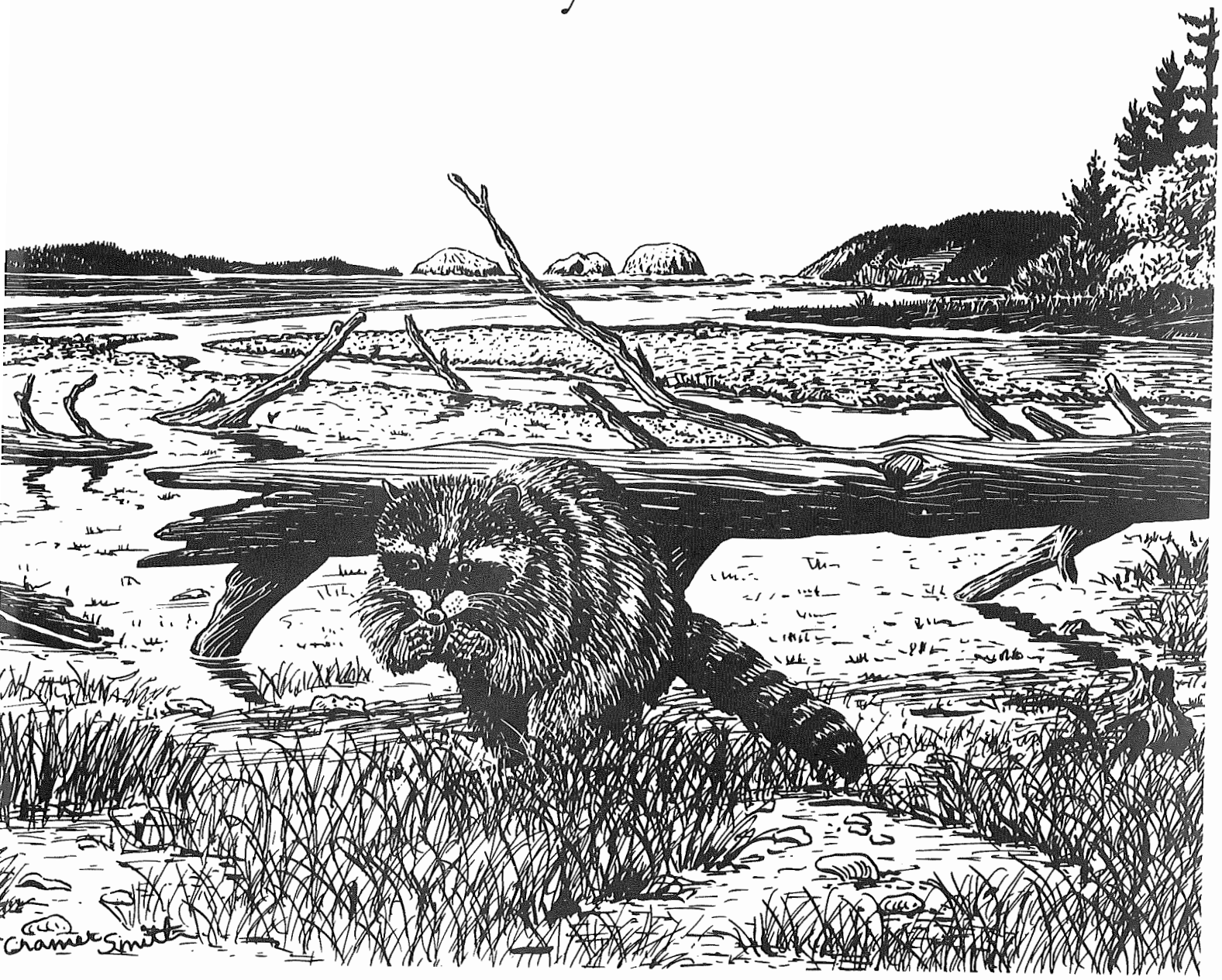
Natural Resources of Sand Lake Estuary



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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 SAND LAKE ESTUARINE SYSTEM

Description of the Area

Sand Lake estuary (Fig. 1) is located in southern Tillamook County. It is one of the smaller Oregon estuaries with an estimated surface area of 1,258 acres (Table 1). There are no population centers around Sand Lake. Development in the estuary and its shorelands is low intensity agricultural, recreational and residential. The Oregon Land Conservation and Development Commission (LCDC 1977a) classified Sand Lake as a natural estuary, which is to be managed to preserve its natural resources and avoid constraint of dynamic processes in the ecosystem.

Table 1. Sand Lake estuary dimensions.[a/]

Drainage area (mi^2)	17
Surface area (acres)	
Water surface at mean low water	131
Water surface at mean high water	528
Tidal and diked marsh surface	730
Total estuarine area	1,258

[a/] *All values from Percy et al. (1973) except marsh area which is estimated from Oregon Department of Fish and Wildlife (ODFW) 1978.*

Sand Lake has the second smallest drainage basin (17 sq mi) of Oregon's 21 estuaries (Table 2). Only Netarts, directly north, has a smaller drainage area (15 sq mi). Netarts and Sand Lake differ from the other estuaries because of their limited freshwater inflow. They are bar built rather than drowned river valleys (Wilsey and Ham, Inc. 1974). However, these two estuaries differ from each other in shape and predominant habitats. Netarts is in an open lagoon with extensive eelgrass beds, while Sand Lake has a major island and extensive marshes. Whalen Island (Fig. 1) consists of stabilized dune and tidal marsh. The Sand Lake drainage basin (Fig. 2) contains active and stable dunes and

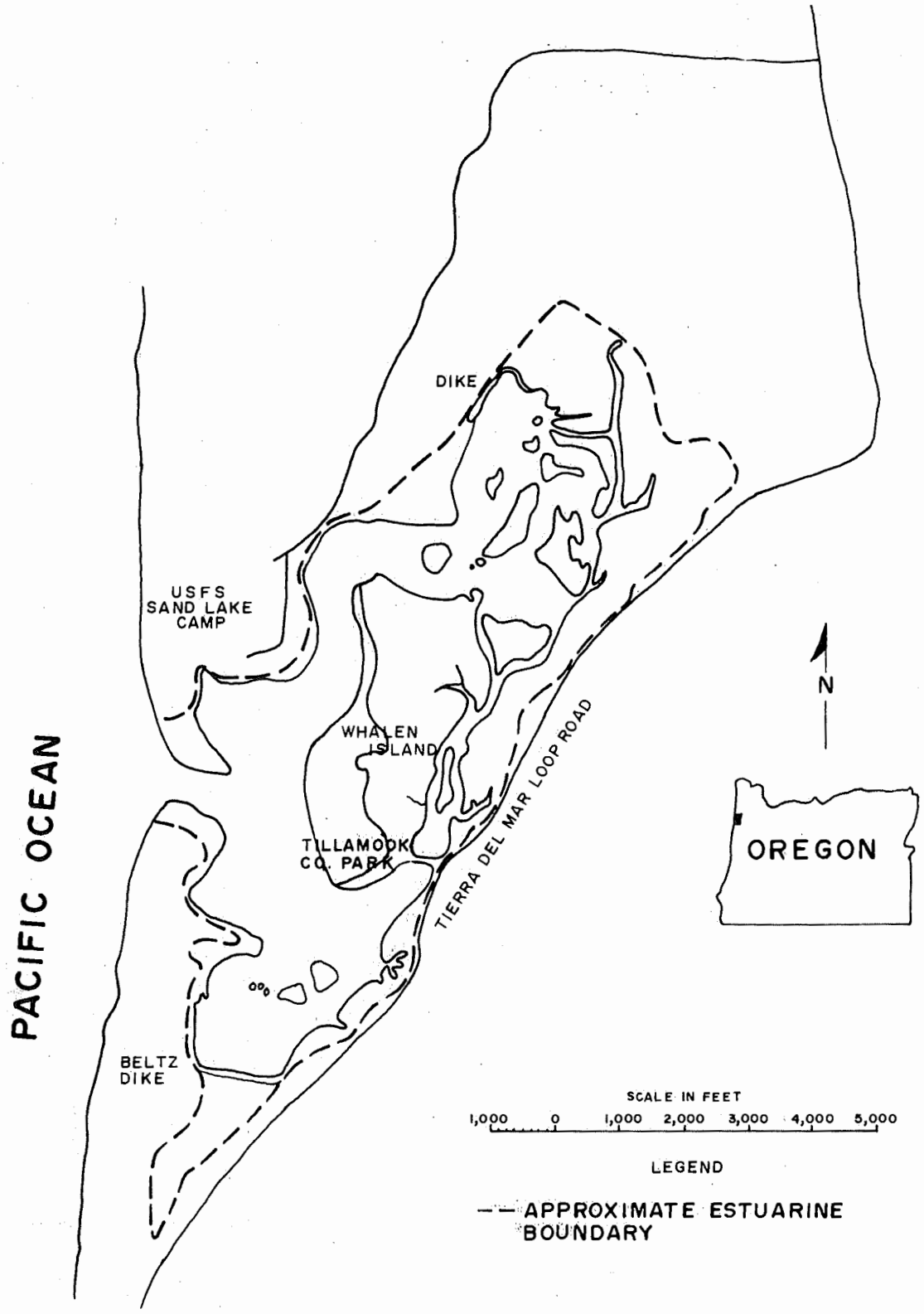

Fig. 1. Sand Lake estuary (base map from Oregon Division of State Lands [DSL] 1973).

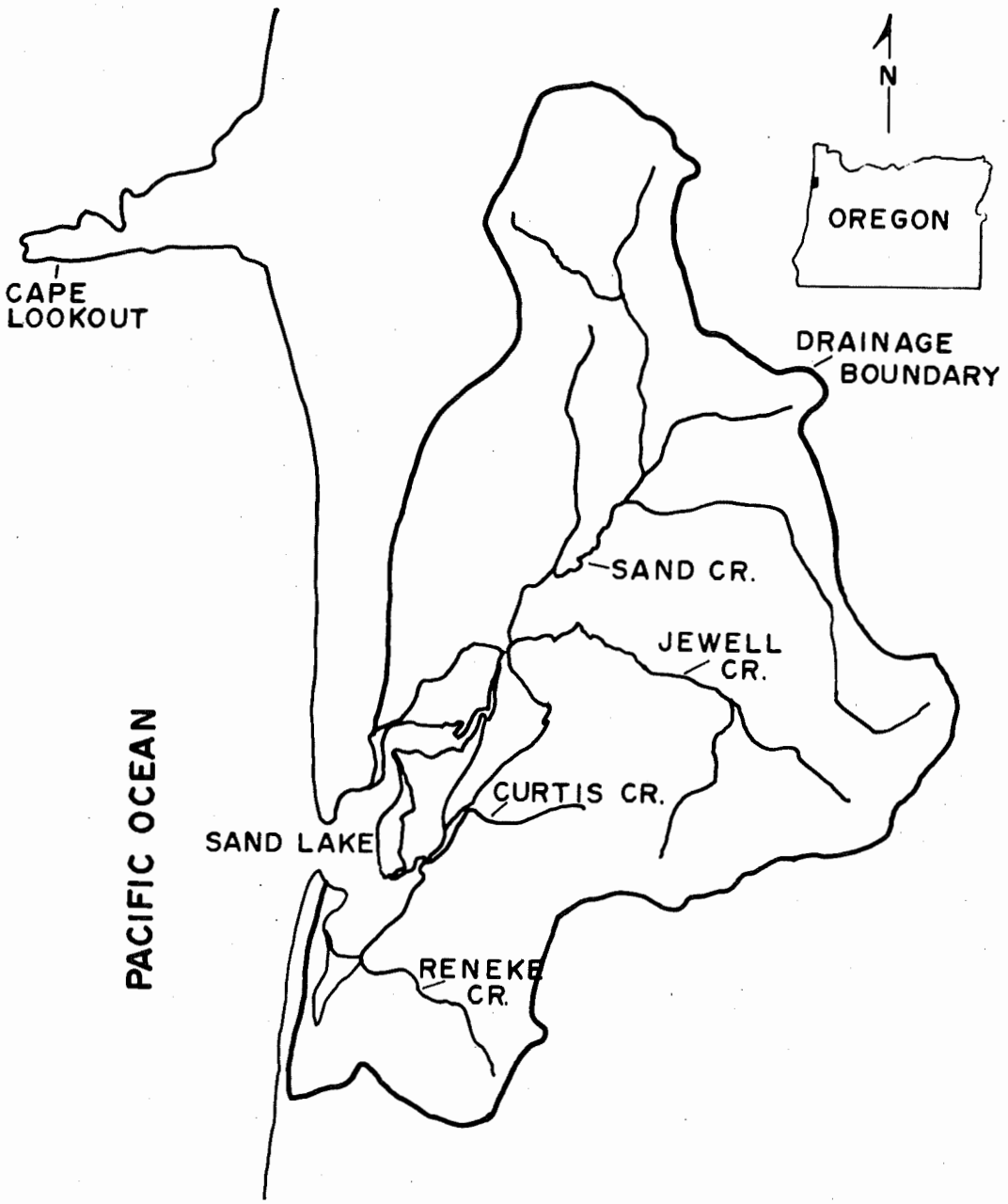

Fig. 2. Watershed of Sand Lake estuary (base map from U.S. Geological Survey Tillamook Quadrangle map).

coastal mountains (USDA Soil Conservation Service 1975). The primary sediment of Sand Lake is sand, which has probably eroded from the dunes.

Table 2. Sand Lake drainage area and tidal prism compared with other Oregon estuaries.

	Tidal prism (ft^3)[a]	Drainage area (mi^2)[b]
Sand Lake	8.2×10^7*	17
Necanicum	4.4×10^7	87
Nehalem	4.28×10^8	847
Tillamook	2.49×10^9	540
Netarts	3.3×10^8*	15
Nestucca	1.8×10^8*	322
Salmon	4.3×10^7	75
Siletz	3.5×10^8	373
Yaquina	8.35×10^8	253
Alsea	5×10^8	474
Siuslaw	2.76×10^8	773
Umpqua	1.18×10^9	4,560
Coos	1.86×10^9	605
Coquille	1.32×10^8	1,058
Sixes	[c]	129
Elk	[c]	94
Rogue	1.2×10^8	5,100
Pistol	[c]	106
Chetco	2.9×10^7	359
Winchuck	[c]	70

[a] *Values indicated by an asterisk (*) are estimated from Oregon Division of State Lands (DSL 1973). All others are from Johnson (1972).*
[b] *Values from Pacific Northwest River Basin Commission (1968).*
[c] *No tidal prism value is available.*

Very little physical and biological data on Sand Lake estuary have been reported. Two studies in the 1940s and 1950s provide some information on cutthroat and steelhad trout in Sand Creek (Sumner 1953; Bali 1959).

Historical Changes

There have been three major alterations to the Sand Lake estuary: 1) a small slough at the southern end was channelized, and a dike and tide gate were placed across the narrow wetland; 2) a road dike and bridge were built to provide access to the east side of Whalen Island; and 3) a series of dikes and

drainage channels in the marshes on the north end of the estuary were built to prevent flooding and provide pasture. These and other smaller alterations are discussed in the subsystem section.

Physical Characteristics

The circulation, salinity, temperature, mixing, and freshwater inflow in Sand Lake estuary have not been documented. Since these characteristics influence the biological communities of the estuary, some of them have been estimated for this report from general information about the location and physical dimensions of the estuary and its drainage basin.

Tides

The mean tidal range in Sand Lake is 5.7 ft. Most of the estuary is above mean low water (MLW). In fact, over half of the total surface area is tidal marsh above mean high water (MHW), according to the Division of Lands tideland map (DSL 1972) and Akins and Jefferson (1973). Johnson (1972) estimated tidal prisms (average volume between high tide and low tide) for West Coast estuaries by multiplying the mean tidal range by the average of the water surface area at MHW and MLW. Sand Lake dimensions were not included in his report. Using the dimensions listed in Table 1, the Sand Lake tidal prism is 8.2×10^7 ft.^{3}. This volume is small compared with most other Oregon estuaries (Table 2). The mean tidal prism for Netarts estuary is four times larger than that of Sand Lake, yet its total surface area is only twice as large.

Freshwater inflow

Freshwater sources for Sand Lake include groundwater and four small creeks (Fig. 2). Jewell Creek joins Sand Creek just north of the estuary. The two creeks drain most of the basin. Curtis Creek, east of Whalen Island,

and Reneke Creek in the southern part of the estuary drain a small portion of the basin. Thompson and Fortune (1968) made 10 measurements of flow in Sand Creek in 1965 and 1966. They ranged from 0.9 cubic feet per second (cfs) in August 1966 to 52 cfs in March 1966. No flows were recorded during December through February. Summer (1953) found that highest water levels in Sand Creek coincided with storms from the southwest.

The average annual and monthly freshwater inflows to Sand Lake estuary were estimated for this report (Table 3). The estimates follow the methods of Glanzman et al. (1971). The estimated mean annual inflow is 109 cfs. Actual mean annual inflow probably varies between 70 cfs and 170 cfs based on proportional flow variations from year to year in nearby streams (Oregon Water Resources Board 1961). Groundwater contribution to inflow was not computed by Glanzman et al. (1971) because it was considered negligible in Netarts estuary. The water storage capacity of the dunes in the Sand Lake drainage basin is large and could contribute ground water directly to the estuary or could moderate the monthly tributary flow values, but neither of these effects have been measured. However, the spot measurements of Thompson and Fortune (1968) of the flow from approximately one-third of the Sand Lake drainage lend credence to the monthly flow values shown in Table 3.

Table 3. Estimated average monthly freshwater inflow to Sand Lake estuary.

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Flow (cfs)	200	174	147	91	50	25	8	5	13	49	159	229

Circulation, mixing, salinity and temperature

Sand Lake has a complex network of channels through the northern marshes and around both sides of Whalen Island, but circulation has not been studied. Netarts estuary is well mixed throughout the year except during and immediately

after heavy rains, when it is partially mixed (Zimmerman 1972). Similar mixing characteristics can be expected in Sand Lake, since the freshwater inflow and depth of the two estuaries are comparable.

During winter, freshwater inflow is probably sufficient to maintain salinity in Sand Lake below ocean levels. Expected high winter inflow (229 cfs in December) would yield approximately 0.5×10^7 ft^3 of fresh water in a half tidal cycle (6.22 hr). During an average winter flood tide, the freshwater inflow is about 6% of the tidal inflow (8.2×10^7 ft^3). The approximate summer inflow volume is very small compared with tidal volume, so salinity throughout most of the estuary probably remains close to ocean levels. The northern channels and marshes associated with Sand Creek are probably the areas of lowest salinity.

Ocean temperature, solar radiation, air temperature and the extensive intertidal area are probably the predominant influences on temperature in the Sand Lake estuary. Sumner (1953) found water temperatures in Sand Creek remained cool throughout the summer, but the small freshwater inflow is unlikely to affect estuarine temperature.

Biological Characteristics

There is little information concerning species composition, distribution, and abundance of plankton, fish, crabs and other invertebrates, or birds and mammals of Sand Lake. Available data are generally discussed below, and specific habitats and associated species are described later for the marine and bay subsystems.

Plankton

Phytoplankton are important primary producers in estuaries. Their growth affects and is affected by water quality. Specht (1974) found that low summer nitrogen concentration limited phytoplankton populations in Sand Lake and

and eight other Oregon estuaries. Laboratory cultures of two phytoplankton species showed that Sand Lake produced the lowest growth rates of all estuarine waters tested. Assuming the laboratory results model estuarine growth rates, the low rate for Sand Lake indicates that it is relatively unpolluted.

Zooplankton have not been studied in Sand Lake, although Zimmerman (1972) completed an extensive seasonal survey of zooplankton in Netarts Bay. The species and seasonal distribution in Sand Lake and Netarts are probably similar. However, the larval clams and other larval invertebrates may be less abundant and diverse in Sand Lake.

Fish and crabs

Fish and crab species in Sand Lake are documented primarily by sport harvest data. No general fish inventories have been conducted. The 1971 Sand Lake Estuary resource use study (Gaumer et al. 1973) indicates there was a substantial recreational fishery for starry flounder (*Platichthys stellatus*), and dungeness crab (*Cancer magister*). Pacific staghorn sculpin (*Leptocottus armatus*), buffalo sculpin (*Enophrys bison*), shiner perch (*Cymatogaster aggregata*) were also caught in significant numbers but were not normally target species. Of 15 Oregon estuaries surveyed in the summer of 1971, the fewest species were caught in Sand Lake (Gaumer et al. 1973). If the diversity of fish is in fact low, it could be related to the lack of subtidal and rocky habitats. Adult seaperch, rockfish, and greenling, which often prefer those habitats, are notably rare in Sand Lake.

Anadromous species found in Sand Lake include steelhead trout (*Salmo gairdneri*), cutthroat trout (*S. clarki*), coho salmon (*Oncorhynchus kisutch*) and chum salmon (*O. keta*). They hold in or migrate through the estuary during fall through spring, (Thompson and Fortune 1968). There was a commercial fishery for chum salmon in the bay until 1957, when commercial salmon fishing

in estuaries was closed by referendum. A small private chum salmon hatchery is located on Sand Creek (Cummings and Korn 1975). Sumner (1953) counted adult upstream salmonid migrants in Sand Creek above Jewell Creek for 3-1/2 years. He estimated that the count in Table 4 included at least 90% of the fish spawning above the trap site. The movement of fish from the estuary was usually linked with freshets that normally occur between October and April. Juvenile salmonids may rear in Sand Lake, but it has not been documented. However, cutthroat, steelhead, and coho do rear from one to three years in Sand and Jewell creeks before emigrating to the ocean (Sumner 1953; Bali 1959).

Table 4. Upstream salmonid migrants counted at Sand Creek trap (Sumner 1953).

Species of fish	1946-47[a]	1947-48[b]	1948-49[b]
Cutthroat trout	224	92	81
Steelhead trout	147	70	47
Coho salmon	233	449	184
Chum salmon	495	363	189

[a] *October 21-September 30.*
[b] *October 1-September 30.*

Birds and Mammals

There are no quantitative surveys to determine the estuary's importance to various bird species. However, Sand Lake probably attracts many kinds of shorebirds and water birds because of the high percentage of intertidal feeding areas, including marshes, seagrass and algal beds, flats, and extensive shrimp beds. Birds would also experience little harassment there, since it is relatively isolated.

Seals and sea lions are not commonly found in this estuary (Mate 1978).

SAND LAKE ESTUARINE SUBSYSTEMS

The Sand Lake estuary can be divided into two subsystems: a highly dynamic

marine subsystem and a more stable bay subsystem. There are no slough or riverine subsystems within this estuary.

Marine Subsystem

The marine subsystem is generally that portion of Sand Lake lying west of Whalen Island (Fig. 3). This subsystem includes approximately 25% of the estuarine surface area. The predominant habits are sand flats and the subtidal, unconsolidated bottom of two main drainage channels. Field observations, aerial photographs, and maps were the primary sources of information on the marine subsystem.

Physical characteristics

The mouth of Sand Lake is flanked by north and south spits. Shifts in channel location, wave forces, and freshwater inflow cause seasonal erosion and accretion at the ends of the spits. Sand buildup during extreme low flows has on occasion temporarily blocked the bar (phone conversation July 18, 1978, with David Heckeroth, ODFW, Tillamook). The mouth is fully exposed to ocean waves (Johnson 1972). The boundary of the marine subsystem at the mouth has been drawn at the foredune vegetation lines rather than at an estimated higher high water line, since the outlet is most likely to shift within these bounds.

Waves and currents actively erode the sand substrate. Aerial photography and maps from the 1970s show that channel locations in the marine subsystem can shift dramatically over short periods of time. An isolated subtidal area near Whalen Island is evidence of an abandoned channel. The northern channel presently cuts along Whalen Island and the northern-most shore of the marine subsystem (Fig. 3). Those areas may be eroding more slowly than the unconsolidated sand flats; however, shoreland erosion is probably a greater concern to land owners.

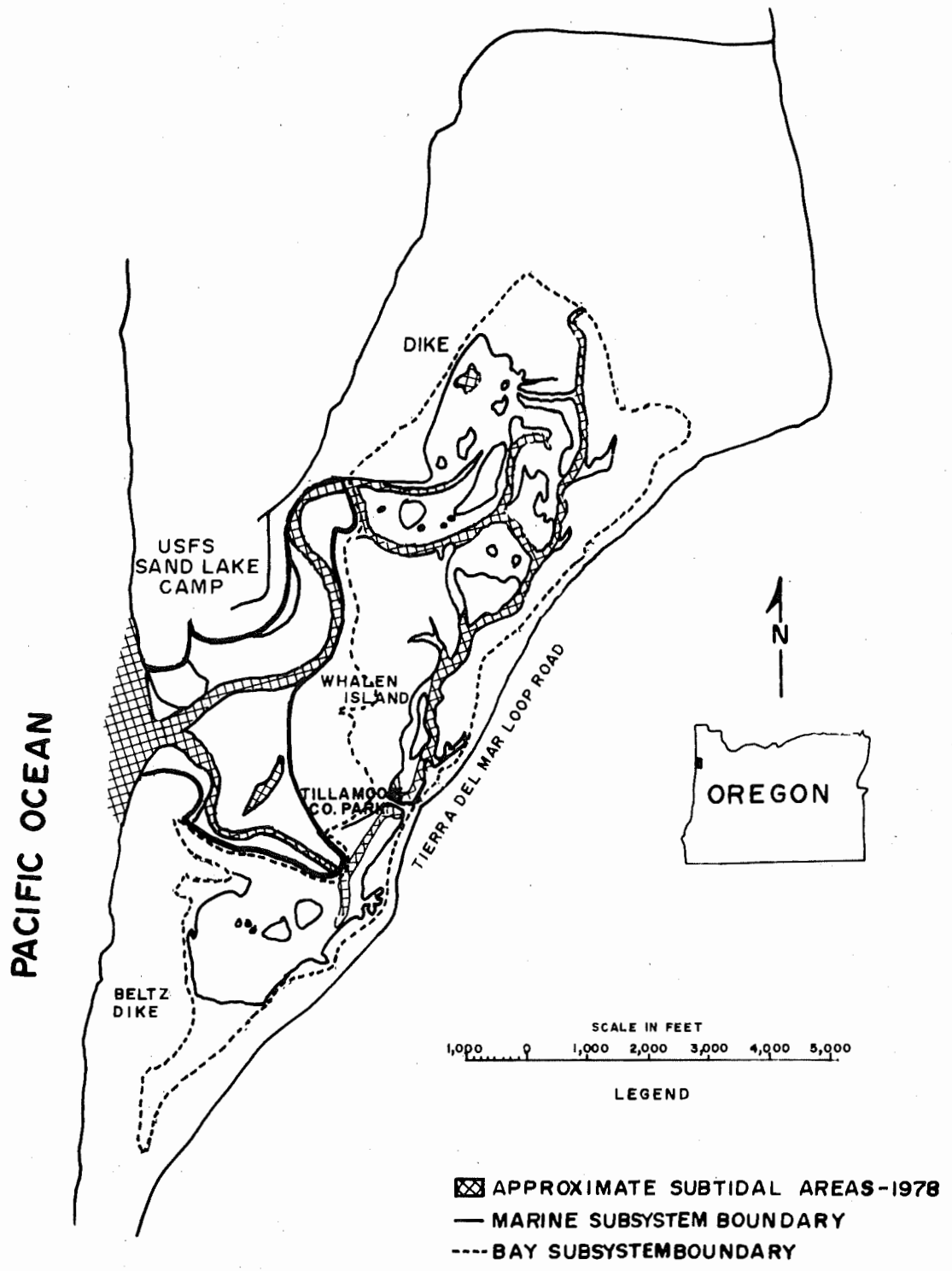

Fig. 3. Sand Lake estuarine subsystems.

Habitats and species

A cursory analysis of habitat distribution in Sand Lake subsystems (Table 5) reveals that approximately 88% of the marine subsystem is comprised of Sand flats and subtidal areas of unconsolidated bottom (Fig. 4). The dominant habitats have no visible vegetation, and the surface appears to have a very low silt content. The habitat types are indicative of a relatively high energy regime. However, in many areas the flat is slightly higher along the channel, thus slowing the drainage from the flats at low tide.

Table 5. Approximate percentage of habitat surface area within Sand Lake estuary and its subsystems.[a/]

Habitat	Marine subsystem	Bay subsystem	Entire estuary
Subtidal	28	7	12
Unconsolidated bottom	23	5	10
Seagrass bed	4	2	2
Algal bed	1		*
Intertidal	72	93	88
Sand shore	*		*
Sand flat	65		16
Undifferentiated flat		16	12
Aquatic bed	3	5	5
Beach/bar	*		*
High marsh	2	47	36
Low marsh	2	14	11
Diked marsh		11	8

[a/] *Values estimated from Habitat Map of Sand Lake Estuary (ODFW 1978).*
* *Less than 1%.*

Shrimp burrows are extensive on the sand flats, especially the lower interior areas. Small cockle (*Clinocardium nuttalli*) and Baltic macoma (*Macoma balthica*) shells were found across the flat. Clam beds within the estuary have not been surveyed. The only known clamming area is located in the bay subsystem. Osis and Demory (1976) examined Sand Lake for possible oyster culture areas and identified the channels and nearby portions of the flats as having low potential due to shifting sand.

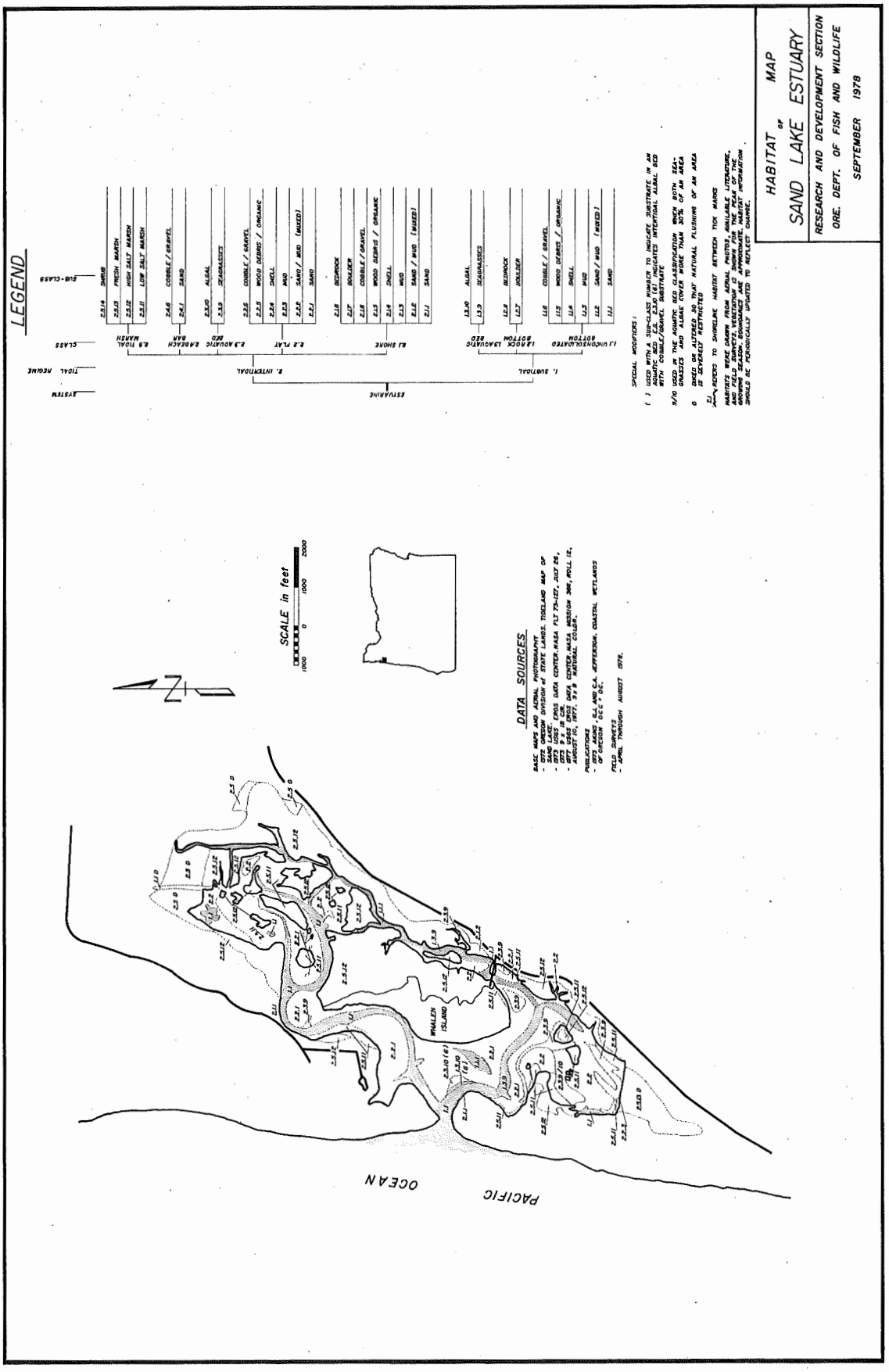

Fig. 4. Habitat map of Sand Lake estuary (ODFW 1978).

Other habitats in the marine subsystem (Fig. 4) are small, yet most are vegetated and probably provide important food and shelter for fish and invertebrates. The southern channel contains a dense growth of eelgrass (*Zostera marina*), and an area near the mouth is a cobble/gravel substrate with attached algae.

The only marsh in the marine subsystem is along the north spit, adjacent to a U. S. Forest Service park (Fig. 1). This marsh has no channels and grades from a low to a high marsh, while exhibiting distinct zones of marsh plant communities. The marsh has been disturbed by vehicular traffic from the park despite signs which indicate the area is closed to vehicles. Tracks left by the vehicles have damaged and destroyed strips of vegetation.

Management recommendations

Some Oregon estuaries are classified as "natural" to insure that a diversity of estuary types are maintained according to the relative degree of development that can and will occur (LCDC 1977a). Sand Lake is one of a few prime examples of unaltered estuarine systems that will be protected. Therefore, planning policies should discourage alteration of the marine subsystem habitats and natural processes. A dynamic feature of the Sand Lake marine subsystem is the shifting of the channels and mouth due to erosion and accretion. Allowance should be made for these changes by restricting development in erosive areas. The only existing development that may be threatened by future erosion is the Forest Service park access road. Relocating the road or sloping and vegetating the shoreline would be preferable to riprapping and should be considered before the situation warrants emergency measures.

The Forest Service park should remain a low intensity facility, and more adequate protection of the marsh should be provided. Pedestrian paths to the estuary should be routed south of the marsh to avoid trampling the vegetation.

Dune buggy drivers seeking access to the duens rather than the estuary are the primary users of the park. If the dunes north of Sand Lake are to be open to vehicles, serious consideration should be given to an alternative access which avoids the estuary and spit. Constant vehicular disturbance is incompatible with a natural estuary. Shorelands in the marine subsystem should be managed for low intensity use (LCDC 1977a).

Bay Subsystem

The eastern side of Sand Lake estuary comprises the bay subsystem (Fig. 3). It is protected from the ocean by Whalen Island and by its distance from the mouth of the estuary. It is about three times as large as the marine subsystem and contains an even higher percentage of intertidal land. The predominant habitats in the subsystem are tidal marshes. The marshes have been studied and surveyed by Akins and Jefferson (1973). Other features reported in this section are described primarily from field observations.

Physical characteristics

The bay subsystem receives all of the direct freshwater inflow to Sand Lake estuary. Silt is present in most sediments of the subsystem, since the wave energies and water velocities are lower than in marine subsystem habitats.

The Whalen Island bridge was constructed on a dike which constricted the channel opening. This delayed tidal flows and increased water velocities, causing the island marsh to erode. Riprap was used to halt the erosion.

Habitats and species

Habitats of the bay (Table 5) contrast dramatically with those of the marine subsystem. Approximately 72% of the bay subsystem is tidal marsh. The majority of marshes are on Whalen Island and north and east of the island. High marshes predominate on the eastern shore and island, while low marshes

predominate in the northern interior of the bay subsystem (Fig. 4). The low marshes appear to be actively expanding across the adjacent flats, but the rate of expansion has not been determined. These low marshes are not completely covered by marsh plants. Portions of those marshes were unvegetated or covered with algae.

There are some small low marshes in the sourthern part of the subsystem, but they do not appear to be actively expanding. The adjacent flat may be significantly lower in elevation than the northern flats, thus inhibiting marsh expansion. An analysis of marshes in Nehalem estuary by Eilers (1975) indicated that slight elevational differences in intertidal areas make a dramatic difference in the degree of exposure during the growing season. Eilers postulated that there is a key elevation at which marsh growth is triggered.

Much of the high marsh in Sand Lake was classified by Akins and Jefferson (1973) as mature high marsh. Such marshes are characterized by a large diversity of marsh plant species. Few mature high marshes remain in Oregon, because most have been diked to provide agricultural land. Other high marsh types found in the bay subsystem were sedge and immature high marsh. The Whalen Island marshes have been heavily grazed, and some leveling and channel alteration has occurred (phone conversation, January 19, 1979, with Dr. Robert Frenkel, OSU Dep. Geog., Corvallis). Frenkel said grazing changes the species composition of marsh plants, but no studies have quantified the impact of grazing on the productivity of west coast marshes.

About 15% of the Sand Lake marshes (8% of the estuary) have been diked, all of which are in the bay subsystem (Table 5). Aerial photographs show that the northern diked marshes (Fig. 4) are drained primarily by ditches. The pattern of old marsh channels is still visible in some areas; however, conversion from marsh to agricultural land is probably well advanced. The diked

marsh at the south end (Beltz dike, Fig. 4) has remained a wetland but has converted from salt marsh to fresh marsh. It is used by large numbers of ducks in the winter, and the dike, although privately owned, provides access to a popular hunting area. The dike apparently was constructed for flood control rather than agricultural purposes, and the diked area has remained essentially undisturbed since the original alteration.

Other intertidal habitats in the bay subsystem include flats, algal beds, and eelgrass beds (Table 5). The southern flat located between Beltz dike and the channel south of Whalen Island (Fig. 4) is secluded from most human activity because of limited access. The substrate appeared to contain sand and silt, but no estimate was made on the proportions. August 1977 aerial photographs suggest an extensive algal mat covering the flat, but during April and June 1978 field observations, algal mats were limited to two small areas (Fig. 4). The flat may include other areas of seasonally dense algal beds. The flat does contain a mixed eelgrass and algal bed. Gaumer et al. (1973) indicated a small bed of cockles in the eelgrass bed adjacent to the channel. No other information is available on the fauna of the southern flat, although it may be an important feeding area for shore birds and waterfowl. A flat adjacent to the Tillamook county park on Whalen Island has a dense shrimp bed and a small eelgrass bed (Fig. 4). Flats in the northern section of the subsystem were not investigated during this study.

Subtidal habitats within the bay subsystem occupy only about 7% of the subsystem area. About a fourth of those are eelgrass beds. Small portions are in isolated depressions in the northern low marsh that do not drain at low tide. The remaining subtidal habitats are in channels, probably dominated by sand substrate (Fig. 4). Sumner (1953) found that cutthroat trout hold in the channels in late summer prior to the first fall freshets.

Management recommendations

The undiked marshes of the bay subsystem should be protected in accordance with the estuary's natural classification. Physical alteration of the marshes (e.g. fill or drainage changes) should be prohibited. Serious consideration should be given to eliminating marsh grazing. Acquisition of either marsh grazing rights or the entire marshlands may be possible. Such action would allow the marsh to revert to its natural function and productivity in the estuary.

Breaching the north and south dikes should be considered only if the net benefits to the estuary are found to outweigh the risk of environmental damage. The northern diked marsh may not readily revert to healthy tidal marsh because of the extent of its alterations. The southern diked marsh provides excellent wildlife habitat that should be protected whether it is freshwater or estuarine.

Circulation in the bay subsystem would be improved if the dike for the Whalen Island bridge was partly or entirely removed and the bridge span enlarged to allow water to flow freely along the eastern side of the island. This would also reduce the current, which has eroded the island marsh.

The Tillamook County park on Whalen Island (Fig. 1) provides the only boating access to Sand Lake. The park provides adequate facilities for low intensity, estuarine-related recreation. Expansion or further development may not be in keeping with the purposes of a natural estuary. For the same reason, shoreland development east of Sand Lake should remain low density. Any expanded shoreland development should be accompanied by erosion control and water pollution control measures that adequately protect the estuary.

SUMMARY AND RESEARCH RECOMMENDATIONS

Sand Lake is a small estuary with a very small drainage basin. Most of

the estuarine area is intertidal. The estuary can be divided into a marine subsystem and a bay subsystem based on physical characteristics. The marine subsystem is dominated by sand flats, while the bay subsystem is dominated by tidal marsh habitats.

There are relatively few alterations within Sand Lake estuary, and shoreland development is at a low density. Agricultural and recreational uses are the only activities with noticeable impacts on estuarine habitats. Future development, including agricultural, residential, and recreational use, should be planned and managed to promote the retention of natural habitats. Uses should maintain water quality and allow for free water movement and natural changes in channel and marsh configuration.

Few alterations are permitted in a natural estuary (LCDC 1977a), and therefore little research is needed to meet planning objectives. However, further information would be valuable to establish Sand Lake's present natural resource components, especially if the estuary's planning status is reassessed.

The highest priorities for baseline research needs include

1. Seasonal measurements of salinity, temperature and dissolved oxygen at various tidal stages throughout the estuary.
2. Circulation patterns under high and low flow conditions and for various tidal ranges.
3. Substrate analysis of Sand Lake habitats and survey of benthic invertebrates.
4. Seasonal survey of fish distribution and abundance.
5. Seasonal survey of bird distribution and abundance.

In addition, the management of Sand Lake and possibly other estuarine marshes could be improved by a study of the impact of grazing on marshes. Research concerning the function of mature high marshes in Sand Lake could

provide a better understanding of the effects of diking in other Oregon estuaries. Sand Lake would also be an excellent study site for evaluating the rates and causes of low marsh expansion.

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