373 acres of natural tidal marsh, located near Bandon, remain undiked (Akins and Jefferson 1973). This amounts to 3-4% of the marshes that historically covered between 9,000 and 12,000 acres[1]. Although Coos and Tillamook bays have also had comparable acreages of marshland removed from the estuary, both still contain a substantial amount of undiked marsh.

The Coquille jetties were among the first authorized (1881) and constructed (1903) in Oregon. They improved navigation by stabilizing and constricting the Coquille's shifting mouth (Lizarraga - Arciniega and Komar 1975). Beaver slough on the Coquille and Isthmus slough in Coos Bay were used to link transportation between the two bays. A short portage over Beaver Hill was also necessary (Fig. 2). Intra-estuary transportation provided the main passage for commerce and people between Bandon and Myrtle Point for many years. There were

[1] *Estimated from USGS 7.5 minute series topographic maps.*

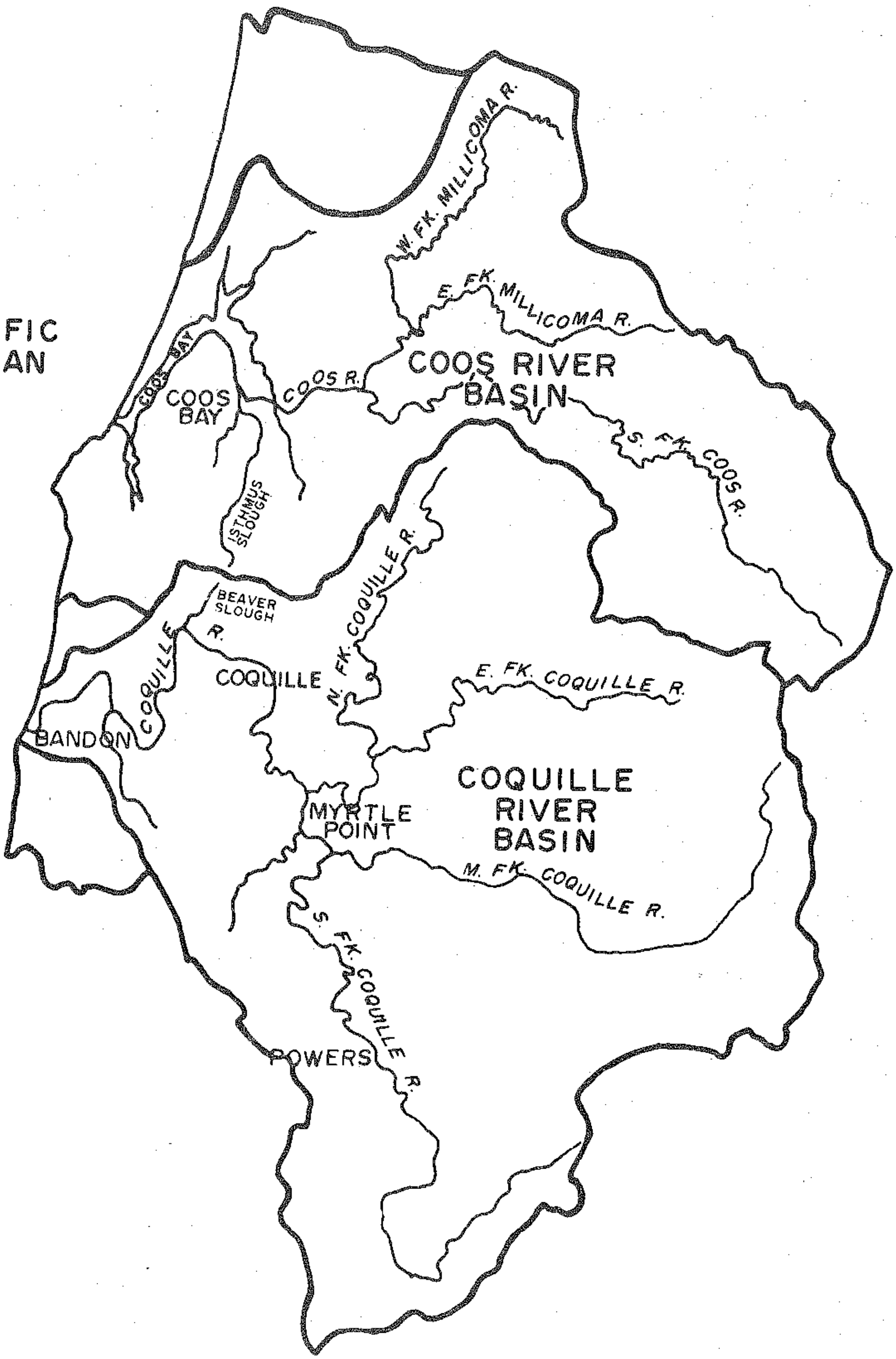


Fig. 2. Coquille River and other Coos County drainage basins (Stevens, Thompson and Runyan Inc. 1974).

several major docking points along the way. Many pilings were driven to support docks and buildings and to secure boats and log rafts. Some of the old pilings have recently been removed. Material from past dredging in the channel has filled some of the lower estuarine intertidal lands (Dicken et al. 1961).

After World War I logging and related activities in the Coquille drainage began to take on increasing economic importance. The use of splash dams to drive logs down river ruined long stretches of river habitat and carried cobble, silt, and debris into the estuary (Thompson et al. 1972). The final log drive on the Coquille was conducted in 1946 (Beckham 1974). Splash dams may have been the major cause of shoaling in the channel bed of the upper estuary and rapid sedimentation in the Bandon area marsh and flats. Lumber mills at Myrtle Point, Coquille, and Bandon still process logs from the area but several smaller mills have closed. Mill sites and lumbering involved several uses, such as dredge, fill, diked log ponds, log rafts, and docks, that changed estuarine habitats. Some alterations are being alleviated by present limitations imposed on dredging, filling, and log rafting and by declining use of the estuary for lumber transportation. Shoaling in the estuary has prevented most commercial navigation beyond Bandon. Improvements in land transportation among cities in Coos County have diverted much developmental pressure away from the estuary.

Physical Characteristics

The limited data available on the physical dimensions, tidal action, water chemistry, and sediments of the Coquille reflect typical characteristics of a long, narrow estuary having large seasonal fluctuations in freshwater inflow. An overview of the physical characteristics of the estuary is presented in this section, while more localized characteristics are described in the marine, bay, and riverine subsystem sections.

Drainage basin

The Coquille drainage system (Fig. 2) is in the geologic boundary between the Coast Range and the Klamath Range. The main stem Coquille is entirely tidal. It is formed by the confluence of the North Fork Coquille and the South Fork at RM 36.3. Middle Fork Coquille joins the South Fork at RM 41 (Fig. 2). The South Fork Coquille arises from Klamath mountains, while the North and Middle Forks are within the Coast Range. The stream beds of the North Fork and Middle Fork are sandstone similar to most other Coast Range streams. The river bottom of the South Fork, which is cobble and boulder, is substantially different. Most of the drainage basin is forest land, but much of the river shoreland is agricultural. The drainage area of the Coquille is exceeded in Oregon only by the Columbia, Rogue, and Umpqua estuaries (Table 1).

Physical dimensions

The Coquille is often referred to as a small estuary. The DSL (1973) computed surface area at mean high water (MHW) for most Oregon estuaries. The value for the Coquille was 771 acres, ranking it 12th among 17 estuaries. However, the DSL computation was based only on the lower 5 miles of the estuary that they mapped. The surface area of the estuary between RM 5 and RM 41 was approximated for this report from estimated channel widths in various sections of the riverine estuary. The additional surface area was a substantial 1,086 ± 300 acres. The Coquille, with a revised surface area of 1,857 ± 300 acres at MHW has an area that is comparable to other medium-sized estuaries like Nehalem, Siuslaw, Alsea, and Netarts.

The depth of the main channel of the Coquille estuary varies considerably. National Ocean Survey (NOS 1977) has computed the depth of the lower four river miles. Reimers et al. (1978) sounded the channel between RM 5 and RM 38. These measurements only provide general, relative depths since they were not charted or corrected for tidal level. The average depth of the main channel of the Coquille was 10-20 ft. The channel near the Bandon marsh and some sections above RM 30 average less than 10 ft in depth. Two holes more than 30 ft deep were located, one between RM 10 and RM 11 and the other near Riverton at RM 15.8 (Fig. 1).

Freshwater Inflow

Streamflow gauges on North, Middle, and South forks of the Coquille have established adequate records for predicting average and extreme freshwater inflow. Only the South Fork gauge is still operational. Median monthly flows are listed in Table 2. The pattern of fluctuation is similar to other coastal river systems receiving no snow melt during summer. Flow is usually lowest in August and September and highest during January (more than 50 times greater than summer levels). Summer flow is frequently less than 100 cubic feet per second (cfs). The Coquille channel banks are topped when flow exceeds 18,000 cfs. Flooding from the main stem occurs an average of three times a winter. Much of the Coquille valley is also inundated during winter from direct rainfall, seepage, and flooding of the 20 small tributaries of the main stem.

Table 2. Median monthly discharge (cfs) of the Coquille River at the mouth. (USACE 1975).

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	ANNUAL
330	3800	6200	7600	6800	5400	3300	1750	550	230	130	130	3,020

Tides

The only recorded tidal data on the Coquille estuary are the mean tide levels at Bandon (Table 3). There is no information on tidal hydraulics and computations of the tidal prism and flushing have been based on only the lower bay area of the estuary. ODFW stream surveys show the extent of tidal influence as 41 miles on both the North Fork and South Fork (Table 1). Percy et al. (1974) indicate the head of tide is between RM 36 and RM 40. RM 41 is used as the head of tide in this report since the area between RM 36 and RM 41 is physically similar and the highest tides during summer probably reach that point.

Table 3. Coquille tidal levels in feet relative to mean lower low water. (NOS 1977, Johnson 1972).

Location	Mean higher high water MHHW	Mean high water MHW	Mean tide level MTL	Mean low water MLW	Mean lower low water MLLW	Extreme low water ELW
Bandon	7.0	6.3	3.7	1.1	0.0	-3.0

During high river flow the tidal fluctuations in the upper estuary are probably greatly reduced. Nicholas observed that high tide during the summer in the Arago boat ramp (RM 32) occurred at approximately the predicted low tide time for Bandon. He estimated the tidal range at Arago as 4-5 ft (personal communication, November 21, 1978, with J. Nicholas, ODFW, Charleston).

Salinity and Mixing

Few measurements of salinity are available for the Coquille. Spring and summer salinity regimes (Fig. 3) have been drawn from data taken on four different days. Department of Environmental Quality (DEQ 1978) monitoring stations in the Coquille are clustered near Bandon and the City of Coquille and are of limited value for describing salinities and mixing characteristics throughout the estuary. Limited data indicate the estuary from RM 27 to the head of tide is fresh year round. Between RM 14 and RM 27 salinity was zero except during summer when slightly saline waters (less than 5 parts per thousand [ppt]) were detected.

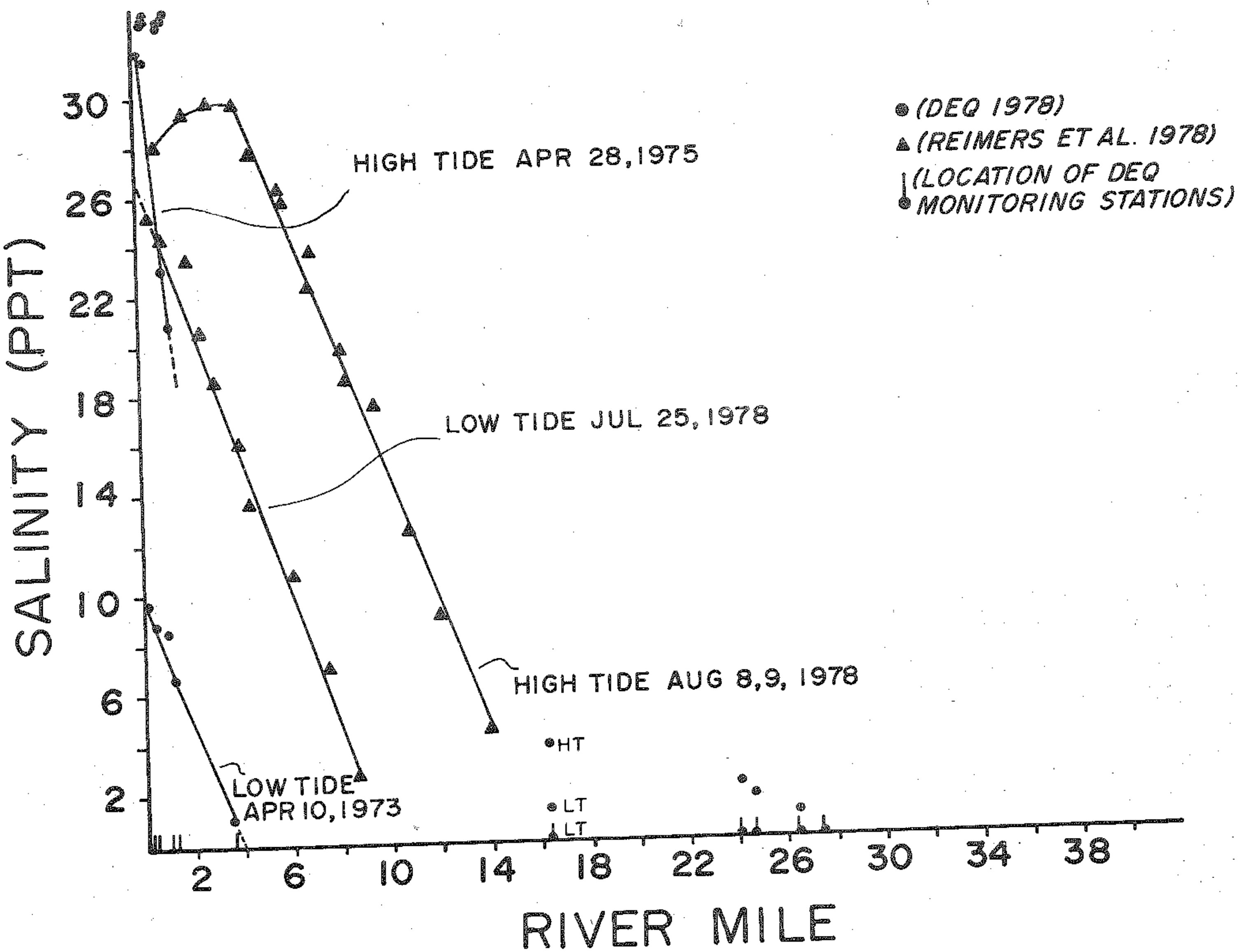


Fig. 3. Surface salinity profiles of Coquille estuary (DEQ 1978; Reimers et al. 1978).

In most Oregon estuaries the maximum extent of salinity intrusion is at or near the head of tide. However, this does not apply to the Coquille, and the difference between extent of salinity intrusion and head of tide for the Columbia is even greater. It is possible that the biological communities of the upper Coquille and Columbia estuaries display similarities that do not occur elsewhere in Oregon. Summer water temperatures in the upper tide water of these two estuaries is also similar, regularly exceeding 68 F (USGS 1977).

During summer salinity at high tide in the lower 3 to 5 river miles was uniform and above 30 ppt, while at low tide all salinity measurements were less than 30 ppt (Fig. 3). Reimers et al. (1979) measured surface and bottom salinity and temperature between RM 0 and RM 9. The difference between surface and bottom salinity was approximately 2 ppt, indicating the estuary was vertically well mixed. Their data also showed that salinity in the channel dropped linearly from 30 ppt to 5 ppt over a stretch of approximately 9 miles that varied in location with the tidal stage (Fig. 3). This is a further indication of the thorough mixing of the fresh and ocean water during the summer. At low tide no salinity values greater than 5 ppt were measured above RM 7. High tide salinities during summer were greater than 5 ppt up to about RM 14. Of the few available upstream salinity measurements, the mouth of Rink Creek (RM 26.4) is the farthest that values greater than 0 ppt have been found.

During winter and spring the freshwater flow strongly limits the intrusion of marine water. The only available measurement of salinity during higher flows is on April 10, 1973. Stream flow data indicated that freshwater flow from the three main forks was 1,500-2,500 cfs that day, a level which is lower than average mid-winter flow and normal for April (Table 2). Salinity at low tide was 9.6 ppt at the mouth, 1.0 ppt near the U.S. 101 bridge (RM 3.5), and 0.0 ppt elsewhere (DEQ 1978). Salinities at low tide during higher flow would be even lower than on April 10, 1973. Spring and winter mixing characteristics can not be established from existing data, but the estuary is likely to be stratified at that time.

Temperature

Summer temperatures in the Coquille rose linearly from cool ocean water levels to warmer riverine temperatures, which nearly coincided with the location of the drop in salinity (Reimers et al. 1978). Above RM 14 all July and August measurements (12 dates during 9 years) showed the temperature at or above 68 F. The high temperature may affect the distribution of juvenile and adult salmonids in the estuary (Reimers et al. 1978). The temperature of the upper Coquille is generally the same as or slightly cooler than the temperature of tributary water (USGS 1961-1977). An extreme temperature of 82.4 F was recorded August 9, 1978, at RM 38 (Reimers et al. 1978). Few winter temperature readings have been made. The lowest recorded water temperature was 40 F on January 11, 1977 (DEQ 1978), when freshwater flow and air temperatures were abnormally low.

Water Quality

The water quality of the Coquille is poor. High fecal coliform counts have been recorded throughout the estuary (DEQ 1978). During the summer dissolved oxygen was often significantly less than saturation in the upper estuary (DEQ 1978). Estimates of sediment loads (Table 3) are extremely high during high flows.

The lack of studies of flushing, tidal currents, and circulation in the estuary limits understanding of the dispersion and duration of pollutants in the estuary. Since the summer volume of freshwater inflow is very small compared with the apparent tidal prism in the estuary, flushing from the upper estuary is likely to require many days. For example, flushing from the upper Yaquina estuary takes 13 days during average August river flow conditions (Zimmerman 1972).

The location of pollution sources combined with flushing and circulation characteristics determines the extent of impact of pollutants on particular locations and habitats. Point sources of pollution in the Coquille are shown in Fig. 4. Estimates of waste loads in 1973 during high and low freshwater flow conditions are shown in Table 4. Urban runoff was the main source of biochemical oxygen demanding material (BOD) during high flows. Forest runoff contriubted over 7,000 tons per day of suspended solids and also was estimated to account for most of the phosphorus and nitrogen load during high flow. During low flows the major source of BOD was industrial and municipal discharge and runoff from livestock operations. Suspended solids were much lower in the summer and were primarily derived from agricultural and forest land runoff. Phosphorus input was chiefly from municipal sewage outfalls. Nitrogen sources included sewage, forests, and livestock.

Erosion may also contribute to sediment loads. Erosion of natural levees and man-made dikes occurs in many places during high flow. Erosion may be the result of naturally fast currents or may be stimulated by shifts in currents from shoreline activities upstream or at the erosion site.

Biological Characteristics

Plankton in the Coquille have not been studied. The Coquille estuary is predominantly subtidal, but there is no information available about the subtidal benthic animals or plants. Information is also lacking on benthic invertebrates in intertidal areas; however, a few observations have been recorded by Gaumer et al. (1973) and students at the University of Oregon Institute of Marine Biology (OIMB 1978). Dungeness crab (*Cancer magister*) have been found

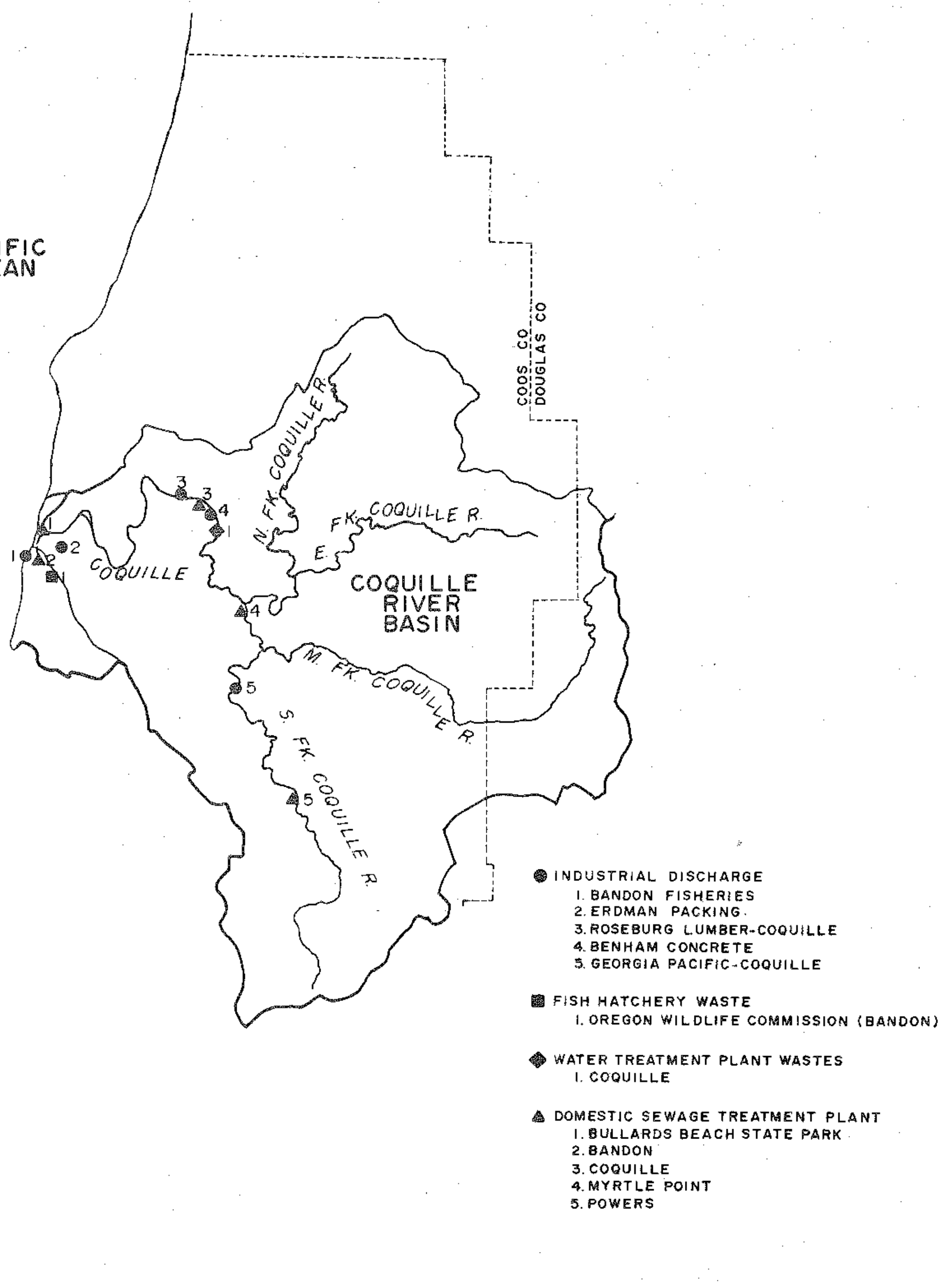


Fig. 4. Point sources of waste discharge in the Coquille drainage basins (STR 1974).

Table 4. Estimated waste loads in the Coquille River, 1973 (STR 1974).

Waste Source	BOD		Suspended solids		Phosphorus		Nitrogen	
	Low flow	High flow	Low flow	High flow	Low flow	High Flow	Low flow	High flow
	lbs/day		lbs/day		lbs/day		lbs/day	
Municipal sewage treatment facilities	181	181	184	184	127	127	164	164
Industrial discharge	520	635	489	719	3	5	43	55
Fish hatchery*	200	125	240	150	3	2	70	44
Solid waste disposal sites*	25	141	-	-	-	1	271	1,536
Water treatment facilities	-	-	93	56	-	-	-	-
Urban runoff	-	4,970	-	18,600	-	119	-	254
Forest runoff	-	-	2,520	15,340,000	20	4,100	101	20,500
Agricultural runoff	-	-	3,190	1,115,000	15	58	14	47
Livestock	390	1,560	390	1,560	32	128	110	440

Other waste sources:
1. Combined sewer overflow (high flow)
2. Dredging operations (low flow)
3. In water log storage

* *These facilities are no longer being used.*

as far upstream as Randolph Island (Fig. 1) during late summer and fall (Reimers et al. 1978).

The Coquille intertidal flats have been singled out as one of the most important bird wintering areas in Coos County. The species composition is highly diverse and includes several rare species, such as peregrine falcon, bar-tailed godwit, and Hudsonian godwit (personal communication, November 20, 1978, Alan McGie, ODFW, Charleston). Waterfowl feed in the Coquille valley during winter. Many of the ducks are believed to travel daily between Coos Bay and the valley. Harbor seals and sea lions are uncommon in the Coquille (Mate 1978).

A limited amount of information is available on the distribution of fish in the Coquille estuary. Most fish data pertain to salmonids. Commercial salmon netting declined from 1923 to the close of commercial salmon fisheries in the estuaries in 1957. McKernan et al. (1950) analyzed the declines on coastal rivers. Extensive logging activity, extreme floods, and intensive fishing effort were all statistically correlated with decreases in fish returns in the Coquille River. Low fall flows, low summer flows, and slight variations in ocean salinity did not appear to affect subsequent Coquille salmon populations. Pollution was not considered to be a limiting factor in any coastal stream.

Today the Coquille continues to support smaller but substantial runs of fall chinook and coho salmon. A remnant population of spring chinook spawn in the South Fork Coquille. Chum salmon populations are considered low, but relatively large numbers of steelhead and cutthroat trout pass through the estuary (Thompson et al. 1972). The populations are comparable with other large coastal streams.

Shad, another anadromous fish, have supported commercial and recreational fisheries in the Coquille for many years. Commercial shad fishing is restricted to the area below the Oregon 42S bridge. Shad are also fished commercially in the Coos, Umpqua, Smith (Umpqua) and Siuslaw estuaries. The shad catch has declined in each estuary (Bauer 1977); however, the fishing effort has also generally declined, and the current status of the population is unknown.

The striped bass is another potentially important game fish in the Coquille estuary. Although striped bass are generally considered anadromous, they apparently live in the Coquille throughout the year (McGie and Mullen 1979). Shad and striped bass are fished in the spring and summer. Cutthroat trout and salmon are fished during late summer and fall, and steelhead fishing takes place during winter in the riverine portion of the estuary. During summer perch and smelt fishing is popular in the lower estuary (Gaumer et al. 1973). Other species are also common in the estuary. Their general distribution and origin, shown in Table 5, is established primarily from Reimers et al. (1978).

SUBSYSTEMS OF COQUILLE ESTUARY

The Coquille estuary can be divided into three subsystems (Fig. 5). The riverine subsystem, where the river channel is the main feature and salinity is substantially lower than other subsystems, predominates. It covers more than 90% of the length of the estuary, extending from RM 3.8, where agricultural diking begins, to the head of tide. The marine subsystem includes the small area near the mouth where marine conditions are common during the summer and where currents and wave energies are strong. The bay subsystem is located between the marine and riverine subsystems. It contains most of the shallow and quiet intertidal flats and marshes of the Coquille.

Table 5. Origin and distribution of fish species of Coquille estuary (Gaumer et al. 1973; Reimers et al. 1978; Smith 1956; Thompson et al. 1972).

		Type of fish			Subsystem[a]			
Common name	Scientific name	Anadromous	Salt-water	Fresh-water	Marine	Bay	Lower riverine	Mid & Upper riverine
Pacific lamprey	*Lampetra tridentatus*	x			?	x	?	?
American shad	*Alosa sapidissima*	x			x	x	x	x
Pacific herring	*Clupea harengus pallasi*		x		x	x		
Northern anchovy	*Engraulis mordax mordax*		x		?	x	x	
Chum salmon	*Oncorhynchus keta*	x						
Coho salmon	*Oncorhynchus kisutch*	x			x	x	x	x
Chinook salmon	*Oncorhynchus tshawytscha*	x			x	x	x	x
Cutthroat trout	*Salmo clarki clarki*	x			?	?	x	x
Steelhead (rainbow) trout	*Salmo gairdneri*	x			?	x	x	x
Surf smelt	*Hypomesus pretiosus*		x		x	x	x	
Eulachon	*Thaleichthys pacificus*		x		x	?		
Pacific tomcod	*Macrogadus proximus*		x		x	x		
Tomsmelt	*Atherinops affinis*		x		x	x		
Threespine stickleback	*Gasterosteus aculeatus*		x	x	?	x	x	x
Bay pipefish	*Syngnathus griseolineatus*		x		?	x	x	
Striped bass	*Morone saxatilis*	x	x	x	?	?	x	x
Redtail surf perch	*Amphistichus rhodoterus*		x		x	x		
Shiner perch	*Cymatogaster aggregata*		x		x	x	x	
Striped sea perch	*Embiotoca lateralis*		x		x	x		
Walleye surf perch	*Hyperprosopon argenteum*		x		x	x		
Silver surf perch	*Hyperprosopon ellipticum*		x		x	x		
White sea perch	*Phanerodon furcatus*		x		x	?		
Pile perch	*Rhacochilus vacca*		x		x	x	x	
Saddleback gunnel	*Pholis ornata*		x		x	x	x	
Pacific sandlance	*Ammodytes hexapterus*		x		?	x		
Black rockfish	*Sebastes melanops*		x		x	?		
Kelp greenling	*Hexagrammos decagrammus*		x		x	?		
Rock greenling	*Hexagrammos lagocephalus*		x		x	?		
Whitespotted greenling	*Hexagrammos stelleri*		x		x	?		
Lingcod	*Ophiodon elongatus*		x		x	x		

Table 5 (continued).

Common name	Scientific name	Type of fish			Subsystem[a]			
		Anadromous	Salt-water	Fresh-water	Marine	Bay	Lower riverine	Mid & Upper riverine
Coastrange sculpin	*Cottus aleuticus*			x		x	?	?
Prickly sculpin	*Cottus asper*			x		x	x	x
Buffalo sculpin	*Enophrys bison*		x		x	x		
Pacific staghorn sculpin	*Leptocottus armatus*		x		x	x	x	x
Cabezon	*Scorpaenichthys marmoratus*		x		x	x		
Speckled sanddab	*Citharichthys stigmaeus*		x		x	x		
English sole	*Parophrys vetulus*		x		x	x	x	
Sand sole	*Psettichthys melanoctictus*		x		x	x		
Starry flounder	*Platichthys stellatus*		x		x	x	x	x
Largescale sucker	*Catostomus macrocheilus*			x			x	x
Brown bullhead	*Ictalurus nebulosus*			x				x
Bluegill	*Lepomis macrochiris*			x				x
Largemouth bass	*Micropterus salmoides*			x				x
Blackside dace	*Rhinichthys osculus*			x				x
Mosquito fish	*Gambusia affinis*			x				x

[a] *x - established occurrance*
? - suspected occurrance

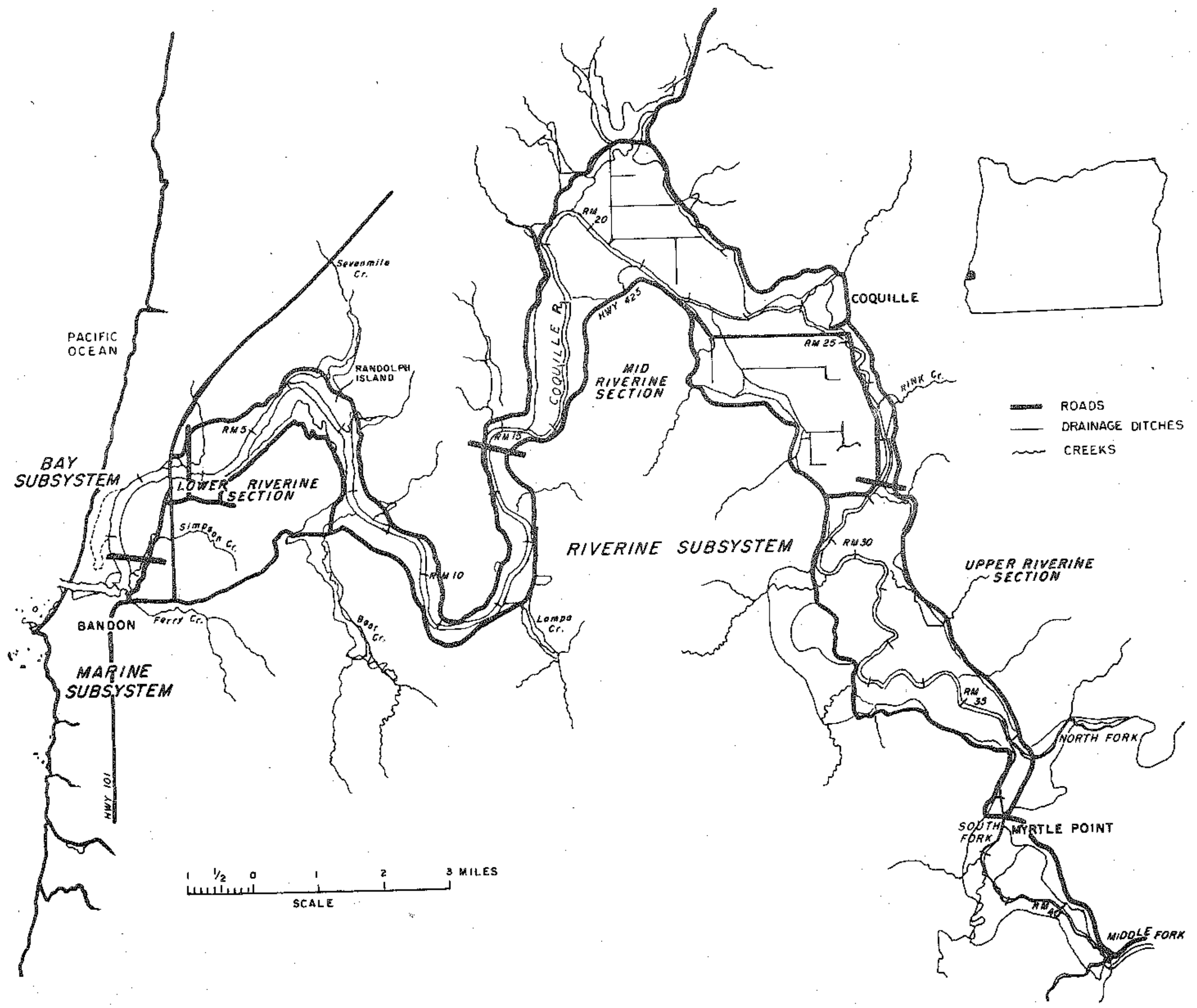


Fig. 5. Coquille estuarine subsystems.

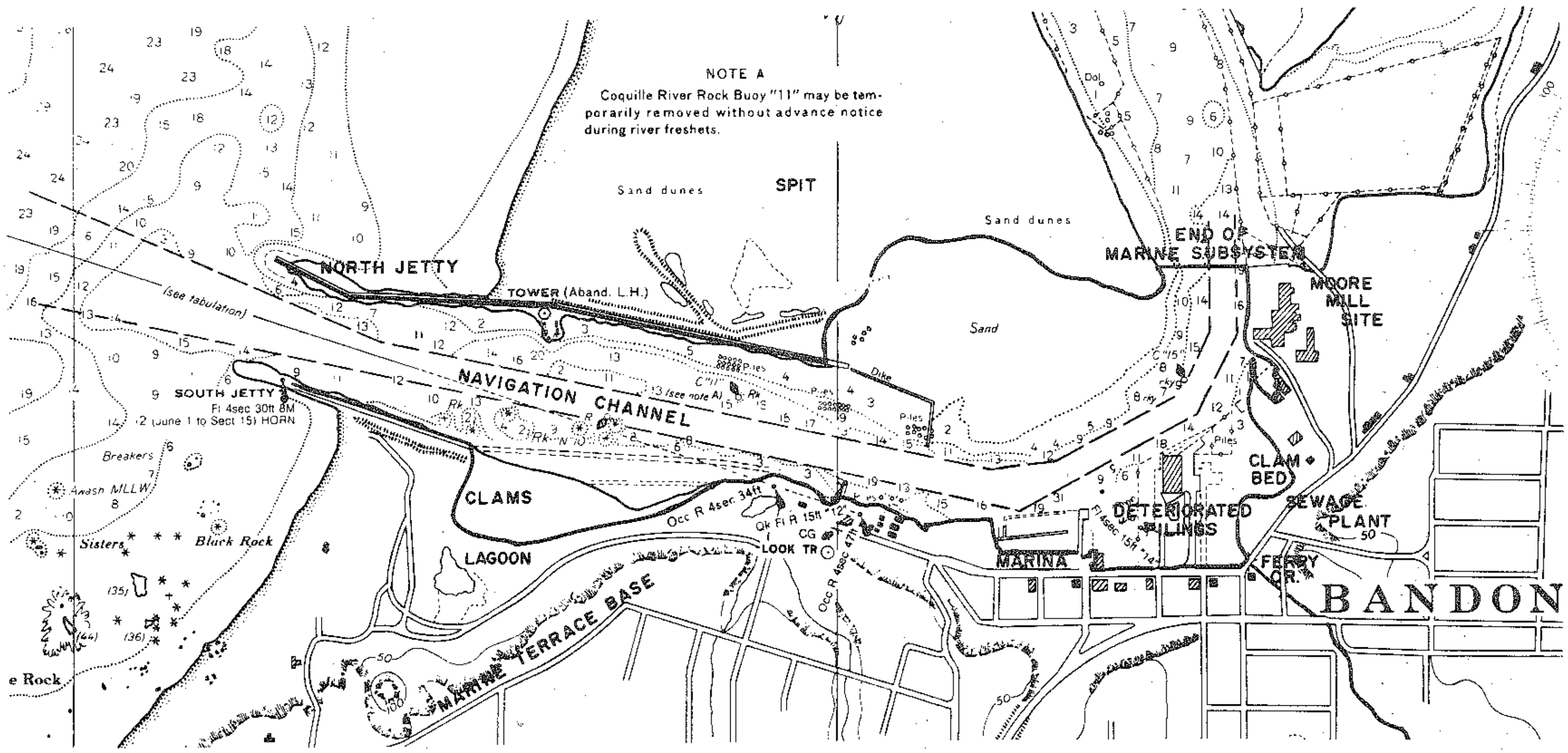
Marine Subsystem

The marine subsystem (Figs. 5 and 6) at the mouth of the Coquille is a very high energy environment. It includes the first 1.3 miles of the channel and covers approximately 145 acres or 4-7% of the estuarine surface area. The habitats of the marine subsystem are highly altered by jetties, dredging, and fill, but it remains one of the more important areas for clams, crabs, and marine and anadromous fish in the estuary.

Alterations

Between 1860 and 1880 and prior to jetty construction, the mouth of the Coquille shifted south against the marine terrace of Bandon (Fig. 6). Jetties restored the mouth to its approximate 1860 location (Lizarraga - Arciniega and Komar 1975). Dredge and fill were used to construct the Port of Bandon marina (Fig. 6) at the turn of the century. The nearby Bandon sewage treatment plant (Fig. 6) is also located on a small fill. The site of the Moore Mill (Fig. 6) at the upper end of the subsystem is the largest single fill of the estuary, covering 25.4 acres (DSL 1972). Filling with dredged material began at the site in 1913 and has gradually continued to the present. The southeastern end of the spit began to noticeably erode after 1939 (Dicken et al. 1961). The extent and location of the erosion directly across from the mill site are strong evidence that the erosion resulted from the constriction of the estuary from the mill fill. The jetties were extended inward on both sides of the channel to help control the currents, but the end of the spit still continues to erode.

The USACE (1975) maintains a 13 ft channel, which extends to the upper end of this subsystem. They annually dredge 4,000-100,000 yd^3 of material, which is taken to an offshore disposal site. Many water-dependent industries were once located on pilings over the flats and shores of the Bandon water front,



LEGEND
SOUNDINGS IN FEET
SCALE 1:10,000

Fig. 6. Marine subsystem, Coquille estuary (NOS 1977).

but only Bandon Fisheries remains active. Deteriorated pilings and wharfs cover much of the flat.

The entire marine subsystem is closed to commercial shellfish harvest by the State Health Division because of the proximity of the Bandon sewage treatment outfall and the marina (Osis and Demory 1976). The Bandon treatment plant discharges treated sewage and Bandon Fisheries discharges waste directly onto the adjacent flats. Nearby marina sediments were chemically analyzed and found to contain excessive amounts of volatile solids, sulfides, oil, and grease (Slotta and Noble 1977).

Physical Characteristics

Northwestern storms bring ocean waves into the marine subsystem that can sometimes cause rough conditions as far upstream as the small boat basin (USACE 1975). Shoaling around the north jetty is common in the summer. Salinity and temperature data show that this region has the strongest ocean influence in the estuary. Yet, as previously discussed, normal winter river flows significantly reduce salinity even at the mouth. The subsystem probably becomes stratified in winter with a freshwater surface layer and saline water near the bottom. One small tributary, Ferry Creek, discharges directly into the marine subsystem. Ferry Creek is channelized through Bandon, and an ODFW fish hatchery is located upstream but is no longer used.

Subtidal habitats and species

The marine subsystem is roughly 60% subtidal (Table 6). Most of the subtidal habitat is located in the channel, but a small section is located in the more protected boat basin (Fig. 7). The USACE (1975) described the substrate of the channel as riverborne fine sands which overlay sedimentary bedrock that is periodically exposed by dredging and high currents. Small rock outcrops between the jetties are also shown in Fig. 6. The rock outcrops are not shown on the habitat map (Fig. 7) due to limitations of scale. No information was available regarding vegetation in the subtidal habitats.

Table 6. Habitat distribution in the Coquille marine and bay subsystems (estimated from ODFW 1978).

	Approximate acreage	
Habitat type	Marine subsystem	Bay subsystem
Subtidal	85	235
Intertidal	60	495
Shores	2	20
Flats	48	80
Aquatic beds	10	45
Tidal marsh	0	320
Total	145	730

The only information on fauna of the subtidal habitats relates to fish and crabs. The data suggest the species of fish in the marine and bay subsystems during summer are nearly identical (Table 5). The marine subsystem provides more rocky habitat than the bay subsystem and may be more important to rockfish, rock greenling, cabezon, and other species that prefer rocky areas. Gaumer et al. (1973) and Reimers et al. (1978) found that surf smelt were the most numerous species seined or fished in the marine subsystem during summer. They were caught primarily near shore and at the boat basin. Dungeness crabs (*Cancer magister*) and red rock crabs (*Cancer productus*) are caught in the channel during summer (Gaumer et al. 1973).

Intertidal Habitats and Species

Intertidal habitats comprise about 40% of the marine subsystem (Table 6). The habitat types include three small flats with differing substrates and algal beds and the boulder shores of the jetties and riprapped waterfront.

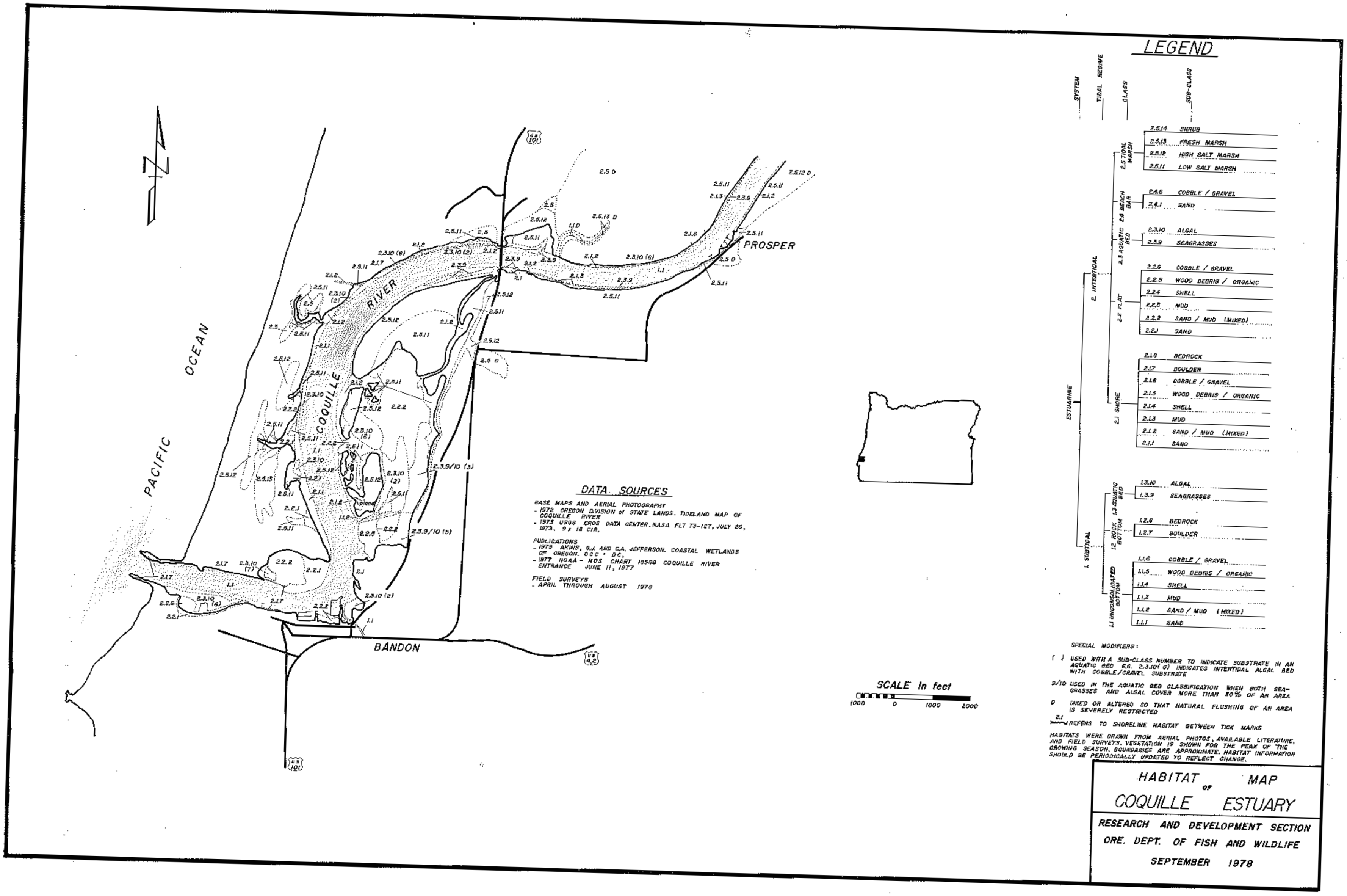


Fig. 7. Habitat map of the Coquille estuary (ODFW 1978).

Flats are located along the south jetty, the Bandon waterfront and the base of the north jetty, where the flat was created by erosion of the spit (Fig. 7). Each of these flats contains an algal bed.

The south jetty flat has a cobble/gravel substrate, except the landward edge which is sand (Fig. 7). Over half of the flat is a bed of macroalgae attached to the cobbles. Softshell clams (*Mya arenaria*) occur in this flat, but their density has not been determined.

The Bandon waterfront flat is divided by a rock road dike. East of the road dike, the substrate is a mixture of sand and mud. A large section is an algal bed (Fig. 7) containing a seasonally dense mat of microalgae. This is the location of the sewage plant outfall as well as the most popular area for digging softshell clams in the estuary (Gaumer et al. 1973). West of the road dike, the substrate is also primarily mixed sand and mud (Fig. 7). Some of the scattered logs and rocks are covered with algae. The OIMB (1978) conducted a cursory survey of the flora and fauna of the Bandon flat. The primary species of algae were *Fucus*, *Ulva*, and *Enteromorpha*. Two phytoplankton samples were dominated by *Coscinodiscus* and *Chaetoceros* spp. (OIMB 1978). Observations of benthic invertebrates included various species of worms, isopods, and amphipods; a few holes of softshell clams and shrimp; and Dungeness crab. Two zooplankton samples mostly contained barnacle nauplii, copepods, and largal polychaete worms (OIMB 1978).

The north jetty flat has a substrate which varies from predominantly sand to mixed sand and mud (Fig. 7). A pile of boulders on the flat provides a base for an algal bed (Fig. 7). Clams have not been found on this flat. Reimers et al. (1978) seined at this site and found many juvenile fish. Although surf smelt were the predominant fish species, there were numerous juvenile chinook salmon from June through November, when seining was terminated. Juvenile coho salmon were caught there in the spring, and several species of juvenile flat fish were common. In mid September many juvenile shad were caught at the north jetty flat. Shad continued to be caught in fewer numbers throughout the fall (Reimers et al. 1978).

Another significant intertidal habitat is the boulder shore along the jetty. Like other Oregon jetties, this habitat is densely inhabited by mussels and many common rocky intertidal plants and animals. No specific analysis has been made of the Coquille jetty communities.

The rocky intertidal habitats in the marine subsystem are important feeding and resting sites for wintering turnstones, willets, surf birds, oyster catchers, and other species of shore birds.

Management Recommendations

The marine subsystem is the main location of water-dependent activities requiring jetties and navigational improvements. Commercial and recreational fishing boats are the primary users, while barge traffic from two mills is infrequent. Although fishing and pleasure boats generally do not require channel depths greater than the present 13 ft depth, they sometimes encounter difficulties crossing the bar. The Port of Bandon desires to remedy the rough condition of the bar, but present proposals are not now economically justified (USACE 1975). If the need for improvements is reevaluated, alternatives to deepening the channel, such as sand by-pass and wave dissipation facilities, should be considered to minimize the detrimental impacts on marine subsystem habitats.

Water-dependent development near Bandon should be planned for vessels that do not require channel depths greater than 13 feet. There is little demand for new water-dependent commerical or industrial development unrelated to fishing or recreational boating. Fewer water-dependent developments are located on the estuary than in the past. Yet if additional barge traffic is a goal of the

Port of Bandon and the City of Bandon, shoreland and estuarine land use in the area between the south jetty flat and the Moore Mill site (Fig. 6) should be regulated to preserve its potential for future water-dependent development. Development should be directed to this area to make the best use of the existing navigation improvements and to limit alteration of presently undeveloped areas. New development on pilings, where deteriorated pilings now stand, would be preferable to locating new barge facilities farther up the estuary.

Intertidal areas on the Coquille have been drastically reduced by diking for agricultural land reclamation upstream and fills in the marine and bay subsystems. Remaining intertidal area should not be further reduced or altered by dredging or fill in order to maintain a diversity of habitats and the integrity of the ecosystem. The north and south jetty flats should be protected. The comprehensive plan requirements of the Estuarine Resources Goal (LCDC 1977b) requires protection and preservation of most intertidal lands. Intertidal fill or dredging at the waterfront would require mitigation by restoring some part of the estuary, preferably the same type of habitat. There are few, if any, areas in the marine subsystem where similar new habitat could be created. If development is permitted in the marine subsystem, removal of dredged spoils from the nearby marsh and flat in the bay subsystem is potential mitigation which could help to offset the loss of intertidal area in the marine subsystem.

Expansion of small boat moorage facilities is an issue on the Coquille. The Port of Bandon would like to increase the capacity of the present boat basin by dredging the adjacent tidal flat. There are potential moorage sites upstream that would not require dredging intertidal habitats. If the boats using the proposed moorage do not require a depth greater than the existing upstream channel (about 8 ft), such sites should be considered. Marinas are common along the upper Siuslaw estuary channel. Improved or expanded storage space on land and launching facilities at the marina would also be preferable to the destruction of tidelands.

Some recommendations for enhancement and protection of the marine habitats in the Coquille estuary should be considered:

1. Waste outfalls should be relocated to the ocean or to the subtidal channel. During summer, discharge should be restricted to periods of outgoing tides. This would enhance flushing of pollutants from the estuary and avoid or reduce their concentration in intertidal sediments.
2. Unused dilapidated pilings with superstructures should be removed to allow greater light penetration on the flat, thereby increasing its primary productivity.
3. Special precautionary measures (timing, containment, etc.) should be required to minimize dispersal of polluted sediment from dredging or disturbance (e. g. piling removal) that could contaminate flats and clambeds. If the alteration is part of an overall enhancement project, the effects of temporary pollution should be balanced against long term benefits.
4. The major rock outcrops outside of the navigation channel (Fig. 6) should be preserved as valuable fish habitat.

Bay Subsystem

On the basis of physical configuration, the bay subsystem of the Coquille can be designated as the broad area between RM 1.3 and RM 3.8 (Fig. 5) where diked marshes begin. The bay subsystem contains large intertidal areas on both sides of the channel. Approximately 730 acres (Table 6) or 30-40% of the estuarine area is contained in this short, 2.5 mile section.

Alterations

The bay subsystem has experienced relatively few direct alterations, but past activities in the upper estuary and watershed have accelerated changes in the bay subsystem intertidal habitats. Direct alterations include several pilings and a pile dike along each side of the channel at the lower end of the subsystem; log storage along the channel and, until recently, on the flat adjacent to Moore Mill; riprap along a half mile of the north shore; a boat ramp at Bullards Beach State Park; fills at the U.S. 101 bridge and the mill site upstream from the bridge; and three dredge spoil islands along the channel on the southern side created prior to 1939 (Dicken et al. 1961).

The Bandon marsh and flat is the largest contiguous intertidal area on the Coquille. It covers roughly 350 acres. Johannessen (Dicken et al. 1961) studied marsh expansion at this site. According to Johannessen, in the last century this entire area was a tidal flat except for a marsh fringe bordering the upland. He estimated from navigation charts and 1939 aerial photographs that the marsh expanded onto the north end of the flat at a rate of 70 ft/yr between 1895 and 1939. From 1939 to 1961 marsh expansion slowed to 4-5 ft/yr. Johannessen attributed the rapid marsh expansion to sedimentation induced by the large scale environmental changes following white settlement.

Physical Characteristics

The bay subsystem probably experiences the lowest tidal and river currents in the estuary. Although no measurements are available, the marine and riverine subsystem are both narrow and largely confined to the channel, while the bay subsystem immediately broadens, dissipating ebb and flood currents. Slower currents enable suspended particles to settle. The channel in the bay subsystem has an average depth of 8-10 ft, significantly shallower than the adjacent marine and riverine channel segment (NOS 1977). As previously described, summer temperature and salinity in the bay subsystem resembled ocean conditions at high tide, while low tide was accompanied by higher temperatures and lower salinities (Fig. 3). During winter and spring, salinity is greatly reduced by high river flows. The river and ocean water are probably stratified at that time. Temperature and salinity have not been measured on the Bandon marsh and flat. Discharges from Simpson and Spring creeks may influence summer salinities on the marsh and flat.

Subtidal habitats and species

Only one-third of the bay subsystem is subtidal. Subtidal areas include the main channel and two small marsh channels (Fig. 7). The substrate of the main channel has not been surveyed. The old spoil islands suggest it is mainly sand. The marsh channels were a mixture of sand and mud. During the summer numerous species of ocean fish utilize the bay subsystem (Table 5), particularly the subtidal habitat.

The presence of a few gaper clams (*Tresus capax*) in the bay intertidal flats (Gaumer et al. 1973) is a strong indication that subtidal clam beds containing gaper clams, some butter (*Saxidomus giganteus*) and little neck clams (*Protothaca staminea*) are located in the channel (conversation, December 18, 1978 with Thomas F. Gaumer, ODFW, Newport).

Intertidal Habitats and Species

There are about 500 acres of intertidal habitats in the bay subsystem. They are characterized by a variety of sediments and vegetation. Nearly two-thirds of the intertidal habitats are marsh; the remainder consists of flats, aquatic beds, and shores (Table 6). The habitats are located at the Bandon marsh and flat and along the spit and north shore (Fig. 7).

The Bandon marsh contains about half high marsh and half low marsh. The low marsh is one of the largest of its type in Oregon (Akins and Jefferson 1973). Frenkel et al. (1978) analyzed marsh plant zonation in Oregon and Washington and selected the Bandon marsh as a study site. The gradation of plants from flat to low marsh, high marsh, and upland species was less distinct at this site than at other northwest marshes. They also found some characterstic freshwater species (e.g. *Scirpus americanus, Lilaeopsis oscidentalis* and *Scirpus cernuus*), indicating there was substantial freshwater seepage into the marsh. The marsh was once grazed by cattle but little evidence of grazing remains (Frenkel et al. 1978). The marsh now is largely undisturbed, except by piles of logs at the high water line.

About one-third of the Bandon flat is seasonally vegetated with an algal mat (Fig. 7). Half of the algal bed also contains a moderate growth of the seagrass *Ruppia maritima*. The substrate of the flat and aquatic bed is a mixed sand and mud (Fig. 7), which grades to a muddier composition from north to south. The southern tip of the flat was a log storage site until recently. Its substrate is densely impacted with wood debris (Fig. 7). The northwestern section is the main location of softshell clams on this flat. The Fish Commission of Oregon (1964) reported low softshell populations in the Bandon flat due to adverse growth and survival conditions, especially the high elevation and resulting excessive exposure of the flat. The middle of the flat is densely covered with shrimp holes. The flat containing wood debris has few shrimp holes but many tube holes of smaller benthic invertebrates.

Neither fish nor invertebrates have been systematically surveyed on the Bandon flat or marsh. However, it is likely to be one of the most important intertidal areas producing organic matter and nutrients, providing habitat for fish and wildlife, moderating currents, and regulating water temperature.

There are about 20 acres of intertidal shore within the bay subsystem. The shore between the Bandon marsh and the main river channel is primarily mixed sand and mud. Two eelgrass beds (*Zostera marina*) are located there (Fig. 7). The southern shore of the channel near the U.S. 101 bridge (Fig. 7) is muddier than the other areas and may be polluted from mill wastes or wood debris from log storage (NOS 1977). Softshell clams and some gaper clams occur along the southern shore (Gaumer et al. 1973). The bay subsystem of the Coquille is open to commercial shellfish harvest between its lower boundary and 3,000 ft below the U.S. 101 Bridge (Osis and Demory 1976). A limited number of softshell clams have been commercially harvested there (Smith 1956).

Reimers et al. (1978) found the northern shore of the channel, the shore along the Bandon marsh, and spit shores were heavily used by shiner perch and juvenile chinook salmon during the summer. The lower intertidal zone of the shores along the spit have a sand substrate, while the upper intertidal zone is a mixture of sand and silt with occasional algal mats (Fig. 7). Upstream along the spit, the shore substrate included a narrow zone of exposed clay sandwiched between sand (Fig. 7). The northern shore contains three habitat zones: algae-covered sand and mud in the lower intertidal area, unvegetated sand and mud substrate, and algae attached to cobble derived from adjacent riprap (Fig. 7).

The sand spit contains a number of drainage channels, small flats, and marshes. The spit also exhibits freshwater characteristics. The largest marsh at the southern end is a freshwater plant community (*Carex obnupta*) and may more appropriately be considered a dune deflation plain wetland. Other stretches of marsh include salt-tolerant species common to Oregon marshes such as salt grass (*Distichlis spicata*), pickleweed (*Salicornia virginica*), and

Pacific silverweed (*Potentilla pacifica*). The narrow marshes on the northern part of the spit are not densely vegetated. Sand mounds raise the elevation, breaking up the marsh. Drift logs densely cover nearly the entire surface of some areas, and off-road vehicle tracks have destroyed vegetation on the low sand marshes not covered by logs. These factors made precise habitat mapping difficult.

The flats associated with the spit (Fig. 7) are fine grained sand. Isolated pockets of softshell clams were located on the flats. In general, the Coquille sand spit provides a diversity of important intertidal and dune habitats.

Two other marshes, separated by U.S. 101, are located on the northern bank of the bay (Fig. 7). The downstream marsh is nearly obliterated by stacks of drift logs. Occasional marsh plants growing between the logs indicate the area would be marsh if the logs were not there. The other marsh upstream from the bridge also contains a small flat with algae and eelgrass. It is a combination of low and high marsh and is partly covered with logs (Fig. 7) and contained by the bridge fill and an agricultural dike.

Management Recommendations

The bay subsystem contains the majority of the intertidal habitat of the Coquille. The Bandon marsh and flats should be considered major tracts and protected accordingly (Estuarine Resources Goal [LCDC 1978b]). The large scale alteration of intertidal marshes in the Coquille valley has greatly reduced the diversity and size of productive intertidal estuarine habitats in the Coquille. The retention and possible enhancement of intertidal habitats in the bay subsystem are essential for protecting the productivity of the estuarine ecosystem. Dredging and filling bay intertidal habitats should be prohibited. Restoration of altered sites should be considered, which would include removing the three spoil islands, removing drift logs from marshland on the spit and near the U.S. 101 bridge, removing unused pilings along the channel, and protecting the spit habitats from damage by motor vehicles. The flat adjacent to Moore Mill (Fig. 7) appears productive for algae, eelgrass and invertebrates, yet the removal of impacted wood debris from the sediment may improve its primary and secondary productivity. An experimental plot should be established to test the effects and feasibility of debris removal.

There are only two shoreland areas in the bay subsystem close to deep water and suitable for limited water-dependent development. The old Bullards dock site, northwest of the U.S. 101 bridge, would require renovation but would be acceptable for uses that would not require dredge or fill. The mill site southeast of the U.S. 101 bridge is suitable for development of water-dependent activities compatible with the depths of the bay channel.

An extension of channel dredging into the bay subsystem will probably never be economically justifiable because of the lack of barge traffic. The channel in the bay subsystem has not been dredged for more than 30 years, and the present depth is probably stable. The minimum depth of 8 ft is sufficient for many recreational and commerical, shallow draft vessels. Deepening the channel could result in a variety of potentially detrimental impacts on habitats, water quality, and circulation, which are described by Schroeder et al. (1977). This impact analysis should be applied to any planning or proposal for deepening the navigation channel of the Coquille. Preliminary baseline research should be required prior to dredging to predict the impacts on clam beds, fish habitat, productivity, circulation, mixing, sediment, and erosion.

Riverine Subsystem

The riverine subsystem extends nearly the length of the estuary from RM 3.8 to the head of tide at RM 41. The subsystem is divided into lower

(RM 3.8-14), mid (RM 14-27.5), and upper (RM 27.5-41) sections based on differences in habitat and salinity.

Alterations

Agricultural diking and drainage

The conversion of marsh to farmland in the Coquille valley covers the entire length of the riverine subsystem. The valley is narrowest in the lower riverine section; and the marshes, including Randolph Island, were continuously diked to create agricultural land. Most of the valley in this area was probably high salt marsh prior to diking. The valley is broadest in the mid-riverine section. The farmland probably originated from high salt marsh, fresh marsh, and shrub wetland under tidal influence. Diking is less extensive in the mid section since natural levees existed along much of the shore. In the upper section over half of the valley is above the 20 ft contour (USGS topographic maps) and isolated from tidal influence, but part of the upper section also was probably fresh marsh or shrub wetland.

All of the original marshes probably had a soil elevation higher than MHW. Since diking, many of these farmlands have subsided, in places to elevations lower than the present channel bed (Beaulieu and Hughes 1975). Mitchell (1978) lists four major factors that contribute to subsidence of diked marshes:

1. The oxidation of organic matter, which had remained undecomposed or partially decomposed in the marsh before drainage;
2. The loss of the buoyant force of water on the substrate after drainage;
3. Physical compaction by equipment and livestock on the drained land;
4. Shrinkage and settling of the substrate particles due to dessication.

As a result of subsidence, dikes and tidegates must be adequately maintained in many areas to prevent permanent flooding. Although they have kept summer high tides from flooding the valley, winter freshwater flow often floods the entire valley. The small tributaries behind the dikes flood as well. Winter flood waters remain on the subsided lands until the groundwater level drops in late spring or early summer. Drainage is inhibited by the dikes and the capacity of the tidegates as well as the subsidence. The natural marsh system probably drained more quickly but flooded at a lower river discharge.

There are approximately 80 miles of creeks and drainage channels in the Coquille valley (USGS topographic maps). Most minor marsh channels were filled or diked at the mouth. Some larger channels were also filled and replaced by straight drainage ditches. The length of natural tidal channels probably far exceeded 80 miles. Tides are now restricted to the main Coquille, North Fork, South Fork, and Bear Creek. The marsh drainages which are now cut off by dikes and tidegates would have represented a significant portion of the tidal prism. Tidal range and currents in the riverine subsystem are almost certainly more extreme now than when they were moderated by flow through the marshes. The old marsh channels may have also influenced water quality and temperature in the estuary.

The diked valley now has little productive input to the estuary. Only about 80 acres of the thousands of acres of diked marsh have reverted to salt marsh due to the lack of dike maintenance. That acreage is located upstream from Prosper (Fig. 7). In many places the diked land is dominated by wetland plants rather than pasture grasses or crops due to freshwater seepage and low pasture elevations. Those wetlands, though no longer estuarine, are important habitat for birds and other animals. In the winter the flooded valley combined with Coos estuary provides one of the largest migratory waterfowl habitats on the Oregon coast.

Other Alterations

In the lower riverine section other alterations are concentrated at Prosper (RM 4.5), Randolph (RM 6), and Parkersberg (RM 8) (Fig. 5). Many of the pilings, wharfs, and boat slips in these areas are infrequently used. Several developments include small fills. The Randolph area is altered to the greatest extent. A public boat ramp is located at the lower end of Randolph Island. Randolph Slough is bordered by the heavily riprapped North Bank Road. Several deteriorated bridges cross the slough, and one to the upper end of Randolph Island was recently converted to a road dike apparently without a permit. The dike has cut off the flow through the slough.

Alterations in the mid section are concentrated at Riverton and Coquille (Fig. 5). A boat ramp, pilings, and unused ferry facilities are located at Riverton. At the City of Coquille, the Georgia Pacific mill uses the estuary channel for temporary storage and transport of logs that are being processed. Waste water is discharged near the city from two industrial and two city treatment plants (Fig. 4). Other alterations at Coquille include a boat ramp and the Highway 42S bridge.

In the upper riverine section, non-agricultural alterations include a boat launch at Arago (RM 33), the bridge at Myrtle Point (RM 37.5), a few pilings, and municipal waste discharge. Although historic depths are not available, the channel in the upper riverine section was formerly deep enough to permit the transport of dairy and other products at all tide levels (phone conversation April 6, 1979, J. Howe, Port of Coquille River). The present shoals probably resulted from past logging practices.

Physical Characteristics

The lower section of the riverine subsystem has a wide channel with one large island (Randolph Island) and five small islands. Depths average 10-20 feet.

Deeper stretches (up to 52 ft deep) occur at RM 5.5 and between RM 10 and RM 11 (Reimers et al. 1978). During summer the lower section experiences a wide range of salinity.

In the mid section the channel narrows and averages 10-15 ft deep. One hole more than 60 ft deep is located at RM 16. Salinity is less than 5 ppt in the summer.

The upper section is narrow and shallow. Reimers et al. (1978) found several areas less than 6 ft deep in the summer and no areas deeper than 20 ft. The water in this section is fresh throughout the year. Water quality in the riverine subsystem is often poor during summer.

Subtidal Habitats and Species

As a result of diking, most of the riverine habitat is subtidal. Only the lower 2 miles of the riverine subsystem (Fig. 7) habitats have been mapped. The substrate of the riverine subtidal habitats has not been sampled, although it is known to contain sinker logs and other wood debris in the lower and mid sections and cobble in the shallow areas of the upper section. Algal blooms are common in the summer when water temperature is high and flushing is slow (STR 1974).

Reimers et al. (1978) found 18 species of fish in the lower section of the subsystem, including anadromous, saltwater, and freshwater species (Table 5). Shiner perch and juvenile chinook salmon were most abundant. They also caught shrimp (*Crangon* sp.) and dungeness crab in the lower riverine portion.

The mid and upper sections contain at least 16 species of fish. Most of them are anadromous or freshwater species (Table 5). Juvenile chinook salmon were most abundant in the spring and summer, and juvenile shad were most abundant in late summer (Reimers et al. 1978). Reimers et al. (1978) found shrimp (*Mysid* sp.) in the mid section and Asian freshwater clams (*Corbicula fluminea*) in the upper section.

Intertidal Habitats and Species

Most of the riverine intertidal habitats are located in the lower section where the shore is broad. The lower intertidal area includes a fringing growth of eelgrass as far upstream as Randolph Island. The shores have a mud substrate except where dikes and riprap have added cobble. In many areas there is a fringe of marsh between the shore and the dikes. Randloph Slough is largely intertidal. A softshell clam bed was found there near Sevenmile Creek (Fig. 5), further upstream than they were previously known to occur.

Although general benthic surveys have not been conducted, Reimers et al. (1978) observed dense beds of the tube-dwelling invertebrate *Corophium brevis* near Randolph and the mouth of Bear Creek. The location and density of the beds appeared to vary during the summer. *Corophium* sp. are important in the diet of juvenile salmonids.

The lower riverine shores appear to be important fish rearing areas (Reimers et al. 1978). Intertidal shores in the mid riverine section are generally narrow and tree lined with mud, wood debris, and gravel substrate. Some tree roots are directly exposed to the water. Branches extend low over much of the shore. In a few locations the shore is a cut bank or dike devoid of riparian vegetation. The shores of the upper section are predominantly cut banks. The banks are high, and erosion often causes tall shoreline trees to topple into the channel (Montagne - Bierly Associates, Inc. 1978).

Management Recommendations

Development in the riverine subsystem is limited by annual flooding and the steep topography of the adjacent upland. Historic water-dependent development sites provide a few appropriate locations for renewed or expanded development. Prosper, Randolph, and Parkersburg in the lower section have some potential for moorages or other water-dependent development. However, the intertidal eelgrass, shore and fringe marsh of the lower section appear important estuarine areas for primary production, benthic invertebrates, and fish rearing. These broad shores should not be extensively dredged or filled. Instead, development should be constructed on pilings to provide use of the channel while maintaining the intertidal habitats. The amount of piling and wharf should be minimized to allow as much light penetration as possible.

Riverton and the northern side of the estuary from Coquille to Johnson are the most suited sites for possible water-dependent development in the mid section. The intertidal habitats of that section are narrow. Development should avoid adverse impacts on water quality, hydraulics, bank stability, and riparian vegetation. In this way shore habitats will probably be adequately protected. In the upper riverine section the type of water-dependent activity is restricted by shallow channel depths, but the development concerns are the same as in the mid section.

A comprehensive stream corridor management program is currently being developed for the Coquille. That program should identify erosive areas and causes and rates of erosion at individual sites. It should also recommend land management practices which will avoid shifting erosive forces downstream, protect riparian vegetation, and avoid massive, expensive structural protection of the riverine shores.

Dredging of the upper riverine section has been recommended by the Port of Coquille River for many years. Such a project may not be economically feasible. Without further information about the physical and biological characteristics of the riverine subsystem, the environmental impacts would be difficult to assess. If sedimentation in the upper river section was the result of outdated logging practices, a single dredging project may provide long term benefits with only a short-term disturbance of the estuary. However, if deepening the channel would require regular maintenance due to continual sedimentation, chronic effects could include destruction of benthic communities, excessive suspended sediments, and release of pollutants, which could harm fish populations. The impact of channel dredging on tidal hydraulics could also be significant. As recommended for the bay subsystem, any plan for dredging should require enough preliminary research to adequately assess the potential physical and biological consequences outlined by Schroeder et al. (1977).

During summer the flushing time through the riverine subsystem is likely to require many days, allowing pollutants to accumulate in the system. The regular occurrence of algal blooms during the summer may indicate the riverine subsystem is currently overloaded with nutrients. Algal blooms can deplete oxygen from the water, killing fish or excluding them from the area. The riverine subsystem should be more adequately monitored during summer to determine the severity of the problem and whether stronger waste discharge control measures are required.

Planning should encourage the removal of unused pilings and floating and sunken wood debris to enhance the visual quality and improve boating and fishing conditions. Removal could cause a temporary increase in turbidity and therefore should be conducted during high flow when flushing is adequate. Although non-native species such as brown bullhead, largemouth bass, and bluegill, which are not abundant, might suffer from loss of habitat due to removal of pilings and debris, the impact on the fisheries for shad, striped bass, cutthroat and steelhead trout, and salmon should be beneficial.

The dike across Randolph Slough appears to be causing extensive sedimentation of silt and organics in the slough. It should be removed and restored to a bridge to permit tidal currents to flow around the island.

Although thousands of acres of marsh were converted to agricultural land, few diked areas provide much potential for restoration. Areas which have potential for restoration should be identified and protected from changes which would inhibit restoration (e.g. filling of old channels). The comprehensive plan should protect the marsh at Prosper (Fig. 7) from reconversion to pasture. Randolph Island, the mouth of Bear Creek, and other areas, especially in the lower riverine section, may have some potential for restoration, but the economic value of the areas for agriculture may preclude their restoration for many years.

SUMMARY AND RESEARCH RECOMMENDATIONS

The Coquille estuary is long and narrow. It encompasses the largest watershed in Oregon that is entirely coastal. Agricultural diking of tidal marshes in the Coquille valley has greatly reduced the estuarine area. Logging in the watershed has contributed to the formation of shoals in the channel and rapid sedimentation of remaining tidelands. Shipping, which was once thriving, is now confined to the lower end of the estuary near Bandon.

Estuarine habitats can be grouped into a marine, a bay and a riverine subsystem. The small marine subsystem near the mouth has been extensively developed for navigation, yet it provides habitat for many marine and anadromous fish during summer. The bay subsystem is short but contains all of the major intertidal tracts in the estuary. This area is highly productive and less disturbed by development than the other subsystems. The riverine subsystem encompasses all but the lower 3.8 miles of the estuary. Dikes and tidegates have confined habitats in the subsystem to the channel and shore. The lower, mid, and upper sections of the riverine subsystem display physical and biological differences resulting from varying salinity regimes and valley formations. The long riverine subsystem is used by anadromous salmonids, shad, striped bass and several species of freshwater fish not commonly found in Oregon estuaries.

There is relatively little pressure for development in the bay and riverine subsystems and only moderate pressure in the marine subsystem. Improved navigation conditions and expanded moorage facilities are the main interest in the lower estuary. Dike maintenance and erosion control are major concerns of farmers in the Coquille valley. Many people are interested in cleaning up debris and unused pilings, which would improve recreational boating and fishing conditions in the riverine subsystem. There have also been proposals to dredge the bay and upper estuary.

We recommend that most ocean-oriented, water-dependent development be concentrated in the marine subsystem where navigation improvements are presently located. Some previously developed areas in the bay and riverine subsystems have potential for improved or expanded water-dependent development as well. Development of those sites should be scaled to use existing channel depths. Environmental conditions in the estuary would be improved by restoration of tideland and tidal marsh where possible, debris removal, strict pollution control, and careful management of riparian vegetation and runoff from agricultural and forest lands.

The following are some of the most critical research needs for managing the Coquille estuary:

1. Tidal dynamics throughout the length of the estuary under various freshwater flows, including head of tide, average tidal range and lag time for riverine locations, tidal currents, circulation and mixing characteristics, flushing times for representative locations
2. Dimensions of the entire estuary including a complete base map, surface area, representative cross sections, and tidal prism

3. An adequate water quality monitoring program to detect problems and sources of low dissolved oxygen, excessive organics, nutrients, and bacteria and to establish average, seasonal chemical concentrations throughout the estuary

4. Habitat maps of the riverine subsystem

5. Water quality and habitat requirements of fishes in the upper estuary, especially shad, striped bass, and juvenile salmonids

6. Distribution of sediments and benthic invertebrates, especially in the intertidal zone of the lower 10 miles

7. Analysis of sediment and clams near the Bandon treatment plant or other areas near sources of pollution to determine the extent of bacterial contamination

8. Evaluation of erosional areas in the upper estuary

9. Seasonal inventory of the occurrence and distribution of fishes in the estuary

10. Inventory of diked marshes, including ownership, condition of dikes and channels, and tidal elevations.

Since there are limited scientific data on the Coquille, comprehensive physical and biological studies should precede major alterations, such as dredging and riprap, which could have a long-term impact on the estuary.

LITERATURE CITED

Akins, G. J. and C. A. Jefferson. 1973. Coastal wetlands of Oregon. Oreg. Coastal Conserv. Dev. Comm. 159 pp.

Beaulieu, J. D. and P. W. Hughes. 1975. Environmental geology of western Coos and Douglas counties, Oregon. Oreg. Dep. Geol. Mineral Industries.

Beckham, C. 1974. The history of logging in Coos county. The *Coos Bay World* daily newspaper. October 16, 1974.

Dicken, S. N., C. Johannessen, and B. Hanneson. 1961. Some recent physical changes of the Oregon coast. Dep. Geogr., Univ. Oreg., Eugene. 151 pp.

English, S. and C. Skibinski. 1973. Coquille River basin practices for water conservation and land use. Student Report. Univ. Oreg. Instit. Marine Biology. Charleston.

Fish Commission of Oregon. 1964. Shellfish investigation progress report. Number 35. April 1962 through March 1964.

Frenkel, R. E., T. Boss, and S. R. Schuller. 1978. Transition zone vegatation between intertidal marsh and upland in Oregon and Washington. Dep. Geogr. Oreg. State Univ., Corvallis. 320 pp.

Gaumer, T., D. Demory, and L. Osis. 1973. 1971 Coquille river estuary resource use study. Fish Comm. of Oreg., Newport. 27 pp.

Lizarraga - Arciniega, J. R., and P. D. Komar. 1975. Shoreline changes due to jetty construction on the Oregon coast. Oreg. State Univ., Corvallis.

Mate, B. Marine mammal distribution on the Oregon coast. Unpublished data. Oreg. State Univ., Newport.

McGie, A. M. and R. E. Mullen. 1979. Age, growth, and population trends of striped bass, *Morone saxatilis*, in Oregon. Oreg. Dep. Fish and Wildl. (in press).

McKernon, O. L., D. R. Johnson and J. I. Hodges. 1950. Some factors influencing the trends of salmon populations in Oregon. Contribution no. 12. Fish Comm. Oreg., Portland.

Mitchell, D. L. 1978. Re-establishment of salt marsh ecosystems following dike removal, study plan. Unpublished draft. Dep. Botany and Plant Pathology, Oreg. State Univ., Corvallis.

National Ocean Survey. 1977. Coquille river entrance. Sounding Chart 18588. U. S. Dep. Commerce, National Oceanic Atmosph. Admin.

Oregon Department of Environmental Quality. 1978. STORET computer print out of water quality data from Coquille estuary. Portland.

Oregon Division of State Lands. 1972. An inventory of filled lands in Coquille River estuary. Salem.

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

Oregon Land Conservation and Development Commission. 1977a. Administration rule, classifying Oregon estuaries. Salem. 6 pp.

Oregon Land Conservation and Development Commission. 1977b. Statewide planning goals and guidelines. Salem. 24 pp.

Osis, L. and D. Demory. 1976. Classification and utilization of oyster lands in Oregon. Informational report no. 76-7, Oreg. Dept. Fish & Wildl. 38 pp.

Pacific Northwest River Basins Commission. 1968. River mile index coastal tributaries:Pacific coast basin, Oregon. Vancouver. 84 pp.

Percy, K. L., C. Sutterlin, D. A. Bella, and P. C. Klingman. 1974. Description and information sources of Oregon's estuaries. Oreg. State Univ., Corvallis. 294 pp.

Reimers, P. E., J. W. Nicholas, T. W. Downey, R. E. Halliburton and J. D. Rodgers. 1978. Fall chinook ecology project. Unpublished data. Oreg. Dep. Fish & Wildl. Charleston.

Schroeder, W. L., K. L. Williamson, R. T. Hudspeth, D. H. K. Farness, M. A. Glick, P. O. Nelson, C. K. Slotti, J. M. Stander, D. R. Hancock, D. A. Bella and R. P. Gale. 1977. Dredging in estuaries, a guide for review of Environmental Impact Statements. Technical Manual. Oreg. State Univ. Corvallis. 313 pp.

Slotta, L. S. and S. M. Noble. Use of benthic sediments as indicators of marina flushing. Oreg. State Univ., Corvallis. 56 pp.

Smith, H. S. 1956. Fisheries statistics of Oregon, 1950-1953. Contribution no. 22. Fish Comm. Oreg., Portland. 33 pp.

Stevens, Thompson & Runyan, Inc. 1974. Coos-Curry environmental protection program. Volume I and II. Coos-Curry Council of Governments. Coos Bay.

Thompson, K. E., A. K. Smith, and J. E. Lauman. Fish and Wildlife resources of the south coast basin, Oregon, and their water requirements (revised). Oreg. Game Comm. Portland. 98 pp.

U.S. Army Corps of Engineers, Portland District. 1975. Final environmental impact statement, Corps of Engineers activities in the Chetco, Coquille and Rogue estuaries and Port Orford, Oregon. Volume I and II. Portland.

U.S. Geologic Survey. 7.5 minute series topographic maps. Bandon, Bill Peak, Bullards, Coquille, Myrtle Point and Riverton quadrangles. Dept. of Interior.

U.S. Geologic Survey. 1961-1977. Water resources data for Oregon, water year 1961-1977.

University of Oregon Institute of Marine Biology. 1978. Student survey. Flora and fauna of Bandon marina flats. Unpublished data. Charleston.

Zimmerman, S. T. 1972. Seasonal dynamics of zooplankton populations in two dissimilar Oregon embayments. Ph.D. thesis. Oreg. State Univ., Corvallis.