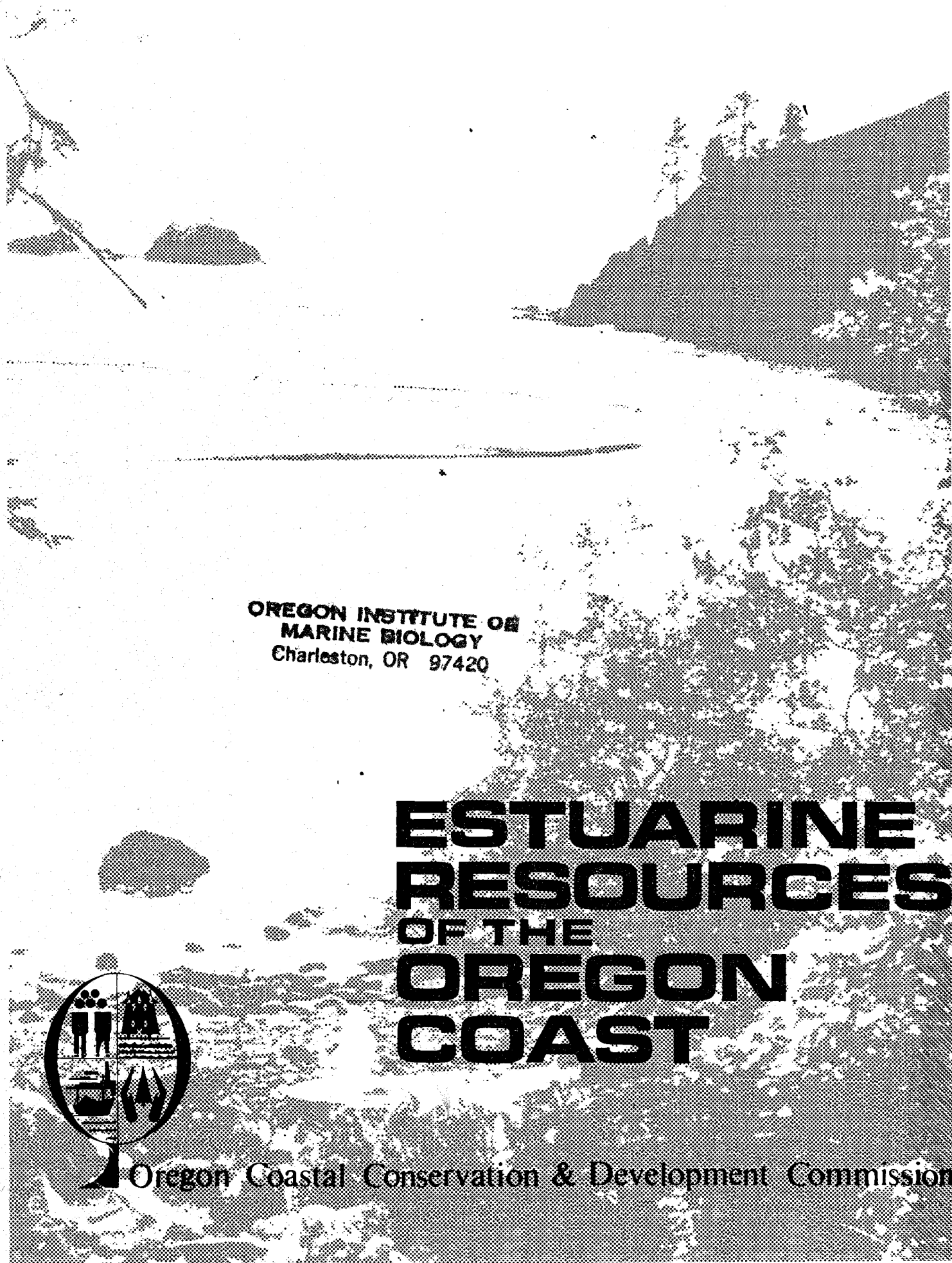

ESTUARINE RESOURCES OF THE OREGON COAST

Oregon Coastal Conservation & Development Commission

ESTUARINE RESOURCES OF THE OREGON COAST

A Natural Resource Inventory Report to the

OREGON COASTAL CONSERVATION & DEVELOPMENT COMMISSION

September 1974

prepared by
WILSEY & HAM INC.
PORTLAND, OREGON

OREGON COASTAL CONSERVATION AND DEVELOPMENT COMMISSION

WILBUR TERNYIK, CHAIRMAN
JEFF BRENNAN, VICE CHAIRMAN
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February 14, 1975

To the 58th Legislative Assembly of the State of Oregon:

This report is one of ten natural resource inventories prepared by the OCC&DC in developing a natural resource management plan for the Oregon coast. The inventory is designed to provide a coastwide identification of the location, extent, characteristics, values and management problems of estuarine resources.

The Commission has compiled and summarized within the inventory what is known about Oregon's estuarine areas. The report contains information necessary for proper protection and management of estuaries and identifies additional information needs for the years ahead. We believe this document is the best possible evaluation and data base that could be gathered within the limited time frame and available budget. Accordingly we wish to commend the consultant team for a job well done and express appreciation for the cooperation and assistance of the numerous individuals and agencies who have assisted in the effort.

The Commission would also like to emphasize that the inventory is a basic working document. In the years ahead, this inventory must be improved and periodically updated to reflect new knowledge and changing conditions. State and local government in carrying out resource conservation and development activities should have a current assessment of the resource situation. Such information is an essential ingredient of continuing effective management of estuaries in the Oregon coastal zone.

Sincerely,

Wilbur E. Ternyik
Chairman

"THE PREPARATION OF THIS REPORT WAS FINANCED IN PART THROUGH A PROGRAM DEVELOPMENT GRANT UNDER THE COASTAL ZONE MANAGEMENT ACT OF 1972 ADMINISTERED BY THE OFFICE OF COASTAL ZONE MANAGEMENT OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION."

The authors of this report are indepted to the OCC&DC staff, in particular Rebecca Kreag and Glenn Akins, and the other governmental agencies who rendered invaluable assistance and helped to make this study possible.

Sincere appreciation is accorded to Dr. David Bella, Ocean Engineering, Oregon State University and Jeffrey Stander, Oregon State University Extension Service for their valuable assistance during the definition of study methodology. We especially appreciate Dr. Bella's assistance in defining the Human Use Chart found herein.

In addition, numerous individuals met with us throughout the course of the study to assist in our data collection process. We thank the following for their time and energy: Lynn Steiger, Bob Jacobsen, Dennis Oster, Wes Badderson, Paul Coyne, Paul Heikkila, Dave Megrath, Bob Moulton and Ted Skelton.

A list of those individuals who responded to the draft of this document can be found at the back of this report. Their efforts to review and comment on the report deserve special appreciation.

CONTENTS

INTRODUCTION

This report is one in a series of inventories of Oregon's coastal zone resources prepared in behalf of the Oregon Coastal Conservation and Development Commission (OCC & DC). Other coastal units and resources inventoried include: freshwater resources, fish and wildlife habitats, uplands, wetlands, visual resources, historical and archaeological resources, the continental shelf, and scientific and research natural areas.

The purpose of this inventory is to provide the OCC & DC with information needed to complete a coastal zone management plan. The legislation which created the OCC & DC directs the Commission to prepare a plan which considers, among other things, the quality, quantity and movement of estuarine waters and the ecological balance of estuarine resources. This report has been prepared to provide general information about Oregon's estuaries and specific information about each estuary. It will be used, together with the other inventory reports, to refine preliminary OCC & DC policies of coastwide significance and to identify resource management considerations for the preparation of a coastal zone management program.

METHOD

The consulting firm of Wilsey & Ham, Inc., Portland, Oregon has performed this study for the OCC & DC under the direction of a special estuary inventory steering committee with Wilber Ternyik as Chairman. Steering Committee members include David Megrath, Jack Broome, Don Knapp, Jeff Brennan, and Georgia Dougherty. Staff administrative coordination was performed by OCC & DC Chief Planner Glenn J. Akins and Rebecca Kreag, Estuary Inventory Project Manager.

In undertaking this assignment, Wilsey & Ham was faced with some significant problems. The limitation of time available to perform the study was most critical. Within approximately two and one-half months, pertinent literature had to be reviewed, field reconnaissance work had to be completed and the final report prepared. The lack of adequate information was another problem. Many volumes of reference materials were reviewed during the course of this study, but in several instances, vital information has been found to be unavailable. This report cites the need for additional research data at several points, particularly with regard to biological systems.

Confronted with a short time frame, an inadequate data base and an assignment which stressed the need to provide a report that would be useful to the Commission in their task of formulating coastal zone management policies, Wilsey & Ham organized a study team comprised of specialists in the physical, biological and social sciences, and the graphic arts. The basic study approach was to rely on these people to 1) review all available information within the disciplines that they each represented, 2) refine and condense this information down to that most pertinent to this study, 3) jointly determine a methodology for organizing and presenting the information in final report form, 4) participate in a field reconnaissance trip to secure missing data and to verify the study methodology, and 5) actively exchange information and critique fellow team members input in order to refine the final report product.

The rationale behind this process was simply that the team members, drawing from their individual background and expertise, and performing in a dynamic relationship with each other, could best decide on the concepts and information which must be presented to the OCC&DC and could determine an efficient and interesting format for portraying this information. Critical to the process were joint work sessions held throughout the study period and almost daily during the ten day field reconnaissance trip. It was during these sessions which were often attended by OCC&DC staff representatives, that the study methodology and concepts of study content and format were hammered out. As the need arose, opinion and input was solicited from the OCC&DC staff and coastal zone experts identified for the team by the staff. Following the field trip and a work session in which the final report outline was developed, the outline was presented to the steering committee for their approval preliminary to completing the draft report. The draft report was then submitted to the staff and steering committee for review and approval to publish the final report.

STUDY TEAM

Wilsey & Ham

Michael J. Brooks - Program Director

Nancy R. Tuor - Economics (Project Manager)

R. Jerome Esmay - Water Resources Management

A. Llewellyn Matthews - Public Policy Studies

Robert L. Burk - Geology, Hydrology

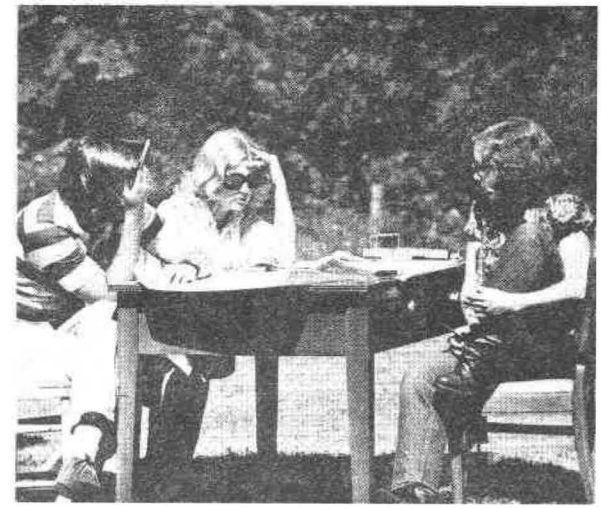
Jeffrey Girvin - Graphics

Sandy Paulsen, Loretta Rann - Clerical

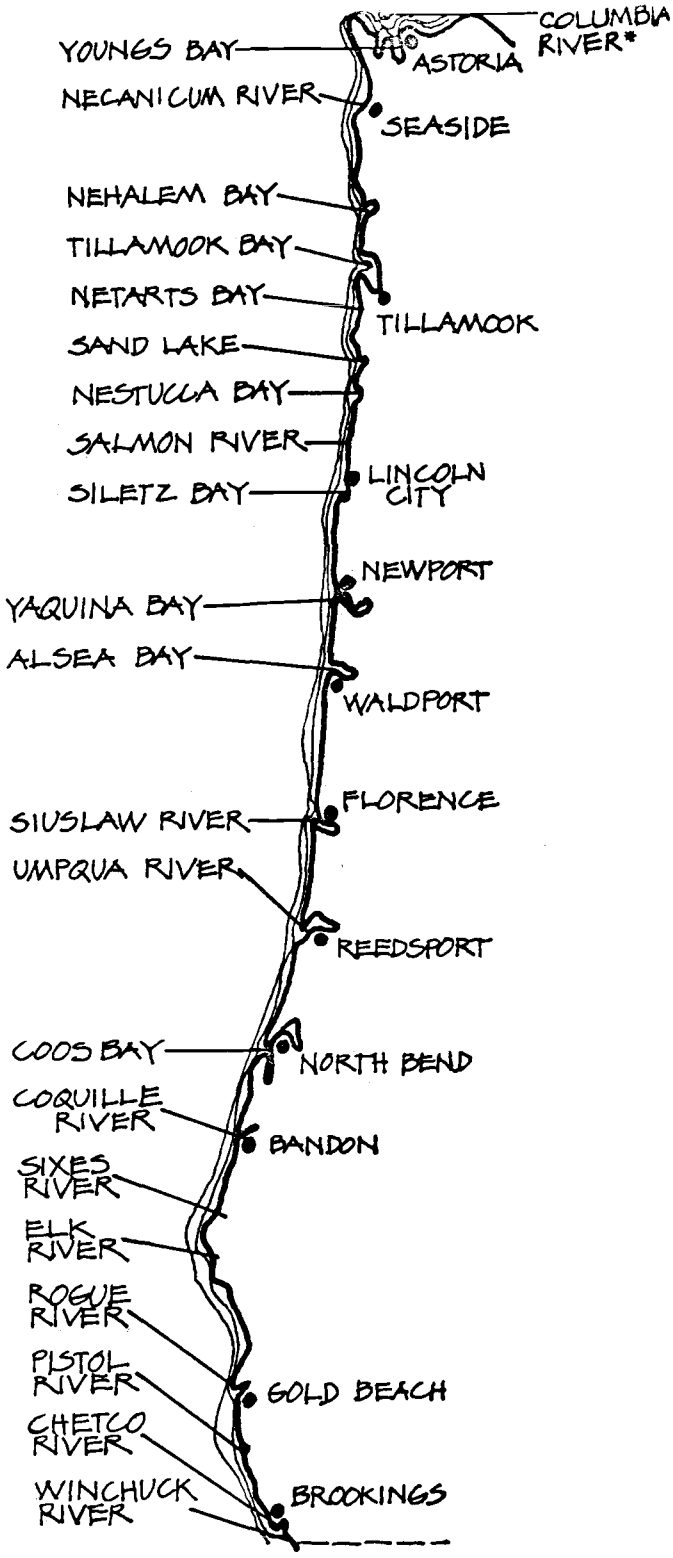
Subconsultants

Stephen V. Shabica - Marine Biology, Oceanography

Frank E. Brown - Terrestrial Ecology



DEFINITION



AN ESTUARY IS A SEMI-ENCLOSED BODY OF WATER ON THE COAST WHERE FRESH WATER FROM RIVERS AND STREAMS MEETS THE OCEAN AND IS MIXED WITH SALT WATER. EXCLUDED BY THIS DEFINITION ARE BAYS, BRACKISH SEAS, LAGOONS AND OTHER BODIES OF WATER IN WHICH THE FLOW OF TIDE IS PREVENTED OR WHERE FRESH-WATER INFLOWS ARE LIMITED OR NON-EXISTANT, AS SUCH, AN ESTUARY IS A MEETING POINT BETWEEN THE SALT WATER, FRESH WATER, AND THE SURROUNDING LAND. THE RESULTING ESTUARINE ENVIRONMENT IS CHARACTERIZED BY HIGHLY VARIABLE PHYSICAL, CHEMICAL AND BIOLOGICAL CONDITIONS. THIS VARIETY OF CONDITIONS ALLOWS ORGANISMS FROM THE SALT WATER, THE FRESH WATER, AND LAND TO LIVE AND PROLIFERATE IN AN ABUNDANCE AND DIVERSITY UNKNOWN TO ANY OTHER SINGLE TYPE OF ENVIRONMENT.

HISTORICALLY THE UNIQUE RESOURCES AND PROCESSES OF ESTUARIES HAVE BEEN EXPLOITED. AS A SEMI-ENCLOSED LINKAGE BETWEEN THE OCEANS AND RIVERS THEY PROVIDE PROTECTED HARBORS AND NATURAL TRANSPORTATION CORRIDORS. BECAUSE OF THEIR VALUE AS BREEDING GROUNDS FOR FISH AND OTHER SEA LIFE, THEY ARE RICH IN FOOD. IN SOME CASES, THEIR OFTEN HIGH RATES OF FLOW AND FLUSH HAVE BEEN USED TO DISPOSE OF GREAT QUANTITIES OF HUMAN WASTES. THESE USES OF ESTUARIES HAVE PLAYED A VITAL ROLE IN THE DEVELOPMENT OF OUR SOCIETY AND THIS ROLE WILL CONTINUE AS OUR COMMERCIAL, RECREATIONAL AND INDUSTRIAL NEEDS EXPAND.

OREGON HAS AT LEAST 21 ESTUARIES WHICH FIT THE ABOVE DEFINITION, EXCLUDING THE COLUMBIA RIVER. THERE ARE PROBABLY OTHERS, AS WELL, BUT THE 21 ESTUARIES WHICH ARE THE SUBJECT OF THIS STUDY ARE SHOWN ON THE ADJACENT MAP.

*THE COLUMBIA RIVER ESTUARY, EXCEPT FOR YOUNG'S BAY, HAS NOT BEEN INCLUDED WITHIN THE SCOPE OF THIS STUDY.

NATURAL FUNCTIONS

ESTUARIES AS SYSTEMS

ESTUARIES ARE INFLUENCED BY A WIDE VARIETY OF PHYSICAL AND BIOLOGICAL COMPONENTS. ALL ESTUARIES ARE UNDERGOING CONSTANT CHANGES AS A RESULT OF THE PROCESSES OF EROSION, SEDIMENTATION, INFLOW OF FRESH WATER, AND TIDAL ACTIONS. THESE PHYSICAL FACTORS ARE DELICATELY BALANCED IN EACH ESTUARY WITH THE RESULT THAT A VARIETY OF ENVIRONMENTS ARE CREATED. CONSEQUENTLY, ESTUARIES SUPPORT A WIDE VARIETY OF ANIMALS AND PLANTS FROM THE SALT WATER, THE FRESH WATER AND THE LAND. AS SUCH, ESTUARIES ARE IMPORTANT TO HUMANS FOR THE AMOUNT OF DIVERSITY OF LIVE WHICH THEY SUPPORT.

FORMATION AND NATURAL AGING PROCESS

Estuaries are dynamic natural systems. The delicate balance and operation of an estuary is dependent on the interrelationships of complex natural processes that go on not only in the ocean and rivers but on land and in the atmosphere as well. Estuaries are fragile environments, and seemingly modest alterations in the processes that govern them can cause major changes in their biophysical character.

Natural forces and human activity can have vivid effects on the nature of an estuary over periods of time which are short even in a modern historic sense. Large bays can be filled with sediment or sand spits eroded away well within an average human lifetime.

To understand the complex and fragile nature of Oregon estuaries it is helpful to understand how they are formed and some of the ways in which they can evolve. Major estuaries along the Oregon coast, with the exception of Sand Lake and Netarts Bay are the result of drowned rivers. During the last glacial episode large amounts of water were present on the land surface in the form of ice and the sea level was approximately 325 feet lower than it is today. During glacial times rivers flowed to the ocean just as they do today, but, the shoreline was much farther to the west. In North America glaciers of continental proportions reached their maximum extent between 16,000 and 18,000 years ago. As the climate became more moderate the ice melted and sea level began to rise until approximately 5000 years ago when it reached nearly its present level.(1) This world-wide rise in sea level caused the submergence or drowning of pre-existing river channels and hence the formation of estuaries.

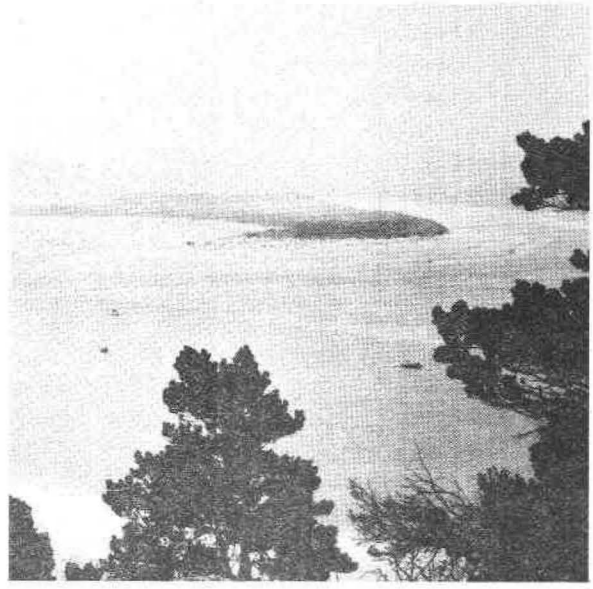
From the moment of their formation, the physical form of all estuaries has been continually modified. Deposition of sediment, wind action, current action, climate and vegetation are among the major factors which affect the physical character of estuaries. Changes in physical form directly influence the biological systems which an estuary can support.

Large areas of wetlands associated with Oregon estuaries have been formed by the recent deposition of sediments. In many estuaries, the natural rate of sedimentation has been accelerated in recent times. This increase has occurred mainly since 1850 and is thought to be directly attributable to human activities (logging, urbanization, agriculture) in the watershed.(2) Increased sedimentation has had the effect of gradually diminishing the area of open water in the estuaries.

Sediments are derived from the erosion of upstream soils and rock units and accumulate in the estuaries. The water currents from rivers and streams flowing through estuaries holds sediments in suspension. As the rate of stream flow decreases, the larger particles begin to settle out in a natural sorting process.

Estuaries are dynamic systems which reflect the erosion and deposition of sediments in a variety of ways. In virtually all estuaries there is a balance between the processes of erosion and deposition and it is incorrect to think of an estuary as having any one set sequence of evolution. All estuaries, regardless of their evolution, are influenced by sand which is derived from the uplands and carried by rivers as well as sand which is derived from the erosion of coastal rock units along the coast by the ocean, which accumulates along the mouth of the estuary. Sand is transported and shaped into narrow stringers or sandspits by wave action, littoral drift (movement of sediment along a beach in a direction parallel to the beach-ocean interface), and wind action.

Some estuaries become closed off from the sea by a sandspit during the summer when river discharge is low and summer ocean waves tend to cause sand to accumulate on the beach front. A change in sediment supply or the erosion caused by larger river flows or winter storm waves can allow such an estuary to re-establish a connection with the open ocean. However, if river flow and storm action are insufficient to breach the sandspit (perhaps due to such factors as changing climate, or uplift of the land, or vegetative stabilization or a high rate of sand accumulation) eventually a fresh water lake may be formed. Later erosion may again open this lake. If that does not happen, however, a marsh may begin to form as the lake is filled in with sediment and vegetation encroaches upon it.



NETARTS BAY: VEGETATED SAND SPIT AT MOUTH OF ESTUARY.

The fluctuations in sea level and the elevation of the land have been and will continue to be major long-term determinants of the shape and position of estuaries. Estuaries are constantly modified by the type and quantities of the sediments carried downstream by the river of the estuary. At present Oregon estuaries appear headed for natural extinction by a gradual filling with sediment. This process can take place within recorded history and in some cases, within a single lifetime.

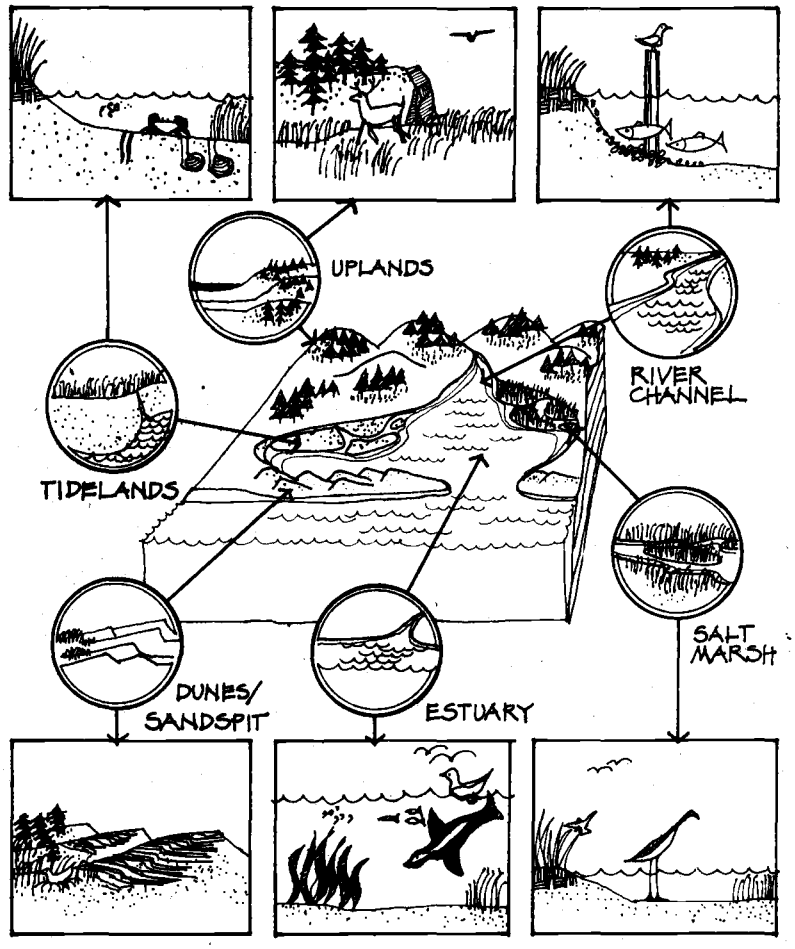
Environmental Components

Estuaries are composed of a variety of physical and biological components. Although estuaries are undergoing constant changes as a result of the processes including sedimentation, fresh water inflow and tidal action, these processes normally occur within the context of a balanced and closely interrelated system. These on-going physical processes have created a variety of environmental components which, in turn, support a variety of estuary plants and animals. The relationships between these components are demonstrated in the diagram on the following page. The diagram shows the major environmental components of a hypothetical estuary. Some components such as salt marshes, tidelands and dunes may be minimal or not present in some estuaries. Likewise not all types of plants and animals will be found in each estuary.

The on-going physical processes of fresh water inflow and tidal action, which modify the physical characteristics of estuaries, also help determine the types of plants and animals which can exist within the estuary. For example, an increase in stream flow could lead to the increased erosion of mudflats and potential loss of clam beds. Turbid waters can cause silting of food producing and spawning areas. In other places, estuary bottoms and mudflats comprised of silts and sands may be considered beneficial because of the populations of economically valuable invertebrates such as oysters, shrimp, and crabs. Excessive turbidity and siltation however can also cause damage to the gills of these animals. Other environmental components of an estuary, shown in the diagram, such as the seemingly barren mudflats, salt marshes and dunes, provide habitat (breeding and feeding grounds) for other wildlife such as aquatic birds and mammals.

The environmental components of coastal wetland areas such as coastal tidal marshes, inland marshes, bogs and swamps, inter-dune wetlands or dune marshes have been comprehensively described in the OCC & DC Coastal Wetlands of Oregon, August 1973. These inland environmental components which may be associated with an estuary will be mentioned herein only to the extent necessary to understand estuaries.

The same physical processes of tidal action and currents which transport sediments to the estuaries also bring nutrients for estuarine life in the form of dissolved solids (inorganic compounds such as minerals) and organic matter (large organic particles and molecules).



ESTUARY COMPONENTS

Nutrients enter the estuaries via three major routes: 1) through land drainage and river waters which leach plant nutrients from the soils and carry them through the estuary, 2) through local estuarine or river pollution and 3) as a result of the tides which carry seawater back through the estuary mouth. (3)

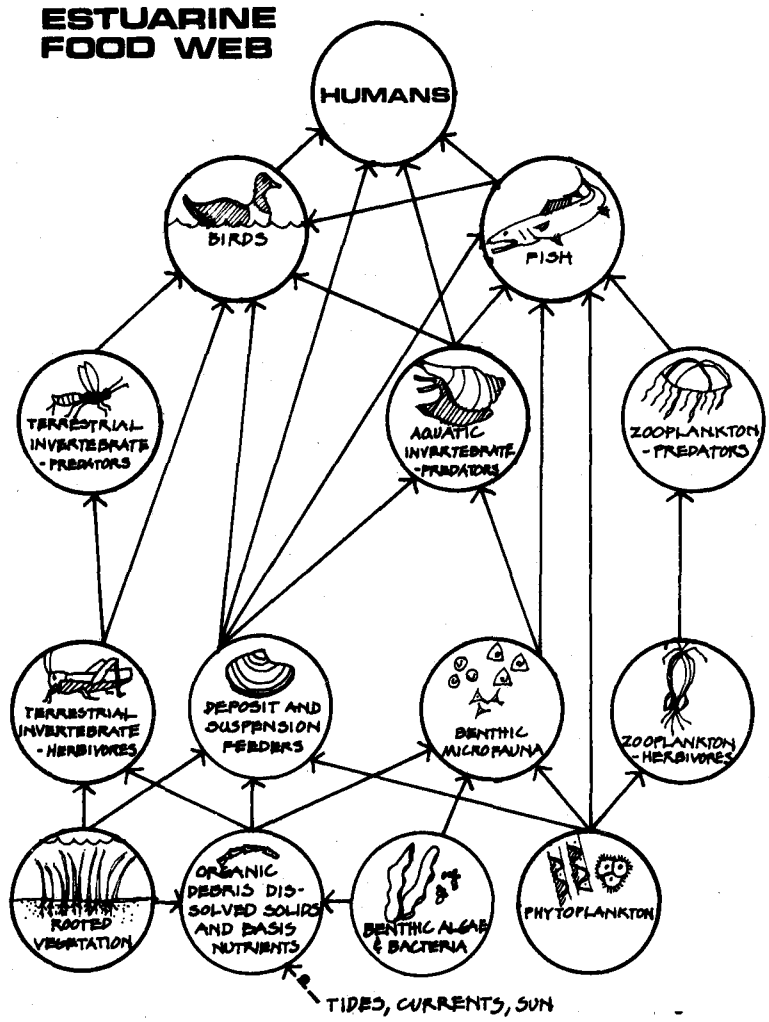
The nutrients become available for a great number of estuarine plants as a result of being carried by the tides and currents. Some of the nutrients (inorganic minerals and large organic molecules) which are held in suspension in the water will be used for phytoplankton (microscopic floating plants) growth, while those nutrients in the form of large particles which settle out in stiller waters may be used by rooted aquatic vegetation. Elsewhere, daily tidal flushing of the salt marshes allows these substances to be used by salt marsh vegetation. Lastly, some nutrients are carried back out of the estuary on the ebb tide.

Food Cycles

The introduction of dissolved solids and nutrients to an estuary and their use as food by phytoplankton and vegetation is the beginning of the estuarine food cycle as shown in the diagram on the following page. All plants and animals participate in this food cycle and consequently each plant and animal is dependent on many others. As shown in the diagram, there are basically three kinds of roles in an estuarine food cycle: 1) producers are the organisms capable of combining solar energy and inorganic materials to produce organic material. Typically producers are green plants and algae; 2) consumers are animals (herbivores) who feed directly on producers, or animals (carnivores) who feed on other herbivores and carnivores or omnivores who feed on both; 3) decomposers are those organisms which break down non-living organic matter and return basic nutrients to the cycle to be used by producers. Although these three simplified roles can be identified, the relationships between the animals and plants filling these roles are complex and almost defy definition. Food cycle relationships are sometimes called "food chains". Their complexity, however, has led others to term these relationships as "food webs". Regardless of the descriptive terms used, they all refer to the process of the conversion of basic nutrients into plants, the consumption of plants by animals, and the decomposition of plant and animal matter into basic nutrients which are then reused in the food cycle.

The specific plant and animals taking part in an estuarine food cycle as producers, consumers and decomposers vary according to the specific environmental components of the estuary, as previously illustrated in the diagram on page 8. The general interactions of the plants and animals depicted on the food cycle may be summarized as follows.

At the base of the estuarine food web are the (primary) producers; the rooted vegetation, algae and phytoplankton of the marsh lands, tidelands and shallow water. The major role of green plants in the food cycle is the production of high energy organic compounds through a process called photosynthesis. In photosynthesis green plants use the suns energy to convert carbon dioxide, water and minerals into plant material. Plants serve as the ultimate food source for all animals. Some estuarine herbivores (plant eaters) feed on live plants and others feed on detritus (dead organic material) which comes from the watershed, shoreland, wetland and estuary vegetation.


ESTUARINE FOOD WEB
HUMANS
BIRDS
FISH
TERRESTRIAL INVERTEBRATE - PREDATORS
AQUATIC INVERTEBRATE - PREDATORS
ZOOPLANKTON - PREDATORS
TERRESTRIAL INVERTEBRATE - HERBIVORES
DEPOSIT AND SUSPENSION FEEDERS
BENTHIC MICROFAUNA
ZOOPLANKTON - HERBIVORES
ROOTED VEGETATION
ORGANIC DEBRIS DIS-SOLVED SOLIDS AND BASIS NUTRIENTS
BENTHIC ALGAE & BACTERIA
PHYTOPLANKTON
TIDES, CURRENTS, SUN

Plankton provides food for a wide variety of organisms. Plankton is comprised of phytoplankton (small floating plants) and zooplankton (small floating animals, some of which mature into larger species). Zooplankton feed on phytoplankton. Zooplankton in turn provides food for many fish such as the young of many species of salmon, flatfish, rockfish, trout and a great number of small fish which later serve as forage for the larger forms. At the "top" of this food web are the economically important salmon, trout, striped bass, flounder, and shad. Some of the shellfish such as crayfish may feed on plankton as well as decaying bodies of larger animals. The food source for some adult fishes, crabs, clams, and shrimp is primarily the plankton, and to a lesser degree, algae and eelgrass. Many of the coastal waterfowl feed mainly on eelgrass as their primary food source.(4)

The eelgrass, Zostera, grows underwater and the rush, Scirpus, grows along the water's edge. Organic plant material from eelgrass beds and salt marshes provide food for the various benthic (bottom dwelling) animals. These benthic animals dwell either in the sediment or just above bottom sediments.

Most benthic animals gather food in one of three ways: First, selective particle feeders which actively capture living organisms or scavenge the organic detritus. Crabs and other mobile species are examples of selective particle feeders. Secondly, non-selective filter feeders are those that sieve water and remove particulate material. Mussels, some species of clams, and worms are examples of filter feeders. Thirdly, deposit feeders are those species which move through the sediment and take in sediment, digesting the organic matter and depositing waste. Some snails and worms are examples. Other deposit feeders bury themselves in sediment but have siphons or other extensions through which they "suck up" detritus. Benthic animals, particularly worms serve as an important source of food for fish and birds.(5)

The various animals in the estuarine systems tend to break down larger particles through chewing and digestion. Wastes generally settle to the bottom and may make up 30-50 percent of the organic sediment. The formation of fecal pellets places these particles on the bottom rather than returning them to the water to increase the turbidity. The fecal pellets are utilized by some benthic animals and are finally degraded by bacteria into basic nutrients, which can then be re-introduced in the food cycle by plants.

In summary, although there is a wide variety of physical and chemical conditions in estuaries which are in constant state of change, the physical and chemical processes of estuaries are delicately balanced and interrelated. The relationships between such processes create the conditions necessary for the formation of specific estuarine environmental components in figure on page 8. These include salt marshes, eelgrass beds, mudflats, dunes and stream channels. The specific environmental components which occur in estuaries allow specific types of plants and animals to exist. Bio-physical characteristics such as salinity, temperature, dissolved oxygen and nutrients also influence what type of animals and plants can live in the estuaries. Each link in the food cycle is related directly or indirectly to all other links. Consequently, disruption to one link in the chain may have an impact on all other organisms in the food cycle. Thus, all the parts of an estuary, both physical and biological, are related to all other parts. The continued functioning of all the parts will ensure the continued value of estuaries to people.

THE VALUE OF ESTUARIES

Estuaries can be considered in both terms of their biological value and their value to people. Ordinarily, an estuary is valued in terms of criteria such as economics or aesthetics. However, estuaries are also important as a natural system for their biological productivity, uniqueness of physical processes, and diversity of environmental components.

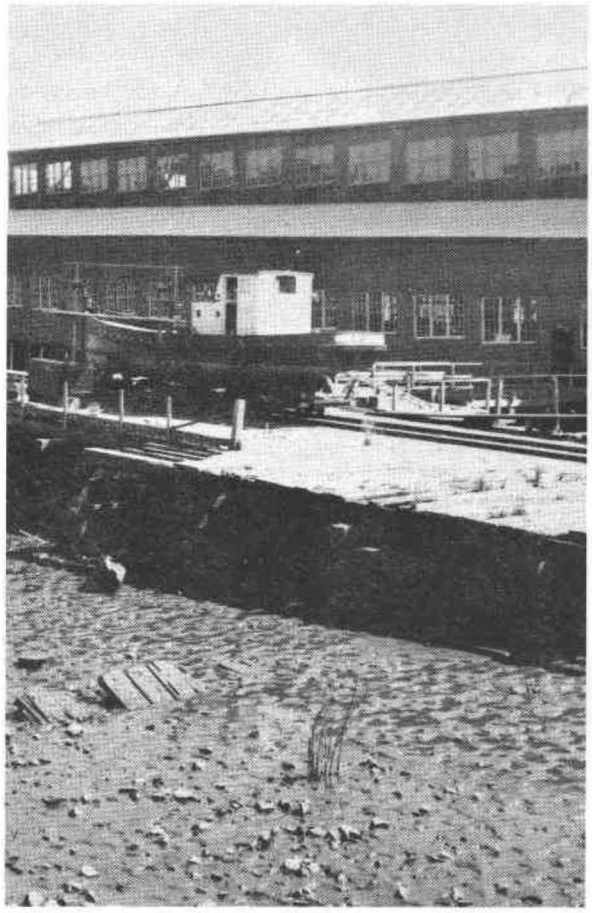
Estuaries have been ranked among the most productive areas of plants and animals on earth.(6) Other highly productive biological systems include marshes, coral reefs and rice fields. Productivity is simply the rate at which raw nutrients and solar energy are used by the biological system to produce higher organisms. Inherent in the concept of productivity is the idea of nutrient recycling through decomposition. Productivity is measured in terms of the rate of use of energy and the recycling of nutrients. Productivity is not determined merely by the quantity of plant and animal matter existing at one time (standing crop).

In most terrestrial biological communities, producers (plants) seem to comprise a greater mass than do the consumers and decomposers. For example a forest is comprised of a large bulk of vegetation which in most cases, is produced and decomposed slowly. In some aquatic communities such as estuaries, the reverse is true and at any given time it would seem that there is a far greater mass of consumer and decomposer animals. In an estuary, however, immense quantities of algae and marsh grasses are produced daily and are almost as rapidly consumed. Consequently there may not be much plant material around at any one time.

Thus, in spite of the fact that animals are more visible in an estuary, over the long run, the quantity and speed at which plant material is produced by any estuary will exceed the production of animal material.(7) In the case of estuaries, organic food in the form of plants, is derived from algae production and the twice daily flushing of the salt marshes. Much of the Oregon marine fisheries and most of the recreational fisheries are dependent on this productivity. Successful offshore and estuarine fishing for chinook and coho salmon, steelhead and cutthroat trout, flounder, green sturgeon, herring, shrimp and crabs is absolutely dependent on the estuaries both for production and nursery grounds or passage to upstream spawning grounds. Estuarine fish, crustaceans, and shellfish serve as food for numerous wading, shore and game birds.

Estuaries are also important for their wide variety of physical and chemical conditions. Without their dilute-saline environments it is likely that many economically important species of aquatic organisms would not exist. Oysters for example, thrive in a 1-2% saline solution. Significant quantities of such saline solutions only exist in estuaries. Also, the annual flushing of estuaries by fresh water inflows is a signal for anadromous fish to begin their spawning runs.

The dilute-saline environment of the estuaries serves as spawning area, nursery and feeding ground for numerous fin fishes, crustaceans, shellfish, and innumerable other invertebrates which make up the estuarine system. Many adult sea animals avoid estuaries because they cannot tolerate (withstand) the lower salinity of an estuary. However, the young of many species are capable of living in the estuary's lower salinity. The estuary serves as a protected nursery where young animals can feed and grow in an environment with few predators. The mix of marine and fresh water aquatic organisms varies according to salinity. As salinity decreases upriver, fresh water organisms become more prevalent.

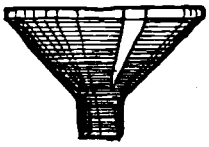


YOUNGS BAY: AN INDUSTRIAL FACILITY HAS BEEN CONSTRUCTED ON PILINGS OVER A MUD-FLAT. WHILE MUDFLATS MAY SEEM USELESS TO SOME, THEY PROVIDE A RICH FEEDING GROUND AND HABITAT AREA FOR MANY SPECIES OF BIRDS AND AQUATIC ANIMALS.

Finally, estuaries are important because they provide a diversity of habitats in very little area. Within this relatively small area, plants and animals from the fresh water, salt water and land can be found. In spite of the limited amount of estuarine environment available, it faces increasing destruction. In its report of the state of our nation and the sea, the U. S. Commission on Marine Science, Engineering and Resources (1969) showed the amounts of estuarine habitat areas lost because of filling and dredging. The percent lost ranged from 0.2 percent in Alaska to 67.0 percent in California. At least 3.5 percent of Oregon's estuarine areas have been destroyed by filling, dredging operations and diking.(8)

The importance of the tidal marsh as a nutrient source to the estuary and the role of the estuary as a nursery for marine fish and shell fish should be reason enough for their protection. Yet the pollution of estuaries and the filling of tidal marshes is having a deleterious effect on their productivity and other characteristics which make them valuable to humans.

CLASSIFICATION SYSTEM



OREGON HAS OVER 21 ESTUARIES. IN ADDITION MANY OF OREGON'S ESTUARIES ARE COMPRISED OF A WIDE VARIETY OF ARMS, SLOUGHS, AND INLETS WHICH ARE OFTEN DIFFERENT FROM THE BALANCE OF THE ESTUARY. THE TASK OF UNDERSTANDING AND FORMULATING POLICIES FOR ALL OF THESE ESTUARIES AND THEIR SUBCOMPONENTS IS ENORMOUS. CONSEQUENTLY, THIS SECTION DEVELOPS A CLASSIFICATION SYSTEM FOR UNDERSTANDING THE SIMILARITIES AMONG THE ESTUARIES AND THEIR SUBCOMPONENTS BASED ON PHYSICAL FORM, THE MIXTURE OF SALT AND FRESH WATER, THE AMOUNT OF TIDELANDS AND EELGRASS, AND THE MARINE AND TERRESTRIAL BIOLOGY.

The estuaries of Oregon with the exception of the Columbia River Estuary are the subject of this study. A number of additional smaller estuaries could be included in an expanded scope of study. The estuaries studied in this document often have a number of subcomponent arms, sloughs, and inlets which are distinctly different in biophysical and chemical characteristics from the balance of the estuary. The special characteristics of geographical subcomponents are given separate consideration within this report.

In an ideal situation, the geographical subcomponents of each estuary would be managed on the basis of their particular characteristics. However, most decision makers do not have the time or scientific background to customize land use policies and regulations on an individual basis. It is far easier to develop a single framework in which Oregon's estuaries can be understood for the purposes of policy and decision making. Such a framework can provide a basis for understanding the biophysical processes which are most critical to estuaries in a general sense.

Inasmuch as one of the primary purposes of this study is to provide a basis for the management of Oregon estuaries, it is necessary to generalize and simplify the information available. In many cases there is a scarcity of data regarding the various geographical subcomponents. There is only enough basic physical, chemical and biological data, however, to understand each estuary in a very general way. The resulting classification system will fulfill the purpose of providing a consistent framework for management decisions.

It should be noted that the classification system developed herein may prove to be of limited value for those engaging in rigorous scientific inquiry. Ultimately, such scientists must approach each estuary and its geographical components on an individual basis. Perhaps in the future, the available basic data will become more refined and will prompt adjustments to be made in the classification system developed for the purposes of this study.

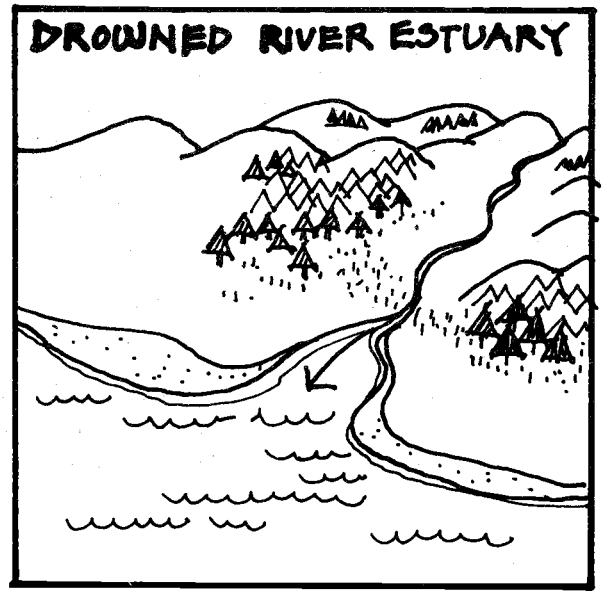
PARAMETERS DEFINED

The many attempts at classifying estuaries in the past have utilized a number of techniques and a variety of criteria to differentiate the various estuary types. Geomorphologists have classified estuaries according to configuration and physical appearances. Drowned river valleys, fault bays, fjords carved by glaciers, and coastal shelf estuaries isolated and sheltered by coastal barrier islands are examples of the estuary types identified by geomorphologists. Physical oceanographers, however, are more likely to differentiate estuary types on the basis of the chemical and physical characteristics of the gross water circulation and distribution of salinity within estuaries. Their estuaries are usually viewed as well mixed, partially mixed, or two layered, and distinguished by the magnitude of fresh water supply, tidal flow, and mixing characteristics. Biologists, meanwhile, are likely to classify estuaries on the basis of the predominant species of plants and animals in each estuary. Because the variation of plants and animals generally reflect the chemical, geological and physical parameters found in the estuaries, detailed biological information can often provide valuable insights into the entire estuary system. At this time, however, little detailed biological data is available. Consequently the parameters utilized in this estuary classification scheme must rely on the broader categories of geomorphology (physical form), mixing characteristics, general relative marine biological value, and general relative terrestrial biological value. Whereas individual geomorphologists, oceanographers, and biologists have categorized estuaries on the basis of their individual field of expertise (9), the classification system developed for this study combines the physical, chemical, and biological criteria commonly used and provides a general description of interactions within each estuary type.

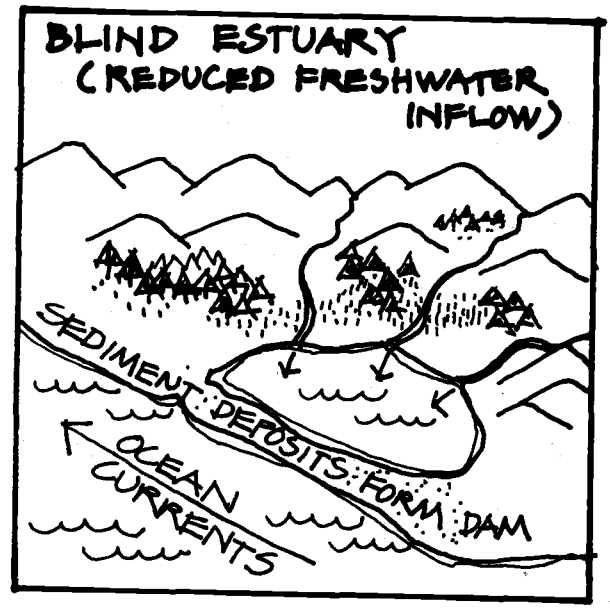
Type of Physical Form

Three basic types of estuaries along the Oregon coast can be distinguished according to physical form: 1) drowned river valleys, 2) "blind" estuaries, and 3) bar-built estuaries.

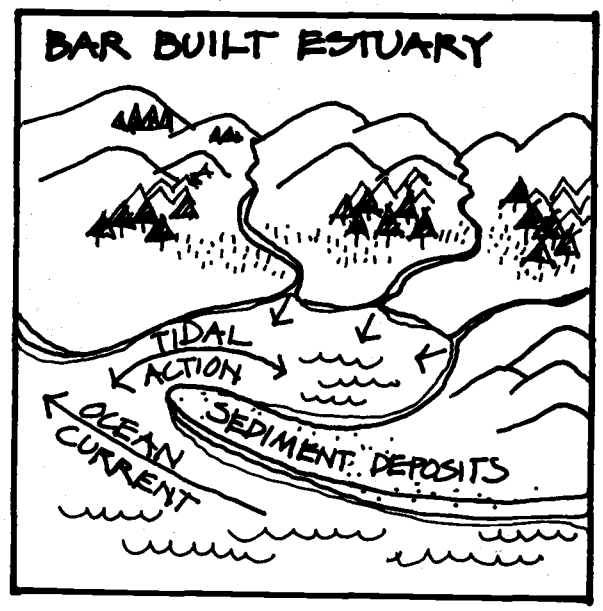
The estuaries which have formed in the inundated mouths of drowned river valleys usually retain the form of a valley in their cross-section, allowing a great deal of tidal flushing to occur. The point at which the river enters the sea is poorly defined and is dependent on the amount of fresh water inflow and tidal cycle. Most of Oregon's estuaries are of this type. Drowned river estuaries are generally the most important for commerce and shipping, due to their natural deep channels.



Blind estuaries are those which have formed in drowned river valleys where fresh water inflow is not great enough to oppose tidal action in the summer months. The deposition of sediments by the ocean seals off the estuary from the sea during part of its annual cycle, typically during the late summer. Blind estuaries are of two types. In northern Oregon, this type of estuary is saline because of the low fresh water influence and because the ocean is the primary force responsible for reopening the mouth. In southern Oregon where the rivers are steeper and "perched" higher, fresh water builds up in the estuary behing the bar. Seasonal rains eventually provide enough water to break through the bar and allow interaction with the ocean. Thus the former type has a higher salinity environment for extended periods of time while the latter supports a less saline environment.



Bar-built estuaries are those which are created by the transfer of sediments along the coast and the subsequent creation of long spits or bars extending from rocky headlands or points. The areas between the spit or bar area and the mainland forms an estuary if fresh water inflow significantly dilutes the seawater. Bar-built estuaries remain open to the sea throughout the year and are usually tide-dominated. It is not the fresh water inflow that keeps the estuary open to sea, but rather the tidal action.

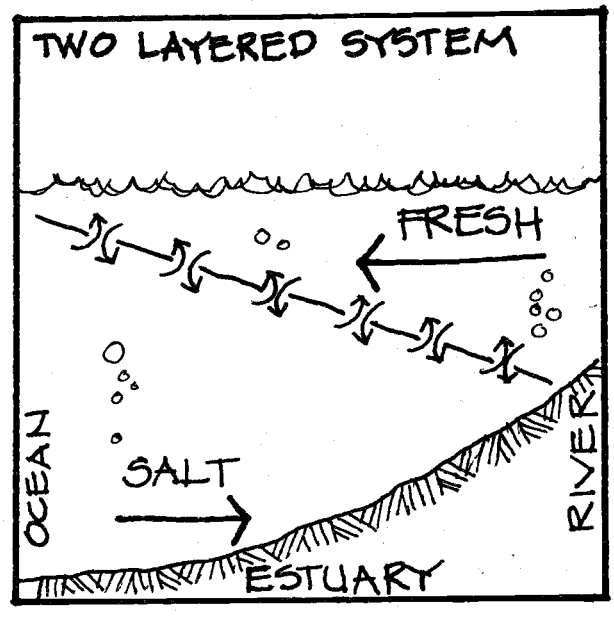


Mixing Characteristics

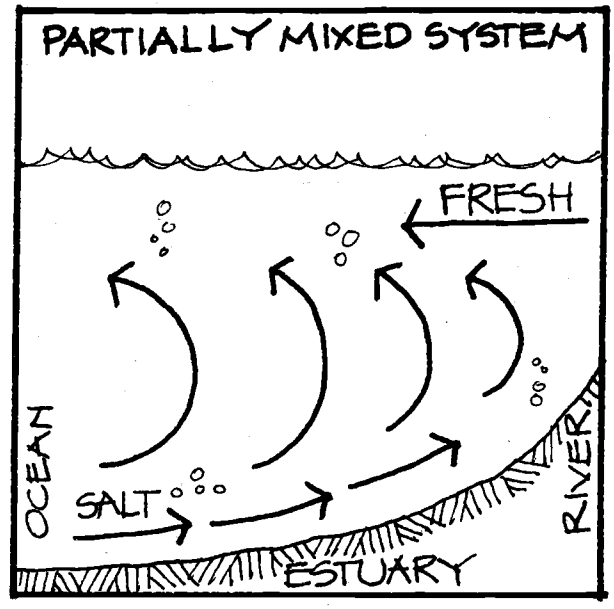
Mixing refers to the dilution of salt water and fresh water in the estuary. Salt water is brought in by the tides and fresh water flows in from the rivers and streams. Because of a multitude of physical factors, such as magnitude of fresh water inflows and the shape of an estuary, the proportions of fresh to salt water can vary widely. Depending on the physical factors involved, the heavier salt water may or may not "sink" to the bottom of the estuary. The numbers and types of fresh water, salt water, and estuarine organisms are a reflection of the salinity.

Mixing is an important parameter in that it can define a habitat both on the basis of salinity and the extent to which there is a salt and fresh water interface throughout the year. In order to "classify" the mixing characteristics of Oregon's estuaries the mixing type which predominates the estuaries circulation through the year was chosen. The following mixing types are most typical: 1) The two layered system, 2) the partially mixed system and 3) the well mixed system. The following descriptions and diagrams illustrate these different mixing characteristics.

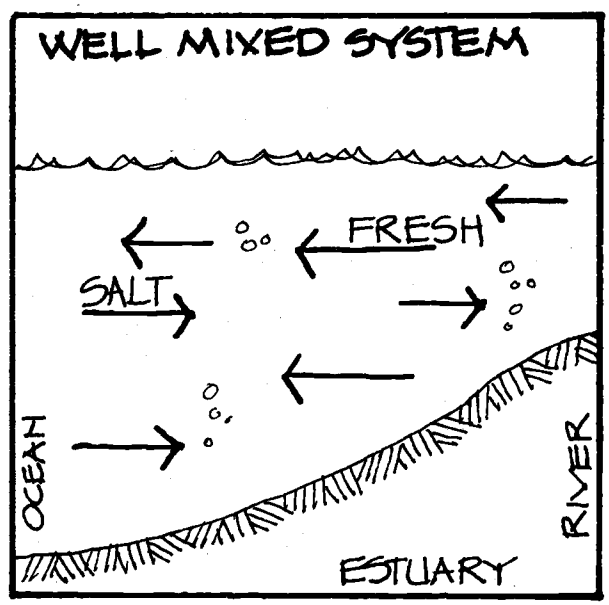
The two layered system is characterized by a large difference in the salinity of the fresh surface water flowing out and the salty bottom layer flowing in. A salt "wedge" made up of inflowing sea water, maintains a relatively constant position in the estuary along the bottom. Some of the salt water mixes at the interface with the fresh water and is again carried out to the sea by the fresh water flow. The inflow of sea water on the bottom maintains the salt wedge and balances the salt lost to the fresh water. A relatively small tidal range exists and this limits the amount of mixing which occurs. A high river run-off with large volume of water flowing seaward on the surface maintains the sharp salinity interface. The estuary has a relatively large depth-to-width ratio which also inhibits mixing. The difference between the surface salinity and the bottom salinity will be greater than 20 percent.(10)



The partially mixed system also has a difference between the salinity of surface and bottom waters, but without the sharp interface of the two layered system. Relatively moderate to strong tides contribute the energy required to bring about moderate mixing between the surface fresh water and the bottom salt water. Moderate run-off also leads to greater mixing as a sharp interface is not maintained. The estuary has a moderate depth to width ratio which enhances mixing. The difference between the surface salinity and the bottom salinity is 4 percent to 19 percent.(11)



In the well mixed system little difference in the salinity of surface and bottom water exists. A relatively large tidal range exists and provides turbulent energy for complete mixing. There is a very low range run-off which allows vertical mixing to be complete. And a low depth to width ratio exists so that the estuary is shallow and may have tidal flats. This low ratio tends to concentrate the turbulent mixing brought about by the tides. The difference between surface salinity and bottom salinity is 3 percent (12) or less.



Over a years time, most estuaries exhibit more than one, and in some cases, all of the above described mixing characteristics. In almost all of the drowned river estuaries, various stages of two layered and partially mixed systems will occur. Some will also exist as well mixed systems during the times of extremely low fresh water inflows.

An estuary which might go through all three mixing systems in the course of an annual cycle could be described as follows. During the winter and spring, snow-melt combined with high rainfalls in the estuary watershed (area from which water is drained) cause high peak flows in the river which flows into the estuary. The lighter fresh water spreads over the surface of the estuary and by the force of its mass, displaces the previously well mixed surface. Once a stable condition is reached, the heavier salt water layer will reach an equilibrium position and will move in and out with the tide. The relatively small amount of salt water that is literally torn from the interface, is diluted and flows out with the overlying fresh water.

As the fresh water inflow becomes lessened during certain times of the year, mixing becomes possible and the distinct line between salt and fresh water begins to disappear. This generally occurs during late spring/early summer and during late fall/early winter.

During the summer and early fall high tides and low fresh water run-off from the land combine to transform the estuary into a vertically homogenous system that shows very little difference in salinity from surface to bottom.

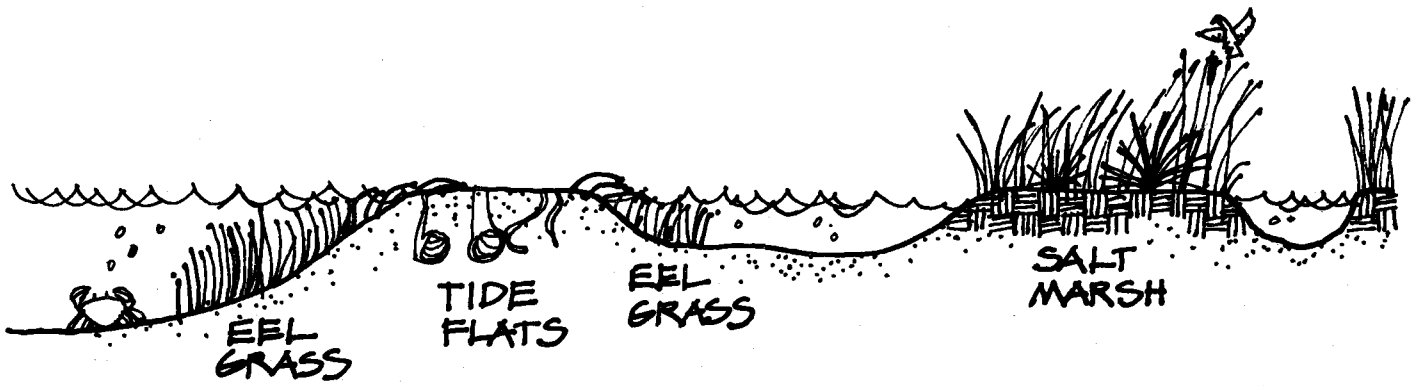
Tidelands and Eelgrass Beds

The percentage of tidelands and eelgrass beds which make up the total estuarine area has been calculated for each estuary and used as an index of estuarine productivity. The classifications of high, moderate, and low percentages are used as a relative measurement of the potential productivity of an estuary. Tidelands are not only important as feeding ground, but also as spawning and nursery grounds. For example, the shiner surfperch, which is one prey of striped bass, spawns over eelgrass in the Coos Bay estuary. Juvenile dungeness crab feed on mudflats at high tide.(13)

The silts, sands, and pebbles of all estuarine deposits take their form as a result of the mechanical separation of the different particle sizes.(14) The depositional areas of these particles of different sizes is a function of the water ability to transport them and, in some cases, the interaction of the particles with sea water. A high velocity current will transport not only greater quantities of material, but also the material transported will have larger particle sizes than the material carried in a low velocity current. The deposition is thus controlled by the currents velocity and the particle size of the sediment.

Many important biological parameters are influenced by the particle sizes of estuarine deposits. For example, the concentration of bacteria is much higher in finer sediments than in coarser sediments. Bacteria in the sediment are rarely studied and are generally unknown estuarine organisms responsible for the degradation of both algal and animal organic wastes into dissolved solids and nutrients. (15) Organic carbon and nitrogen, the basic components of life, have higher concentrations in fine sedimentary deposits than the coarser deposits.(16)

The tidelands of Oregon's estuaries vary from coarse gravels to find muds. Muds are nutritionally very rich, but are difficult to colonize by surface animals and thus support organisms which live predominantly in the sediments such as bacteria, clams, worms, and shrimp.(17) The problems associated with fine muds are exemplified in the plight of the native oyster Ostrea lurida which is unable to tolerate muds because it would smother. These bare muds are initially colonized by the species of eelgrass, Zostera, a grass-like flowering plant. Eelgrass is generally a shallow water plant, but it does occur in the bays and along channels. Mudflats with an abundance of eelgrass supports a wider variety of organisms than uncolonized mudflats and provides as the staple winter food form any waterfowl species, especially the black brant.(18) Eelgrass supports animals which live among its roots, at its bases and on its blades. It also contributes large quantities of organic detritus upon which feed a variety of estuarine animals, (clams, crabs, shrimp, fish, and waterfowl). The numbers and types of animals and plants in the tideflats, and eelgrass beds and marshes support the wide variety of animals important to man commercially, recreationally and aesthetically.



For the purpose of classifying estuaries on the basis of tideflats and eelgrass beds, the total percentage of all the estuaries surface area comprised of tideflats and eelgrass beds was calculated from maps prepared for the OCC&DC inventory report "Fish and Wildlife Habitats of the Oregon Coastal Zone." Tideflats and eelgrass bed areas were calculated at mean sea level (MSL) and compared to the total estuarine area, also computed at mean sea level, as shown on data maps prepared by the Oregon Division of State Lands.

In the classification system, High, Moderate, and Low ratings were applied to each estuary according to the following table:

Eelgrass Beds		Tidelands	
Greater than 10%	: High	Greater than 50%	: High
2.1% - 99%	: Moderate	31% - 49%	: Moderate
Less than 2%	: Low	Less than 30%	: Low

If no information was available for a given estuary, it was rated according to on-site observations.

Biology

Terrestrial Components:

The relative productivity, health and degree of modification of any ecosystem can generally be determined by comparing the diversity of plant and animal species of one area with another area. For example, urban environments usually support great numbers of only a few species of mammals and birds, (rats, mice, starlings, robins, etc.). Nearby agricultural areas may support twice as many species of animals, and undisturbed marshlands may, in turn, support four or five times as many species of animals as the urban environment.

For the purposes of this study, an approach was developed to measure the variety and complexity of each estuary in order to categorize the Oregon estuaries according to the high, moderate or low value of their associated terrestrial wildlife and plant species. On-site observations provided much of the basic data for classifying the estuaries on the basis of the relative value of the terrestrial wildlife and plant species. An extensive secondary research effort supplemented the field work.

Basically five factors were analyzed for each estuary in order to determine relative diversity: 1) the complexity of the physical form of the estuary, 2) the extent and types of mudflats, eelgrass beds and wetlands (see OCC&DC Coastal Wetlands of Oregon, August 1973), 3) the type of land/water edge conditions with particular consideration towards the type of adjacent land uses; 4) the percentage of the total Oregon coastal waterfowl use accommodated by each individual estuary and, 5) the "special features" of each estuary, such as heron rookeries, eagle nests, otter, seal or sea lion colonies and unique botanical areas.

The first, estuary complexity, refers to the character and variety of the estuary's physical form. Estuaries which have broad open bays, narrow shallow inlets, sheltered warm coves, deep cold channels and a variety of islands, for example, attract and support a greater variety of wildlife than estuaries that can offer only one or two types of surface water habitats.

Secondly, the extent of eelgrass within each estuary is an indicator of the estuary's marine productivity (which relates directly to the wildlife productivity of the estuary). Mudflats and wetlands are, in general, the most productive portions of an estuary. Many species of wildlife (particularly shorebirds) rely upon the mudflat environment. The type of mudflat is an important consideration; gravel-bars and coarse sand "mudflats" are, for example, typically less productive

and valuable than silty or fine sand "mudflats". Many species of wildlife (particularly furbearers and birds) are dependent upon the estuarine wetlands, particularly salt marsh wetlands. The type of wetlands is quite important; certain species of birds and mammals are only associated with certain wetland types. The most valuable estuaries are those which provide a number of different wetland habitats.

The character of the land/water edge plays a major role in determining what species of wildlife are found in which estuaries and how many occur. An estuary does not necessarily attract large numbers of waterfowl, shore birds and other wildlife because it has large eelgrass beds, a high percentage of silty mudflats, and a great diversity of wetland habitats covering many acres. If the estuary is surrounded by intense urban uses or human activity, many species intolerant of human activity which would otherwise be found at that estuary will not occur there. The land edge character is also important, for another reason. A diversity of land edge habitat types is likely to support a diversity of wildlife species and provide a greater number and variety of living spaces than an estuary with only one or two habitat types on its land edges. The adjacent land character is an important consideration because many estuary wildlife species depend on habitats of the surrounding areas for at least some of their habitat requirements. For example, many geese and "grazing" ducks can't successfully winter in a protected estuary unless suitable fields and pastures are available nearby for feeding.

Each estuary's proportion of the total "waterfowl-use-days" of the Oregon coast accommodated by each individual estuary was used as a check that the field study and estimations of relative habitat value did in fact reflect actual conditons.

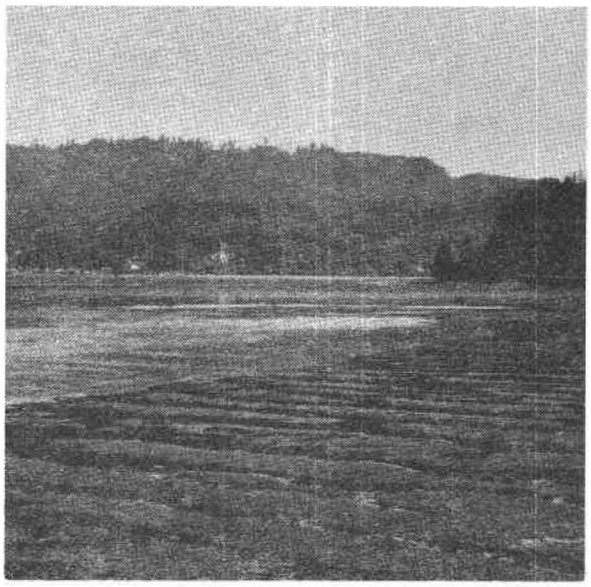
The final factor for rating terrestrial biological value was unique flora or fauna and other special features. The consideration of special features did result in adjusted ratings for some borderline estuaries.

In summary, estuaries were rated as very high, high, moderate, low and very low in terrestrial wildlife value according to the complexity of physical form; the percentage of eelgrass beds, mudflats and wetlands; and the complexity of their land/water edge habitats. Then, waterfowl use days and special features if any, were used to modify the classification.

Marine Components:

Whereas the previous components of the classification scheme have been oriented towards the estuary as a natural entity, the calculation of the marine biological component is more human-oriented. Very little concrete information exists on the marine productivity of the estuaries which would be useful in a comparative sense. Consequently, the available anadromous fish spawning data for each estuary was used in combination with Fish Commission of Oregon statistics regarding those major groups of invertebrates caught by man, for recreational and commercial purposes. The classification depends on information regarding the following animals; chinook, coho, and chum salmon; steelhead and cutthroat trout; dungeness and red rock crabs; ghost and mud shrimp; and native littleneck, soft shell, cockle, butter and gaper clams. Oyster grounds and herring spawning grounds were also considered.

Since the numbers of these larger animals available for spawning and recreational use probably reflect the productivity of the food components of the estuary, it was concluded that the classification should have a high degree of value for the relative comparisons of estuaries. It is obvious that the loss of the food supply for the chinook salmon, for example, would also result in lowering of the number of chinook in the estuary or even the total loss of the spawning population.

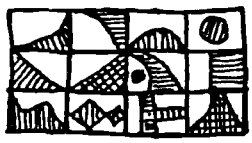


THIS PHOTO ILLUSTRATES A MUD-FLAT EXPOSED AT LOW TIDE. MUD-FLATS ARE NUTRITIONALLY RICH AND SUPPORT SUCH ANIMALS AS CLAMS, CRABS, SHRIMP AND WORMS.

A high, moderate, or low relative marine biological component was determined for each estuary by comparing its major marine biological values to an average established for all the estuaries according to the following method. The mean number (arithmetic average) of individuals, for all estuaries, of each species of anadromous fin fish and each invertebrate species listed above was established by combining the information from the 'Description and Information Sources for Oregon Estuaries' and the 'Fish Commission of Oregon's Division of Management and Research: Resource Use Studies for Each Estuary'. After the mean for all the estuaries had been calculated, the availability of anadromous fish and invertebrates of the individual estuaries was compared with the mean. If the individual species of the estuary was above the $\pm$ 15% range of the mean number for all estuaries its relative marine biological component was rated as high in value. If it was within the $\pm$15% range, its relative marine biological component was rated moderate. If it was lower, the marine biological component was considered to be low relative to the other estuaries.

It will be stated that this method is not optimum, but the state of information regarding the biological productivity of Oregon's estuaries is quite poor. In some cases, absolutely no data or information exists at all. However, in the effort to add some concrete objectivity to this study, it was necessary to depend on the available information.

12 ESTUARY TYPES



AS A RESULT OF THE CLASSIFICATION SYSTEM DEVISED IN THE PREVIOUS SECTION, 12 HYPOTHETICAL OREGON ESTUARY TYPES ARE DERIVED. MOST OF THE MANY ESTUARIES AND THEIR SUB-COMPONENT ARMS, SLOUGHS AND INLETS CAN BE DESCRIBED IN TERMS OF THE CHARACTERISTICS OF THE 12 HYPOTHETICAL OREGON ESTUARY TYPES.

Oregon's estuarine resources are contained within at least 21 separate and distinct estuaries. Many of these in turn, can be divided into several separate and distinct geographical subcomponent units which differ from one another in their biophysical and human use characteristics. The task of dealing with each of these 40 to 50 estuary subcomponents in explaining the concepts important to the development of a management program is quite unwieldy. For the purposes of this study, a classification scheme has been devised to allow a more manageable basis for discussing Oregon's estuaries. This system provided a means for combining similarities found in all estuaries and their subdivisions in terms of the following parameters discussed in the previous section: 1) physical type, 2) mixing characteristics, 3) extent of tidelands and eelgrass beds and 4) the terrestrial and marine biological values. These combinations of parameters have yielded 12 hypothetical estuary type classifications which encompass all of the Oregon estuaries and their subcomponent units. Each estuary type is unique and has a specific combination of biophysical parameters. It also follows that each estuary type will have unique values and will be most suited for a specific set of uses. The management of each estuary should take into account the particular characteristics of the estuary type.

DETAILED DESCRIPTION OF EACH OREGON "ESTUARY TYPE":

ESTUARY TYPE I: "BLIND"/WELL MIXED ESTUARIES WHICH HAVE MODERATE MARINE BIOLOGICAL VALUE AND LOW TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A LOW PERCENTAGE OF EELGRASS AND TIDELANDS.

In terms of physical characteristics, these estuaries are generally small and during periods of low river flow and high sand accumulation, they may become closed off from the ocean. Sand and gravel are the most frequent particle size in the bottom sediments. The major rivers feeding these estuaries have steep stream gradients and narrow flood plain areas. Due to the coarse nature of sediments in the river channels, subsurface flow may comprise a large portion of the total flow. Sediment yield from the drainage basin is generally low. Extensive areas of sand dunes are not common for the area surrounding this type of estuary.

Type I estuaries are not complex in physical form. They have a low percentage of eelgrass (almost none). They have a low percentage of tidelands, and a low

percentage of diked, intertidal gravel, or inland marshes. Tidelands comprise less than 30% of the total estuarine area. Their land edge character is diverse and rather natural; the adjacent land character is diverse and provides moderately valuable big game wintering range and waterfowl feeding sites.

The marine biological component of this estuary type consists primarily of information pertaining to anadromous fish runs: chinook and coho salmon, and steelhead and cutthroat trout. This estuary type has a moderate number of anadromous spawning fish. The numbers of anadromous spawning fish are close to an average for all the Estuary Types. The extensive gravel beds which typify this estuary type are unique to the estuaries of Oregon and provide a highly suitable habitat for fish.

ESTUARY TYPE II: BAR BUILT/WELL MIXED ESTUARIES WHICH HAVE HIGH MARINE BIOLOGICAL VALUE AND HIGH TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A HIGH PERCENTAGE OF EELGRASS AND TIDELANDS.

Type II estuaries have small watersheds with a number of minor tributaries and no major rivers. If it were not for their sandspits, these estuaries would exist as open bays. Both mudflats and sandflats are present within the tidelands area. Presently inactive landslide areas are characteristic of their watersheds. The deposition of sediments in these estuaries by their tributaries is low.

Type II estuaries are high in complexity of physical form and have a high percentage of eelgrass (greater then 2.1%) and a high percentage of tidelands (greater than 60% of the total estuary). The wetlands are usually mature tidal marshes. The land edge character is moderately diverse and natural. The adjacent land character is natural and low in diversity.

Type II estuaries are characterized by the general absence of the spawning runs of any anadromous fish. The classification is based on the moderate presence of the dungeness and red rock crabs, high numbers of ghost and mud shrimp, and high numbers of softshell, native littleneck, cockle, butter and gaper clams, which thrive on the sand and mud substrate. This estuary type is also characterized by high saline waters and has the potential for being periodically cut-off from the influence of the tides.

ESTUARY TYPE III: DROWNED RIVER/WELL MIXED ESTUARIES HAVE VERY LOW MARINE BIOLOGICAL AND MODERATE TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A VERY LOW PERCENTAGE OF EELGRASS AND TIDELANDS.

Type III estuaries are comprised of small estuaries which may be entirely closed off from the ocean during periods of low river flow. Estuary shoreland areas that receive periodic flooding are very large compared to the size of the stream and the estuary.

Type III estuaries display a moderate complexity of form and have a very low percentage of eelgrass beds (less than 2%) and a very low percentage of tideland (less than 30%). The adjacent land as well as the land edge character is moderately diverse, and is comprised of inland marsh types in a fairly natural state.

The creeks have sediments of mixed sand, gravel and mud. The sediment types combined with low salinities limit this estuary type to low anadromous fish runs

and few marine invertebrates. Scarce marine biological information existed for estuaries of this type at the time of this study, consequently, parameters were described on the basis of personal observation and comments by local citizens.

ESTUARY TYPE IV: DROWNED RIVER/WELL MIXED ESTUARIES HAVE LOW TO MODERATE MARINE BIOLOGICAL VALUE AND VERY LOW TERRESTRIAL VALUE. THEY HAVE A LOW TO MODERATE PERCENTAGE OF EELGRASS AND TIDELANDS.

Type IV estuaries occur in broad lowland areas of large bays with numerous arms, sloughs or inlets. Fresh water input to these estuaries is relatively minor. The inorganic sediments usually consist of silt and clay with some gravel. Unprotected bank areas are highly erodable.

Type IV estuaries are not complex in physical form. They have a low to moderate percentage of eelgrass beds (less than 9.9%) and a moderate percentage of tidelands (between 31% and 49%). The land edge and the adjacent land is not very diverse and is primarily urban in character.

Type IV estuaries generally support a few small anadromous fish runs of chinook and coho salmon, and steelhead and cutthroat. Low numbers of dungeness and red rock crabs are taken, but high numbers can occur. The absence of softshell, native littleneck, cockle, butter and gaper clams is noted as well as the presence in moderate to high numbers of ghost shrimp.

ESTUARY TYPE V: DROWNED RIVER/WELL MIXED ESTUARIES HAVE LOW TO MODERATE MARINE BIOLOGICAL VALUE AND HIGH TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A MODERATE PERCENTAGE OF EELGRASS AND TIDELANDS.

Type V estuaries are large and have major rivers flowing through them. Mudflats predominate over sand flats throughout most of the tidelands. Most of the slopes surrounding estuaries of this type are gentle. Sedimentation in the estuaries occurs at a rapid rate.

Type V estuaries are low in complexity of physical form. They have a moderate percentage of eelgrass (2.1% to 9.9%) and tidelands (31% to 49%). The immature high marsh wetlands are not diked, although in other estuaries such marshes are usually diked. Their land edge and adjacent lands are low in diversity and have been greatly affected by human activity.

Type V estuaries generally have small anadromous fish runs of chinook and coho salmon and cutthroat and steelhead trout. Dungeness and red rock crabs, ghost shrimp, and softshell, native littleneck, cockle, butter and gaper clams are all harvested in high numbers.

ESTUARY TYPE VI: DROWNED RIVER/WELL MIXED ESTUARIES WHICH HAVE MODERATE MARINE BIOLOGICAL VALUE AND MODERATE TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A LOW PERCENTAGE OF EELGRASS AND A HIGH PERCENTAGE OF TIDELANDS.

Estuaries of this type are small sloughs adjacent to a major estuary. Sediments within this type are predominantly muds. Surrounding slopes are gentle.

Type VI estuaries are not complex in physical form. They support little or no eelgrass (less than 2%), but do have a high percentage of tidelands (greater than 60%). Neither their land edge or adjacent land character is complex. The

adjacent land is comprised of a very low percentage of immature and mature high marshes. Although some of these wetlands are diked, they are of moderate value for wintering waterfowl.

This estuary type is characterized by sloughs which contribute high quantities of organic detritus to the estuaries in which they are located. Spawning grounds, nursery areas, and fishing areas for a moderate number of fish and invertebrate crustaceans and clams are prevalent.

Because there is absence of biological information or when the information is available it is incomplete, classification of the marine components of estuaries of this type is based on on-site observations.

ESTUARY TYPE VII: DROWNED RIVER/WELL MIXED ESTUARIES WHICH HAVE MODERATE MARINE BIOLOGICAL VALUE AND HIGH TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A MODERATE TO HIGH PERCENTAGE OF EELGRASS AND TIDELANDS.

Within this estuary type are the sloughs adjacent to a major estuary. Direct fresh water inflow is minor. The bottom sediments are fine muds with some local concentrations of sand where shoreline erosion is rapid or where stream processes have a strong influence. Slopes of the surrounding areas are usually gentle to moderate.

Type VII estuaries are moderately to highly complex in form. They have a moderate to high percentage of eelgrass (greater than 9.9%) and are usually moderately high in tidelands (greater than 49%). Their land edge character is high in complexity and their adjacent land character is diverse and is comprised of a high percentage of wetlands. In general, Type VII estuaries have remained in their natural state with few human alterations.

As with the previous estuary type, biological information pertaining to this estuary type is generally non-existent.

ESTUARY TYPE VIII: DROWNED RIVER/PARTIALLY MIXED OR TWO LAYERED ESTUARIES WHICH HAVE LOW OR MODERATE MARINE BIOLOGICAL VALUE AND VERY LOW TO LOW TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A LOW TO MODERATE PERCENTAGE OF EELGRASS AND TIDELANDS.

Estuaries of this type have small to medium sized watersheds with rivers which have corresponding low to medium stream flow. Bottom sediments range from mud to sand and gravel. The physical characteristics of these estuaries and the surrounding areas vary greatly. They are grouped together principally on the basis of biological and mixing information.

Type VIII estuaries are low in complexity of physical form. They have a low to moderate percentage of eelgrass beds (less than 9.9%) and tidelands (between 31% and 49%). The land edge and adjacent land character is low in diversity and relatively urban.

Type VIII estuaries have small numbers of anadromous fish runs of chinook, coho and chum salmon, and steelhead and cutthroat trout. Dungeness crab, ghost and mud shrimp and softshell clams are taken, but in low numbers.

ESTUARY TYPE IX: DROWNED RIVER/PARTIALLY MIXED OR TWO LAYERED ESTUARIES HAVE LOW TO MODERATE MARINE BIOLOGICAL VALUE AND A HIGH TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A LOW TO MODERATELY HIGH PERCENTAGE OF EELGRASS AND A MODERATE TO HIGH PERCENTAGE OF TIDELANDS.

The slopes of adjacent areas may be gentle to very steep.

Type IX estuaries exhibit a moderate complexity of physical form. They possess a low to high percentage of eelgrass and a moderate percentage of tidelands. Their land edge and adjacent land character is moderately diverse and relatively natural and is comprised of a high percentage of diked, bulrush, sedge and high marsh wetlands.

The marine biology of Type IX estuaries is similar to Type VIII estuaries. Type IX estuaries have small numbers of anadromous fish runs of chinook, coho and chum salmon, and steelhead and cutthroat trout. Dungeness crab, ghost and mud shrimp and softshell clams are taken, but in low numbers.

ESTUARY TYPE X: DROWNED RIVER/PARTIALLY MIXED OR TWO LAYERED ESTUARIES HAVE MODERATE MARINE BIOLOGICAL VALUE AND MODERATE TO HIGH TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A LOW TO MODERATE PERCENTAGE OF EELGRASS AND TIDELANDS.

These estuaries have large watersheds and have higher than average stream flows. The estuaries themselves are medium sized. The bottom sediments range from sand to mud. Slopes of the area are gentle to moderate. The sedimentation load is fairly high.

Type X estuaries have a high complexity of physical form. They have a low to moderate percentage of eelgrass (less than 9.9%) and tidelands (between 31% to 60%). Their land edge and adjacent land character is diverse and are usually comprised of a high percentage of low salt marshes, immature and mature high marshes and diked wetlands.

Type X estuaries are characterized by moderate to high anadromous runs of chinook, coho, and chum salmon and steelhead and cutthroat trout. High numbers of shrimp are harvested. Dungeness crabs and softshell clams are represented in low numbers.

ESTUARY TYPE XI: DROWNED RIVER/PARTIALLY MIXED OR TWO LAYERED ESTUARIES HAVE HIGH MARINE BIOLOGICAL VALUE AND MODERATE TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A LOW TO MODERATE PERCENTAGE OF EELGRASS AND TIDELANDS.

Estuaries of this type have a very large watershed. Fresh water inflow is average. Bottom sediments range from mud to sand and gravel. Sedimentation can be a problem.

Type XI estuaries are low in complexity of physical form. They possess a low to moderate percentage of eelgrass (less than 9.9%) and tidelands (less than 60%) (mostly sandy or gravelly). Land edges and adjacent lands are fairly diverse, but are relatively urbanized with little remaining wetlands.

Type XI estuaries are characterized by large anadromous fish runs of chinook, coho, and chum salmon, and steelhead and cutthroat trout. Low numbers of marine invertebrates are harvested.

ESTUARY TYPE XII: DROWNED RIVER/PARTIALLY MIXED OR TWO LAYERED ESTUARIES HAVE HIGH MARINE BIOLOGICAL VALUE AND HIGH TERRESTRIAL BIOLOGICAL VALUE. THEY HAVE A MODERATE PERCENTAGE OF EELGRASS AND TIDELANDS.

Estuaries of this type have medium sized to very large watersheds. The overall size of the estuary is average to large. Fresh water inflow is substantial and is maintained throughout the year.

Type XII estuaries are highly complex in physical form. They support a moderate percentage of eelgrass (less than 9.9%) and tidelands (31% to 49%). Their land edge character is moderate to high in complexity; their adjacent land character is diverse and somewhat urban. They possess a high percentage of wetlands of the diked marsh, immature high marsh, and mature high marsh types and lesser amounts of sedge marsh and bulrush marsh types.

Type XII estuaries are characterized by large anadromous fish runs of chinook, coho, and chum salmon, and cutthroat and steelhead trout. Dungeness and red rock crabs, ghost and mud shrimp, and softshell, native littleneck, cockle, butter, and gaper clams are generally taken in high numbers.

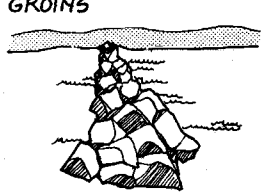
ACTIVITY IMPACTS

EVERY MAJOR ACTIVITY IN WHICH MAN ENGAGES HAS AN IMPACT ON THE ENVIRONMENT. THE TYPE OF ENVIRONMENTAL IMPACT VARIES ACCORDING TO THE TYPE OF ESTUARY IN WHICH THESE ACTIVITIES ARE PERFORMED. THE RELATIONSHIPS BETWEEN ENVIRONMENTAL IMPACT OF ACTIVITIES AND THE TWELVE ESTUARY TYPES ARE ILLUSTRATED.

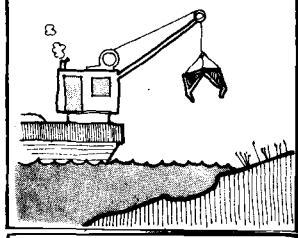
The unique commercial and aesthetic resources provided in estuaries, have attracted business, industry and agriculture and the subsequent development of communities and cities along the shorelines. Many alterations to the natural estuary condition have been made in order to increase the potential of the systems to provide for various human activities. It has been explained earlier in this report that estuaries are balanced, interrelated systems. This section will seek to demonstrate that they may be altered appreciably by human action. In order to define the extent of man's affect on the estuarine resources, the following impact matrices have been developed. Thirty-one shoreland, estuaries, and watershed activities have been identified as human actions which may produce qualitative change in the estuary systems.

The generalized level of impact of each activity upon each of the estuary types which were derived in the previous section is here presented in a simplified matrix format. To determine the generalized impact of an activity in a specific estuary type:

1. Determine which estuary type fits the estuary of interest.
2. Find the activity in the matrix; read the activity description.
3. Read the impact level which corresponds to the estuary type determined in Step 1.
4. Most impact level indicators are keyed to footnotes; read the footnote which corresponds to the impact indicator selected, to understand how the level of impact was determined.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	ESTUARY TYPE 1	2	3	4	5	6	7	8	9	10	11	12
JETTIES, BREAKWATERS, GROINS 	Jetties: Rock mounded structures extending from the shore to guide the flow of water. Groin: Rock mounded structures extending into the channel to control bank erosion. Breakwater: Rock mounds or blocks of concrete and stone constructed in open sea to dissipate the energy of the waves.	HIGH	A	A	A	B		B	B		B			
		MEDIUM										A		
		LOW					C			A			A	C

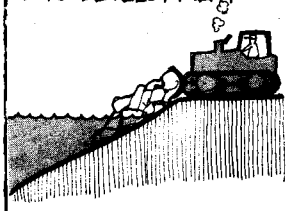
FOOTNOTES: A. Can destroy character of the estuary and reduce biological diversity. Offshore littoral drift can be affected. Jetties are usually self-extending and lead to dredging. B. Out of character with the estuary. Construction impacts would greatly alter the estuary. C. Consistent with present use.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	ESTUARY TYPE 1	2	3	4	5	6	7	8	9	10	11	12
DREDGING 	Dredging is the mechanical removal and replacement of bottom sediments. Methods include pumping, dragline, and clam shell dredging. Disposal of dredged materials may take place on land or tideflat areas, or in the open ocean.	HIGH		A	A				A		D	D		
		MEDIUM				B	C						E	D
		LOW												

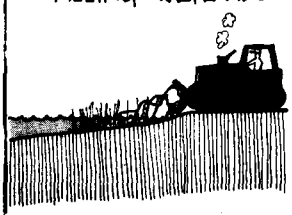
FOOTNOTES: A. Pristine, natural environment would be destroyed. B. Bank removal may be beneficial. May increase current action and flushing rates. Polluted bottom materials would be stirred up. C. May increase current action and rates. D. Important land edge/water edge habitats would be impacted. E. Consistent with present use.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
DISPOSAL OF DREDGED MATERIAL IN OR NEAR ESTUARY 	Placement of sediments removed from estuary channel on either adjacent land areas, or in the open sea.	HIGH		A	A			B	B			D		
		MEDIUM				B				C	B		E	F
		LOW												

FOOTNOTES: Causes particle size change, reduces sediment turnover, reduces biota. Greatest impact occurs with in-water disposal. Runoff from spoils adverse impact, siting and methods are important. A. Too small. B. No flushing. C. Well flushed. D. Habitat displacement. E. Timing important to minimize biological impacts. F. High biological value of land edge/water edge habitats.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
FILLING IN ESTUARIES FOR DEVELOPMENT 	Placement of fill materials in estuary lands to raise land above the level of tidal influence.	HIGH												
		MEDIUM												
		LOW												

FOOTNOTES: This is an irreversible action which depletes the already too small supply of estuaries, sedimentation and turbidity become important major problems. Important fringe habitats in tidelands and eelgrass beds are destroyed.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
FILLING WETLANDS 	Placement of fill materials in wetlands to raise land above the level of tidal influence.	HIGH												
		MEDIUM												
		LOW												

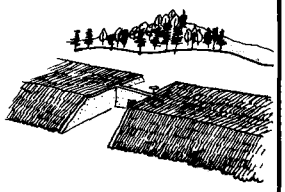
FOOTNOTES: Wetlands are a vital part of estuarine system, providing detritus and nutrients for biological systems. Fill is also a source of turbidity and negatively impacts marine biological components.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
DIKES FOR WETLANDS RECLAMATION FOR AGRICULTURE 	Construction of earthen banks around wetland areas to prevent tidal inundation and provide for agricultural use of the land	HIGH		A	A									
		MEDIUM												
		LOW				B								

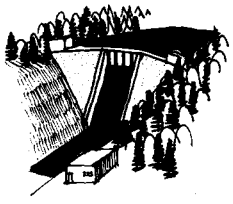
FOOTNOTES: A. Not compatible with estuary uses. Would destroy character of the estuary. B. Consistent with present uses. All other types: Increases stream velocity and sedimentation in main channel. Loss of important wetland habitat areas.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
SEAWALLS, RIPRAP, BULKHEADS 	Seawall: Wall or embankment protect shoreline areas from erosion. Bulkhead: A vertical, or near vertical structure used to retain fills, filled areas or eroding natural areas. Riprap: Foundations or sustaining wall of stones placed upon a bank to prevent erosion.	HIGH		B					E					
		MEDIUM	A		A			E			E	E		E
		LOW				C	D			E			F	

FOOTNOTES: A. Creates barrier. Loss of remaining shoreline habitats impacts terrestrial wildlife. B. Would destroy pristine, natural environment. C. Beneficial for erosion control. D. With selective siting. E. Siting important, could adversely affect wildlife habitats. F. Consistent with present use.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	ESTUARY TYPE 1	2	3	4	5	6	7	8	9	10	11	12
TIDEGATES 	Tidegates are structures which are placed in a water channel to prohibit inflow of salt water during high tides.	HIGH	■	■	■	■	■	■	■	■	■	■	■	■
		MEDIUM												
		LOW												

FOOTNOTES: Tidegates eliminate the marine component of an estuary and in essence create "non-estuaries". They reduce the tidal influence and prism of an estuary as well as altering the salinity. Wildlife habitats are changed substantially.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
UPSTREAM DAMS 	Structure containing water within reservoirs to control flooding and provide for irrigation and other uses.	HIGH	A	B		B		B	B	A	A			
		MEDIUM			A							A	A	A
		LOW					A							

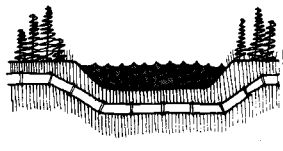
FOOTNOTES: A. Dams trap sediments, divert water and change chemical content of the water. Low flow augmentation can occur. Barriers to natural fish runs. B. Not consistent with physical characteristics of the estuaries.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
CAUSEWAYS 	An earthen embankment placed across a water channel for purposes of roadway construction.	HIGH	■	■	■		■	■	■	■	■	■	■	■
		MEDIUM				A								
		LOW												

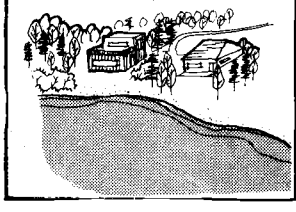
FOOTNOTES: A. Consistent with present uses.
All others: Severely affects mixing and fish migrations. Acts as sediment trap, channelizes the mainstream and may increase the need for dredging.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
BRIDGES & OVERWATER STRUCTURES ON PILINGS 	Structures which are supported above the water surface on pilings, retaining walls, abutments, etc. Significant impact occurs at the time of construction of support members.	HIGH												
		MEDIUM	A	B	B			B	B		B	B		
		LOW				■	■			■			■	C

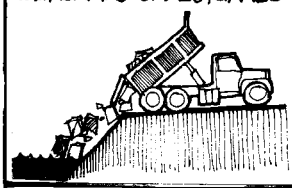
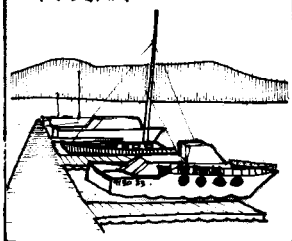
FOOTNOTES: A. Construction timing critical to minimize habitat damage. B. Short-term impact high during construction. C. Site selection very important.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
UNDERGROUND PIPES OR CABLES ACROSS ESTUARY 	Laying of pipes or cables beneath the bottom of the estuary. Short-term construction impacts will be high due to the disturbance of bottom sediments. The timing of construction and site selection are important to minimize adverse impacts.	HIGH												
		MEDIUM												
		LOW	■	■	■	■	■	■	■	■	■	■	■	■

FOOTNOTES:

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
SHORELAND DEVELOPMENT 	Construction of industrial, commercial, residential or transportation facilities on the shorelands adjacent to the estuaries.	HIGH	A	A	A									
		MEDIUM					C	D	C	C	C	E	E	E
		LOW				B								

FOOTNOTES: A. Storm water runoff will adversely impact water quality. Adjacent habitats are of value for winter range. B. Consistent with present use. C. Habitat destruction or displacement. Construction timing and methods important. D. Poor flushing, increased runoff would present water quality problems. E. Big game winter range would be affected.

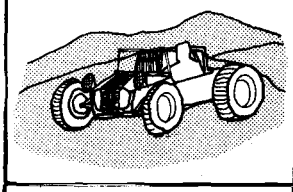
ACTIVITY	DESCRIPTION	IMPACT LEVEL	ESTUARY TYPE 1	2	3	4	5	6	7	8	9	10	11	12
SEWAGE DISPOSAL & OTHER EFFLUANT DISPOSAL 	Discharge of treated or untreated human waste into the estuary. Although such discharge may be in conformance with present standards, water quality and possible health hazards may result.	HIGH	A	A	A	A		A	A					
		MEDIUM								B	B	B		
		LOW					B							
		FOOTNOTES: A. Raises water temperature, adds nutrients, competes for oxygen with biota, adds toxic materials and heavy metals to water. Possible health hazard. B. With maintenance of minumum flows and diffused discharge into the main channel.												
SOLID WASTE DISPOSAL ON SHORELANDS, WETLANDS OR ESTUARIES 	Placement of solid waste (garbage) or earth upon estuary lands would reduce areas of existing water surface or habitat areas.	HIGH												
		MEDIUM					A							A
		LOW												
		FOOTNOTES: A. With proper site selection. All other types, removes habitats, provides visual pollution and allows leeching of toxic substances into estuaries.												
INDUSTRIAL WASTE DISPOSAL 	Industrial wastes are by-products of manufacturing activities, and are frequently liquid in form.	HIGH	A	A	A	A	A	A	A	A	A	A		
		MEDIUM											B	B
		LOW												
		FOOTNOTES: A. Adds high level of toxic material to water. Increases oxygen demand and water temperature. Harmful to existing habitats. B. Site selection is very important. Requires maintenance of minimum channel flow and discharge into the main channel. May require little or no discharge in the summer and construction of retention ponds.												
BOAT HOUSES & OTHER PERMANENT FLOATING STRUCTURES 	Permanent or semi-permanent floating structures that are held fixed in one location with provisions for accommodating fluctuations in water depth.	HIGH		A	B			B			E			
		MEDIUM							D			D		D
		LOW				C	D			D			D	
		FOOTNOTES: A. Would ground at low tide. B. Too small. C. Potential minor mud flat damage. D. Site selection very important. E. Potential high biological impact.												
MARINA 	A marina development having moorages for commercial or pleasure craft, or both. Other facilities may include a boat launch, repair facilities and general supply services.	HIGH	A	B	A			E	E		C			
		MEDIUM				C				F		D		
		LOW					D							D
		FOOTNOTES: A. Too shallow and narrow. B. Would destroy unique, pristine natural areas. C. Lack of adequate flushing for waste disposal. D. With careful site selection. E. Small, inaccessible, no flushing. F. Small, would destroy high biological value. G. Too small.												
MOTORIZED RECREATIONAL NAVIGATION 	Use of small power boats within the estuary channels for sports fishing and pleasure boating.	HIGH	A	B	A				D		D			
		MEDIUM						C				E		
		LOW				C								E
		FOOTNOTES: A. Too small, noise impacts, potential erosion problems. B. Displacement of wildlife. C. Potential bank erosion and sediment problems. D. Noise deleterious to pristine, natural environment. E. Noise would adversely impact wildlife.												

ACTIVITY	DESCRIPTION	IMPACT LEVEL	ESTUARY TYPE 1	2	3	4	5	6	7	8	9	10	11	12
COMMERCIAL NAVIGATION 	Use of estuary waterways by tugboats, barges, commercial fishing vessels, freighters and log rafts.	HIGH	A	A	A	B		B	C		E			
		MEDIUM								D		D	F	
		LOW												G

FOOTNOTES: A. Too small, dredging of mouth would be necessary. B. Too small, high impact on bottom materials. C. Disturb sediments and clams, crabs and shrimp. D. Disturb sediments. E. Too small and pristine. F. Potential bank erosion problems. G. Displacement of wildlife.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
HUNTING 	Recreational activity in which game animals are killed for sport. Major game animals along the Oregon coast include waterfowl and deer.	HIGH	A	A	A	A		A			A	A		
		MEDIUM					B		B	B			B	B
		LOW												

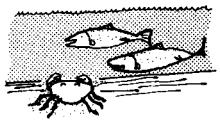
FOOTNOTES: A. All of the wintering waterfowl and watering pigeons can be disturbed at one time. Little feeding and resting can occur. B. Flocks of waterfowl and pigeons have ample alternative resting and feeding areas. Hunting pressure will not totally disturb the birds.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
MECHANICAL RECREATION ACTIVITY 	Free use of undeveloped areas by recreational vehicles such as motor bikes, jeeps, campers, etc.	HIGH		A	A				A		A			
		MEDIUM												
		LOW					B			B			B	

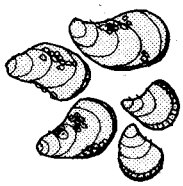
FOOTNOTES: A. Destruction of pristine, natural areas. B. With site restrictions as to area and time of year.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
HARVESTING ESTUARY PRODUCTS IN TIDEFLATS 	Clamming and other forms of removing edible or commercially valuable animal species from tideflats.	HIGH												
		MEDIUM												
		LOW												

FOOTNOTES: Intensity of use, access, area and timing restrictions are necessary to alleviate high biological impacts.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
HARVESTING ESTUARY PRODUCTS IN OPEN WATERS 	Collection of fish, crabs, oysters and other commercially valuable animal species from the open waters of an estuary.	HIGH												
		MEDIUM												
		LOW												

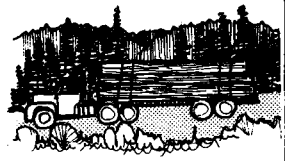
FOOTNOTES: Area, intensity, access and timing restrictions are required or higher biological impacts are likely.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
AQUACULTURE 	Introduction of animal species into the estuarine environment for cultivation and harvest.	HIGH			B			E						
		MEDIUM	A			C				F	F			
		LOW		A			D		E			D	D	D

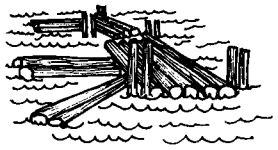
FOOTNOTES: A. Habitat displacement could occur, additional nutrient input may cause water quality problems. B. Too small. C. No flushing. D. Site selection important. E. Additional nutrient input may cause water quality problems. F. Low flushing ability, possible nutrient problems.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	ESTUARY TYPE 1	2	3	4	5	6	7	8	9	10	11	12
AGRICULTURAL (LOW INTENSITY) 	Growing and harvesting of food for consumption by humans and/or other animals	HIGH						A						
		MEDIUM	A	A	A				A					
		LOW					B						B	B

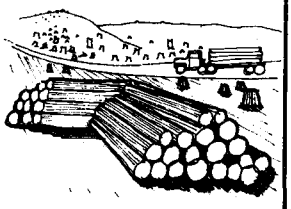
FOOTNOTES: A. These estuaries exhibit low flushing capabilities, thus nutrients added by agricultural runoff have higher impact. Pesticides and fertilizers also affect estuary. Higher the intensity of farming, higher the impact. B. Greater relative dilution of nutrients.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
TIMBER HARVESTING (TYPICAL PRACTICE) 	Harvesting of timber and road construction associated with that process. These actions greatly increase the erosion of sediments into the river channels, thus increasing the rate of siltration in the estuary.	HIGH	B	A	A	A	A	A	A		A			
		MEDIUM								C		C	D	C
		LOW												

FOOTNOTES: A. Since these estuaries have poor flushing ability, siltation from road construction fills the estuaries and creates marshes. Turbidity and the need for dredging are also increased. B. In addition to A, above, gravel beds for spawning fish would be silted over. C. Flushing capacity makes watershed logging acceptable. Won't fill in or drastically change nature of the estuary. D. Adequate flushing, little eelgrass will be affected by sedimentation.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
LOG STORAGE – WATER 	Requires construction of log cribs to hold log rafts. Logs are bound into rafts and stored in the water, confined to specific areas by the cribs. Water storage of logs provides for increased accumulation of debris in the water as well as along the estuary bottom. Debris accumulation can be accelerated by the methods which with the logs are placed in the water.	HIGH	A	B	B	A		A	A	D	B	E		
		MEDIUM					C						F	F
		LOW												

FOOTNOTES: A. No flushing of debris due to low river flows. B. Too small. C. Ample storage area. D. Low flows, inaccessible. E. Loss of important biophysical habitats. F. Good dilution capacity.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
LOG STORAGE – DRY LAND 	Storage of logs on flat areas of dry land in close proximity to the water. Logs are stored prior to processing or transporting. Debris collects upon the site and may accumulate in the estuary due to storm water runoff.	HIGH	A	B	A			D	D	E	F	G		
		MEDIUM												
		LOW					C						C	

FOOTNOTES: A. Too small for log transporting. B. Pristine, unique natural areas. C. With careful site selection. D. No dilution of run-off. E. Inaccessible, no natural flushing. F. Size limitations. G. Loss of important biological habitats.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
MINING SAND & GRAVEL 	Removal of sand and gravel deposits from streambeds.	HIGH		B	B	C	C	C	D		B			
		MEDIUM	A							A		A	A	A
		LOW												

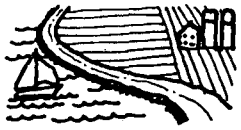
FOOTNOTES: A. Gravel important for spawning grounds. High impacts will always occur during actual mining. Moderate impacts on flood plains if mined properly. B. Destruction of important habitats. C. Inconsistent with physical limitations of the estuary. D. Would destroy wildlife habitats, as well as character of the estuary.

ACTIVITY	DESCRIPTION	IMPACT LEVEL	1	2	3	4	5	6	7	8	9	10	11	12
SCIENTIFIC RESEARCH, EDUCATION 	Study of the estuaries and their components to provide educational and scientific data. Scientific research of the biophysical characteristics of all estuary units is sorely needed	HIGH												
		MEDIUM												
		LOW												

FOOTNOTES: Intense investigation may have some small impacts on wildlife displacement

HUMAN USES

AREAS OF HUMAN ACTIVITY



IN TERMS OF MANAGING ESTUARIES, TWO AREAS OF HUMAN ACTIVITY ARE IMPORTANT: THE ESTUARY SHORELANDS AND THE ESTUARY WATERSHED. A UNIVERSALLY APPLICABLE DEFINITION OF SHORELANDS WILL BE DIFFICULT TO DERIVE, BUT A SHORELANDS AREA COULD BE LEGISLATED. WATERSHEDS ARE USUALLY DEFINED AS THE DRAINAGE BASIN.

SHORELANDS

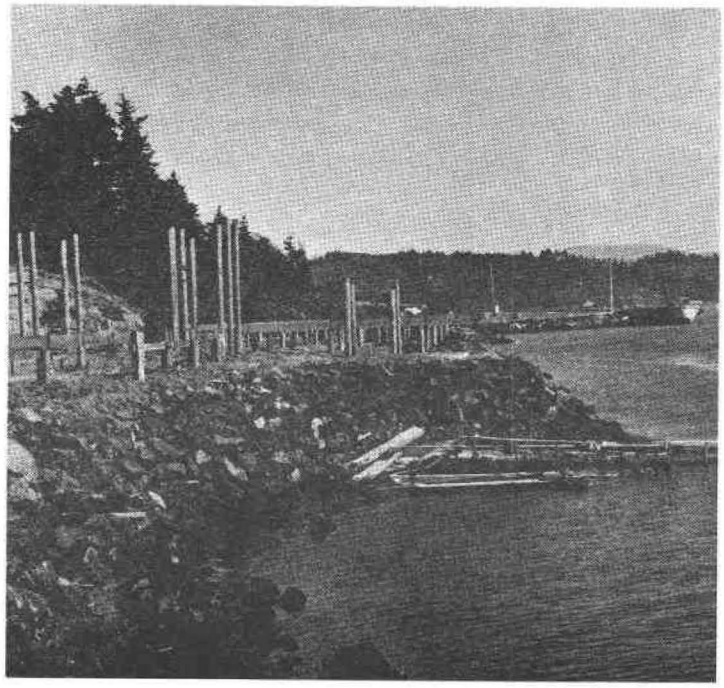
The estuaries of Oregon have been important focal points of human activity on the coast. Every estuary reflects some degree of human use, but the type and intensity of this use varies. Consequently, when an attempt is made to define estuary shorelands, this variety of human use patterns, together with the multiplicity of physiographic conditions and biological communities that can occur adjacent to estuaries, makes such an attempt very difficult indeed.

Yet such a definition is important when a management program is contemplated. Management policies directed toward the retention and orderly use of estuarine resources must deal with the way people use estuary shorelands because, as has been pointed out in the previous section, activities on the shorelands directly influence the condition of these resources. This study does not attempt a shorelands definition but at this point it seeks to identify some important considerations that must be recognized when such an attempt is made for Oregon's coastal zone.

A simple definition based on proximity will not be adequate. As will be described in the section on management concepts to follow, some states have written legislation which define shorelands as occurring within a given distance from a body of water. Three typical situations illustrate the inadequacy of such an approach. First, in highly urbanized areas, this arbitary distance may be too large. For example, often in Oregon's urbanized estuaries, it is only the immediate waterfront land uses which have a distinct influence on the estuary from a human activity standpoint. Secondly, in less developed regions an arbitrary distance definition may not include enough land area. Agricultural uses that occur on the broad flood plains adjacent to some of Oregon's estuaries significantly influence the condition of these estuaries in terms of storm runoff and water quality. Also the flood plains may be comprised of extensive wetlands which provide important habitat for wildlife. Thirdly, in areas which are undeveloped because of steep topography, an arbitrary distance may include areas which aren't directly relevant to the water. For example, a forested area above a steep cliff may not even contribute much drainage or sediment to the estuary below. Thus, management policies keyed to a limited shorelands zone would not be correctly applied in these common situations.

Deciding a proper frame of reference to be applied when devising a shorelands definition may be difficult. Generally it is thought that areas included within a shorelands definition ought to at least relate to the estuary as a body of water, but the way in which this relationship is viewed may vary. For example, a scientist may define the shoreland zone in terms of physical processes such as erosion and deposition of sediments, or in terms of wildlife habitats. A person concerned with aesthetics might define shorelands in terms of those areas which can be seen from the estuary and those areas from which the estuary can be seen. A developer may think of the immediate shoreline zone as including land on which water dependent activities can be constructed. Although it is not a desireable approach, a policy maker may be required to think of the immediate shoreline zone as in terms of a set number of feet from some point of tidal influence simply so that the shoreline can be easily regulated. It should be noted that a definition which will satisfy a scientist may not necessarily meet the definitional needs of a planner or a developer, a policy maker, etc.

It may not be possible to devise a universally applicable definition of shorelands. The interests to be served by such a definition are too diverse and conflicting. On the other hand it may be possible to develop a variety of limited definitions which satisfy particular needs such as scientific study, aesthetic considerations or development. Since Oregon's coastal zone is finite, another approach would be to legislate an actual shorelands boundary which is plotted on a map and derived from a variety of considerations important to each geographical location encountered. Such a boundary developed at the state policy level could be arbitrated with each local jurisdiction. In summary, the purpose of a definition of shorelands should be considered and the limitations of any definition should be recognized.



THIS PHOTO ILLUSTRATES FILLING AND RIP-RAPING AT THE WATERS EDGE.

WATERSHEDS

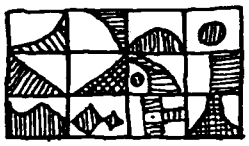
Watersheds are closely related to estuaries in that they contribute fresh water and sediments to the estuary. The watershed associated with a given estuary is more conducive to precise definition than is the immediate shoreline zone because the factors to be considered are less complex. The estuary watershed is delineated by the lands from which drainage is derived and which ultimately flows into the estuary. The dividing line between watersheds can be established on the basis of topography.

Both human activity and biophysical conditions in a watershed are closely related to estuary processes. As an example of these interrelations consider the volume of freshwater flowing into an estuary. The fresh water volume is influenced by human activities such as damming of streams, logging, urbanization, irrigation and use of cooling water. Fresh water volumes reaching an estuary are also related to physical factors such as watershed size, precipitation, type of vegetation, soils, and geology. The amount of water inflow determines in part the estuarine salinity and mixing conditions which in turn affect the animals and plants associated with an estuary.

The amount of sediment reaching an estuary is also related to human activity and natural conditions in the watershed. Many of the Oregon estuaries are filling with sediment at a rapid rate due at least in part to watershed logging, forest fires, agriculture, steep unstable slopes, easily erodable soils and streambank erosion (natural and that accelerated by humans).

There are numerous examples of how watershed areas are related to an estuary. The important point is that complex relationships do exist and that watershed uses must be consistent with estuary uses if a viable system is to be maintained.

CLASSIFICATION SYSTEM



THE OREGON ESTUARIES ARE MAJOR PHYSIOGRAPHIC ELEMENTS IN THE COASTAL REGION. AS SUCH, EACH ESTUARY REFLECTS GENERAL COAST WIDE TRENDS IN LAND USE. LAND USE TRENDS ARE RELATED TO REGIONAL RESOURCES SUCH AS WOOD PRODUCTS, SEA-FOOD PRODUCTS, RECREATIONAL AMENITIES AND AGRICULTURE. ALL OF THE LAND USES CAN BE RATED ACCORDING TO THEIR INTENSITY AND THE MANNER IN WHICH THEY RELATE TO ONE ANOTHER.

TRENDS IN HUMAN USE

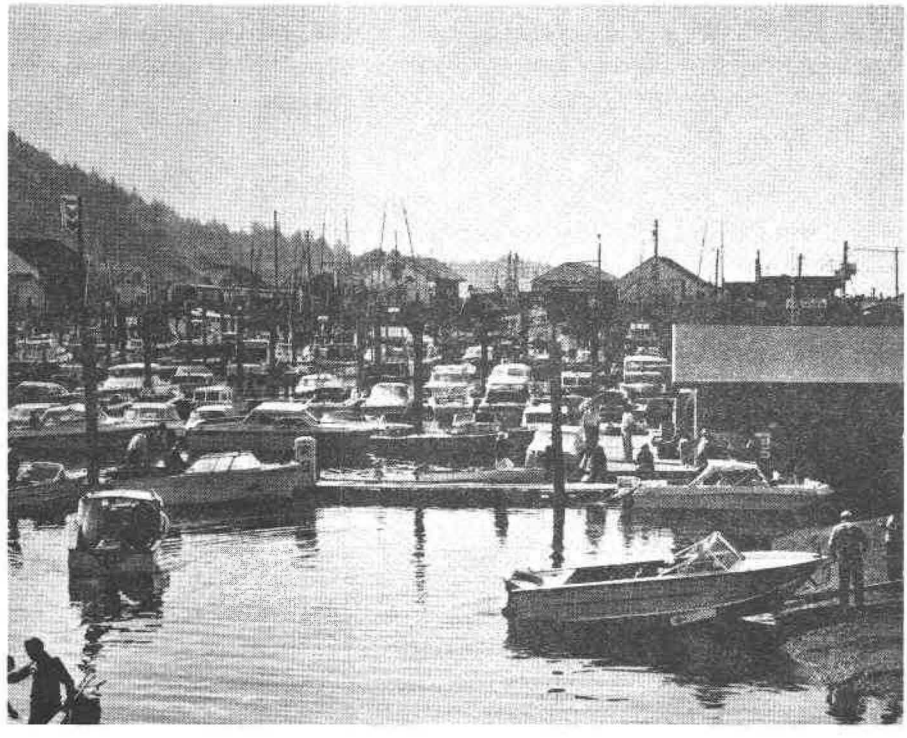
For the purpose of studying the human use of the land associated with an estuary it is necessary to consider the uses occurring in both the immediate shoreline zone and the watershed. The problems in defining areas within the immediate shoreline zone were previously explored. It was noted that watershed of an estuary is somewhat easier to define. In order to obtain a data base for studying human use of the land associated with the Oregon estuaries, for the purposes of this report, land uses were surveyed which were considered most relevant to a wide spectrum of definitional needs. Land use maps portraying the results of this survey will be presented in the section on individual estuaries.

Although the land use maps give a broad overview of the human uses, they are limited in the detail and in the type of data which can be conveyed. The land use maps do not reflect either the intensity of human use or the functional relationships in human use. In order to analyze more than spatial or geographical relationships in land use, it is necessary to compare general trends in human use and to develop a methodology whereby the land use of the estuaries can be compared on a relative scale.

Some general trends in human use occur along the Oregon coast which affect all the estuaries to some extent. The trends identified here are general, and may be reflected in individual estuaries to varying degrees. The economy of the coastal zone is a major factor which affects land use in all estuaries. The economy of the coastal area is primarily dependent on log harvesting and the processing of wood products as well as the availability of means for transporting wood products. The transport of logs and wood products is a function of the waterways, highways, and railroads.

The need to transport wood products has provided impetus to develop some of the major estuaries into ports. Some ports serve as focal points of the wood products industry and international trade. Such ports receive unprocessed logs and wood products from the length of the Oregon coast. The desirability of these major estuaries as ports is directly related to shipping channel deepening, harbor protection activities and maintenance of waterways by dredging. Dredging spoils can then be used for land fills to create sites for industries or sometimes in northern Oregon, to create beaches. Other estuaries may be used for a minimal amount of log rafting and may not be extensively dredged.

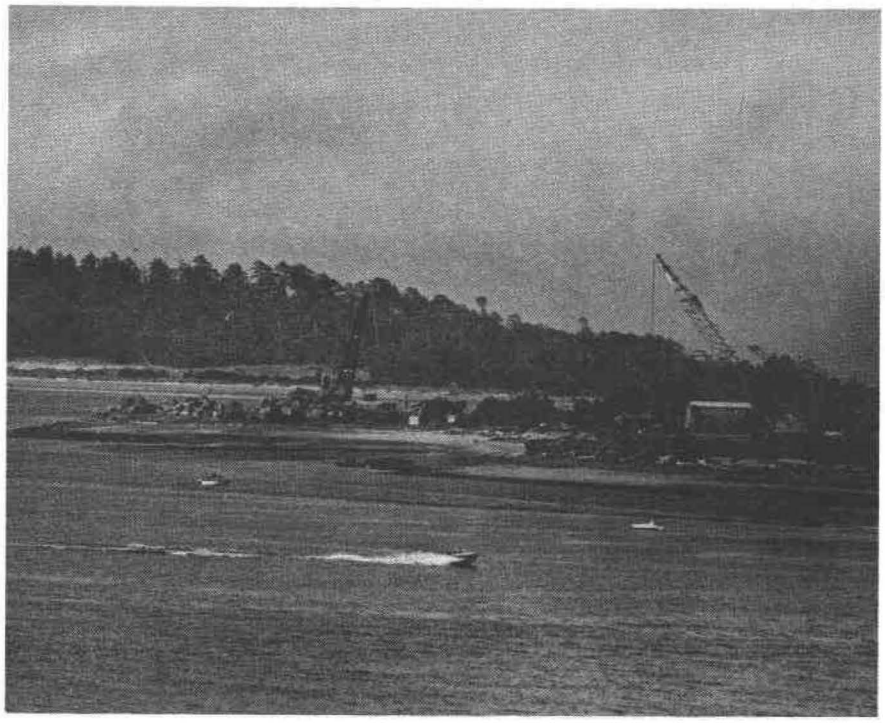
The intensity of the use of an estuary for seafood processing industries somewhat reflects its intensity of use for wood products processing, simply because dredging, harbor protection and maintenance are conducive to commercial boating facilities. The seafood processing industries can be related to its role in the regional economy. For example, fish catches from up and down the coast may be landed and processed, or the seafood industries may only process local fish catch or the entire seafood catch may be transported elsewhere for canning and processing. In some cases estuaries where intensive wood and seafood processing industries occur also attract related industries such as ship building and can manufacturing. Thus, the estuary industrial land use is directly related to the resource base.



TILLAMOOK BAY: THIS SMALL BOAT BASIN AT GARIBALDI SERVES BOTH COMMERCIAL FISHING VESSELS AND PLEASURE BOATS.

Another trend which affects land use in the estuaries involves the tourist industry. Tourism and recreational enterprises are growing rapidly along the length of the coast. Land use conflicts are arising in many places, particularly along estuary shorelines. Water dependent industries are increasingly interspersed with business enterprises catering to tourists who come to "see and smell" the sights. Also, with the increase in fishing , estuaries often intensively used by vacationers also support small boat basins and charter fishing fleets. In many instances, even the relatively undeveloped estuaries will support clusters of commercial facilities providing convenience goods to vacationers, boaters and other water users. Strip commercial uses are springing up along the highways everywhere. As the general population becomes more affluent, an increased demand is generated for second homes and retirement homes along the coast. The amenities of the estuaries attract the bulk of this development. The intensity of uses relating to the tourist trade could threaten the very amenities which originally made the area attractive.

Residential land development is generally resulting in a decrease in available agriculture land adjacent to the estuaries. Farmland occurs on the flat river valleys and most diked salt marshes and is used for pasturage and grazing. In some localities, a specialty crop may be produced. Often, farmlands adjacent to estuaries are broken up by terrain or by other land uses, consequently farmland does not often occur in large economic tracts. At those estuaries where the adjacent land is intensively farmed, production is currently on the increase due to improved agricultural techniques in spite of the fact that the total number of acres used for agriculture is decreasing.



TILLAMOOK BAY: UPON COMPLETION, THIS NEW JETTY CONSTRUCTION WILL ASSIST IN NAVIGATION.

Trends in watershed land use, particularly logging and agriculture have important implications for estuaries. Logging occurs in the watersheds of all estuaries but often not within viewing distance of the waterfront or the highways serving the waterfront. The intensity of logging does not relate directly to uses of the waterfront, rather logging causes increased siltation which may alter the biological components of an estuary and change the rate at which sediment is deposited.

This general synopsis of the relationships between the various land uses occurring on estuarine shorelands represents general trends, parts of which are true for each estuary. The trends in land use are also characterized by their own political-economic inertia, which dictate that existing land uses increase in intensity or at least continue.

Political and economic pressures operate to increase the intensity of land uses. These pressures are illustrated by the necessity to dredge waterways to maintain existing shipping channels or to create deeper channels; and the use of dredged spoils to create land fill sites to accommodate new industries. As technological advances occur in transportation and industry, a demand is generated for deeper shipping channels. Thus, once development has begun, political and economic pressures will probably operate to increase the intensity of development.

To a lesser extent, socio-ecological pressures will operate to lessen the intensity of land use or at least to preserve the status quo. For example, the natural amenities of an area limit the intensity of use which an estuary can support and still maintain its attractiveness to residents, vacationers and retirees. It should be noted that socio-ecological pressures to reduce the intensity of development or to preserve the status quo do not appear to be as strong as the political-economic pressures to increase the intensity of land use.

USE CHART

The complexity of human use patterns occurring near Oregon's estuaries prevented a detailed analysis of such use for each estuary within the scope of this study. Instead, a general system for catagorizing uses in terms of functional relationships and levels of intensity has been devised. The use chart on the following page portrays levels of decreasing use intensity beneath each of several catagories. Each intensity level contains a description characterizing the condition of human activities that can be expected to occur within the estuary shorelands. These descriptions have been tested by comparing them with all of the estuaries under study and adjusting them to reflect actual conditions (so that they truly portray the range of use intensities encountered in Oregon's coastal zone).

USE CHART

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	-Widespread heavy industry -Raw materials drawn from a regional base -Manufacture of highly refined product, i.e. paper or canned seafood -Product marketed interstate and internationally	-Urban commercial district close to waterfront. Uses are primarily related to serving a major urban center and do not necessarily relate to waterfront -Extensive strip commercial development leading to urban center	-Service by deep draft yessels and super barges -Dredging to maintain 40-foot channel -Highway and good public road access to both sides of estuary -East-west highway access -Rail and/or air transit available -Jetties and/or other structural improvements	-Major, widespread urban/suburban development adjacent to or in close proximity to estuary	-Concentrated areas of tourist-commercial development along urban waterfront -Intensive use of beach activities, sight-seeing, fishing, boating or other recreation activity -Extensive marina developments for charter and pleasure craft	-Widespread "agribusiness" often associated with nearby processing industry -Physical modifications to make agriculture feasible are widely practiced (irrigation, diking and clearing.)	-Removal of most harvestable timber -Low potential for sustained yield	-Intensive widespread farming, feedlots -High irrigation and diking
4	-Limited or scattered industry, served by barge and occasional small freighter -Raw materials drawn from adjacent counties -Limited final processing -Possible extra-regional market	-Large urban commercial district not in close proximity to waterfront or small urban center adjacent to waterfront -Strip commercial or commercial clusters on roads leading to small urban centers	-Super barges and commercial fishing vessels -Dredging between 18-40 foot depths -Highway access to at least one-half of estuary. Secondary road access to remainder -Rail or air transit available to nearby urban center -Jetties	-Moderately widespread, or one or two major clusters of urban/suburban housing -Possibly some minor clusters -Established vacation/retirement homes or new vacation/retirement homes under construction	-Minor clusters or strips of tourist commercial uses mixed with minor clusters of urban development -Significant charter fishing and small boat basin facilities -Novelty attractions nearby	-Moderately widespread farming -Moderate use of physical alterations necessary to make farming possible -Some specialty crops	-Generally immature forests -Low stand age diversity -Moderate sustained yield potential	-Moderate, but widespread, farming and grazing
3	-Few mills or clusters of fish processing served by small barges, but good surface transport -Raw materials and market predominantly local, although fresh fish market may be interstate	-Small urban center serving local populace -Scattered groups of commercial uses on roads leading to urban center	-Small barges, limited facilities for commercial fishing and pleasure boats -Highway or good public road to no more than one-half of estuary -Some private access elsewhere -Jetties	-Minor clusters of urban/suburban and widespread rural residential -Some vacation/retirement homes	-Scattered enterprises oriented towards tourist trade -Moderate sports fishing and shell fishing -Marinas and moorage facilities	-Small scattered farms oriented primarily towards grazing -Possibly one specialty crop	-Controlled logging with some stand age diversity -High sustained yield potential relative to maximum for area	-Moderate farming and grazing over limited portions of land
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

TOLERANCE OF USE

THIS SECTION DESCRIBES THE TOLERANCE OF USE WHICH EACH OF THE TWELVE ESTUARY TYPES CAN ENDURE BEFORE THEIR ENVIRONMENTAL COMPONENTS ARE SIGNIFICANTLY ALTERED. THE USE LEVELS WHICH ARE ANALYZED FOR THEIR TOLERANCE ARE THE SAME LEVELS OF USES WHICH FORM THE BASIS OF THE LAND USE CHART GIVEN IN THE PREVIOUS SECTION.

The human use chart explained in the previous section portrays levels of decreasing intensity of use under each land use category. Each intensity level description explains the nature and extent of the uses involved. For instance, under the industrial category, at intensity level four, it states: "Limited or scattered industry, served by barge and occasional freighter". This description statement actually summarizes a broad scale of human use which is accomplished by implementation of such activities as those which were illustrated in the section entitled Shoreland Activity Impacts. These activities combine to comprise the industrial uses characteristic of this intensity level. Examples of these activities include commercial navigation which in turn is supported by dredging; disposal of dredged material; and the construction of seawalls, riprap, bulkheads, jetties, breakwaters and groins. The construction of the industries themselves require filling estuaries and wetlands for development which in turn requires mining sand and gravel. The physical form of the industries may result in overwater structures on pilings or boat houses and other permanent floating structures. They may be accessed by causeways. Once completed. the industries may engage in industrial waste disposal.

In the Shoreland Activity Impact section, the impact matrices showed the degree of impact for each activity that could be expected to occur within each of the twelve estuary types. It follows that if each human use description in the use chart involves several separate activities, it should be possible to make deductions about the cumulative effects of all of the specific activities which can be implemented to obtain a given level of land use intensity. Further, it should be possible to determine for each estuary type, the maximum use intensity levels that can be achieved before the cumulative impacts significantly alter the environmental components within the estuary type.

Each physical component of an estuary has a level to which it is capable of tolerating change before the nature of that component is significantly altered. For example, clams are able to tolerate a certain rate of siltation before they can no longer survive. Thus, if excessive sediment loads are deposited in the estuary by the river system, clam communities will disappear and the biological component of the estuary will have changed. In most cases, however, the effects

of alteration to a system are not limited to one component. Not only does siltation affect the ability of clam populations to flourish, the siltation process changes the physical character of the system, eventually filling mudflats and creating marshes.

Due to the interrelatedness of estuary components, an alteration to one part of the system may cause indirect change to many others. Filling of a mudflat destroys a habitat for bottom dwelling organisms which are an important food source for shorebirds. Thus filling of the mudflat will not only alter the marine biological component of the estuary, but will affect bird populations as well. These relationships between estuary features are critical to determining a threshold level for the overall system.

The following threshold of tolerance charts illustrate the ability of each estuary type to absorb alteration without changing its biophysical character. As a synthesis of the human use charts and impact matrices, these levels reflect the impact of human activities associated with intensity of use.

The threshold level of each estuary type has been established based upon the definition of a maximum level of human activity that will not substantially alter the existing biophysical character of the estuarine system. Intensification of activities beyond the established tolerance level would alter the estuary to the extent that it would require reclassification into another estuary type category. Human actions which produce the smallest alterations in the existing biophysical conditions are those activities or levels of activities which are preferred within the estuarine system.

A multi-disciplinary approach was used to establish the threshold of tolerance levels for each of the twelve previously described estuary types. Factors weighed included physical features, marine and terrestrial biological diversity and water quality. Even with this approach, however, it must be cautioned that the threshold of tolerance levels depicted on the following charts are not finite lines, but should be viewed as ranges of possible levels. This depiction is particularly important since not all of the individual estuaries fit exactly the estuary type threshold levels due to their various mixtures of biophysical characteristics. A further discussion of the possible application to planning decision-making of these threshold charts can be found on page 206.

The threshold of tolerance levels have been superimposed on the basic human use chart previously defined. The threshold level is depicted with a heavy black line, while the half-tone area above the line illustrates the intensity of development which will alter the present character of the estuary.

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	-Small urban center serving local populace -Scattered groups of commercial uses on roads leading to urban center	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	[illegible]	Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE I

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3								
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity		-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE II

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jettie -Limited road access t actual estuarine wate front, although highw may be in proximity	[illegible]	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	[illegible]	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE III

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	-Limited or scattered industry, served by barge and occasional small freighter -Raw materials drawn from adjacent counties -Limited final processing -Possible extra-regional market	-Large urban commercial district not in close proximity to waterfront or small urban center adjacent to waterfront -Strip commercial or commercial clusters on roads leading to small urban centers	-Super barges and commercial fishing vessels -Dredging between 18-40 foot depths -Highway access to at least one-half of estuary. Secondary road access to remainder -Rail or air transit available to nearby urban center -Jetties	-Moderately widespread, or one or two major clusters of urban/suburban housing -Possibly some minor clusters -Established vacation/retirement homes or new vacation/retirement homes under construction	-Minor clusters or strips of tourist commercial uses mixed with minor clusters of urban development -Significant charter fishing and small boat basin facilities -Novelty attractions nearby	-Moderately widespread farming -Moderate use of physical alterations necessary to make farming possible -Some specialty crops	[illegible]	[illegible]
3	-Few mills or clusters of fish processing served by small barges, but good surface transport -Raw materials and market predominantly local, although fresh fish market may be interstate	-Small urban center serving local populace -Scattered groups of commercial uses on roads leading to urban center	-Small barges, limited facilities for commercial fishing and pleasure boats -Highway or good public road to no more than one-half of estuary -Some private access elsewhere -Jetties	-Minor clusters of urban/suburban and widespread rural residential -Some vacation/retirement homes	-Scattered enterprises oriented towards tourist trade -Moderate sports fishing and shell fishing -Marinas and moorage facilities	-Small scattered farms oriented primarily towards grazing -Possibly one specialty crop	[illegible]	-Moderate farming and grazing over limited portions of land
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE IV

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	[redacted]	[redacted]	[redacted] foot channel -Highway and good public road access to both sides of estuary -East-west highway access -Rail and/or air transit available -Jetties and/or other structural improvements	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
4	-Limited or scattered industry, served by barge and occasional small freighter -Raw materials drawn from adjacent counties -Limited final processing -Possible extra-regional market	-Large urban commercial district not in close proximity to waterfront or small urban center adjacent to waterfront -Strip commercial or commercial clusters on roads leading to small urban centers	-Super barges and commercial fishing vessels -Dredging between 18-40 foot depths -Highway access to at least one-half of estuary. Secondary road access to remainder -Rail or air transit available to nearby urban center -Jetties	-Moderately widespread, or one or two major clusters of urban/suburban housing -Possibly some minor clusters -Established vacation/retirement homes or new vacation/retirement homes under construction	-Minor clusters or strips of tourist commercial uses mixed with minor clusters of urban development -Significant charter fishing and small boat basin facilities -Novelty attractions nearby	-Moderately widespread farming -Moderate use of physical alterations necessary to make farming possible -Some specialty crops	[redacted]	-Moderate, but widespread, farming and grazing
3	-Few mills or clusters of fish processing served by small barges, but good surface transport -Raw materials and market predominantly local, although fresh fish market may be interstate	-Small urban center serving local populace -Scattered groups of commercial uses on roads leading to urban center	-Small barges, limited facilities for commercial fishing and pleasure boats -Highway or good public road to no more than one-half of estuary -Some private access elsewhere -Jetties	-Minor clusters of urban/suburban and widespread rural residential -Some vacation/retirement homes	-Scattered enterprises oriented towards tourist trade -Moderate sports fishing and shell fishing -Marines and moorage facilities	-Small scattered farms oriented primarily towards grazing -Possibly one specialty crop	-Controlled logging with some stand age diversity -High sustained yield potential relative to maximum for area	-Moderate farming and grazing over limited portions of land
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE V

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3	-Few mills or clusters of fish processing served by small barges, but good surface transport -Raw materials and market predominantly local, although fresh fish market may be interstate	-Small urban center serving local populace -Scattered groups of commercial uses on roads leading to urban center		-Minor clusters of urban/suburban and widespread rural residential -Some vacation/retirement homes	-Scattered enterprises oriented towards tourist trade -Moderate sports fishing and shell fishing -Marinas and moorage facilities	-Small scattered farms oriented primarily towards grazing -Possibly one specialty crop		-Moderate farming and grazing over limited portions of land
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE VI

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-Small scattered farms oriented primarily towards grazing -Possibly one specialty crop	[illegible]	[illegible]
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE VII

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4		-Large urban commercial district not in close proximity to waterfront or small urban center adjacent to waterfront -Strip commercial or commercial clusters on roads leading to small urban centers	-Super barges and commercial fishing vessels -Dredging between 18-40 foot depths -Highway access to at least one-half of estuary. Secondary road access to remainder -Rail or air transit available to nearby urban center -Jetties	-Moderately widespread, or one or two major clusters of urban/suburban housing -Possibly some minor clusters -Established vacation/retirement homes or new vacation/retirement homes under construction				-Moderate, but widespread, farming and grazing
3	-Few mills or clusters of fish processing served by small barges, but good surface transport -Raw materials and market predominantly local, although fresh fish market may be interstate	-Small urban center serving local populace -Scattered groups of commercial uses on roads leading to urban center	-Small barges, limited facilities for commercial fishing and pleasure boats -Highway or good public road to no more than one-half of estuary -Some private access elsewhere -Jetties	-Minor clusters of urban/suburban and widespread rural residential -Some vacation/retirement homes	-Scattered enterprises oriented towards tourist trade -Moderate sports fishing and shell fishing -Marinas and moorage facilities	-Small scattered farms oriented primarily towards grazing -Possibly one specialty crop	-Controlled logging with some stand age diversity -High sustained yield potential relative to maximum for area	-Moderate farming and grazing over limited portions of land
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE VIII

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-Small scattered farms oriented primarily towards grazing -Possibly one specialty crop	[illegible]	-Moderate farming and grazing over limited portions of land
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE IX

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4						-Moderately widespread farming -Moderate use of physical alterations necessary to make farming possible -Some specialty crops		
3		-Small urban center serving local populace -Scattered groups of commercial uses on roads leading to urban center		-Minor clusters of urban/suburban and widespread rural residential -Some vacation/retirement homes	-Scattered enterprises oriented towards tourist trade -Moderate sports fishing and shell fishing -Marinas and moorage facilities	-Small scattered farms oriented primarily towards grazing -Possibly one specialty crop	-Controlled logging with some stand age diversity -High sustained yield potential relative to maximum for area	-Moderate farming and grazing over limited portions of land
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE X

THRESHOLD OF TOLERANCE

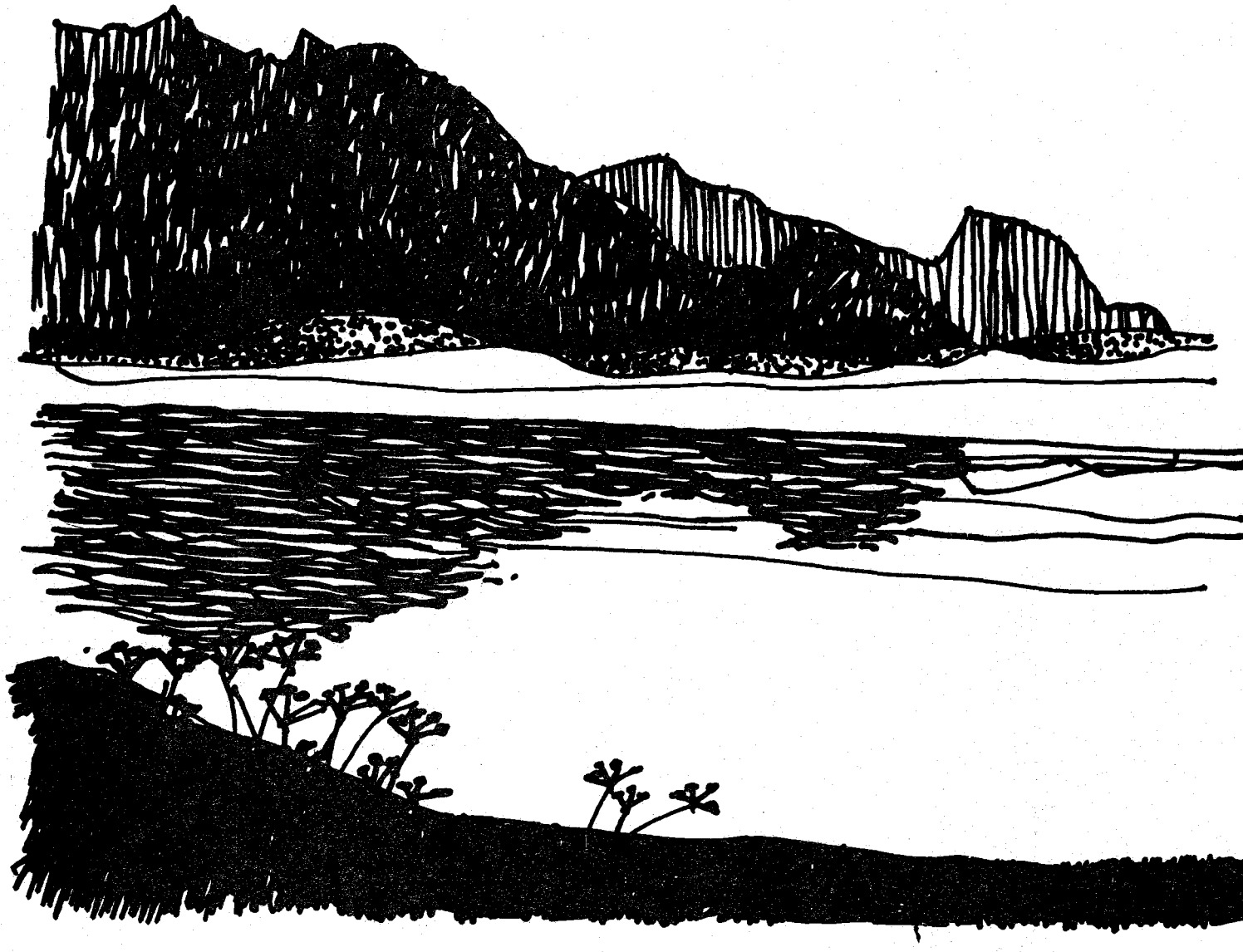
	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4	-Limited or scattered industry, served by barge and occasional small freighter -Raw materials drawn from adjacent counties -Limited final processing -Possible extra-regional market	-Large urban commercial district not in close proximity to waterfront or small urban center adjacent to waterfront -Strip commercial or commercial clusters on roads leading to small urban centers	-Super barges and commercial fishing vessels -Dredging between 18-40 foot depths -Highway access to at least one-half of estuary. Secondary road access to remainder -Rail or air transit available to nearby urban center -Jetties	-Moderately widespread, or one or two major clusters of urban/suburban housing -Possibly some minor clusters -Established vacation/retirement homes or new vacation/retirement homes under construction		-Moderately widespread farming -Moderate use of physical alterations necessary to make farming possible -Some specialty crops	-Generally immature forests -Low stand age diversity -Moderate sustained yield potential	-Moderate, but widespread, farming and grazing
3	-Few mills or clusters of fish processing served by small barges, but good surface transport -Raw materials and market predominantly local, although fresh fish market may be interstate	-Small urban center serving local populace -Scattered groups of commercial uses on roads leading to urban center	-Small barges, limited facilities for commercial fishing and pleasure boats -Highway or good public road to no more than one-half of estuary -Some private access elsewhere -Jetties	-Minor clusters of urban/suburban and widespread rural residential -Some vacation/retirement homes	-Scattered enterprises oriented towards tourist trade -Moderate sports fishing and shell fishing -Marinas and moorage facilities	-Small scattered farms oriented primarily towards grazing -Possibly one specialty crop	-Controlled logging with some stand age diversity -High sustained yield potential relative to maximum for area	-Moderate farming and grazing over limited portions of land
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE XI

THRESHOLD OF TOLERANCE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4	-Limited or scattered industry, served by barge and occasional small freighter -Raw materials drawn from adjacent counties -Limited final processing -Possible extra-regional market	-Large urban commercial district not in close proximity to waterfront or small urban center adjacent to waterfront -Strip commercial or commercial clusters on roads leading to small urban centers	-Super barges and commercial fishing vessels -Dredging between 18-40 foot depths -Highway access to at least one-half of estuary. Secondary road access to remainder -Rail or air transit available to nearby urban center -Jetties	-Moderately widespread, or one or two major clusters of urban/suburban housing -Possibly some minor clusters -Established vacation/retirement homes or new vacation/retirement homes under construction	-Minor clusters or strips of tourist commercial uses mixed with minor clusters of urban development -Significant charter fishing and small boat basin facilities -Novelty attractions nearby	-Moderately widespread farming -Moderate use of physical alterations necessary to make farming possible -Some specialty crops	-Generally immature forests -Low stand age diversity -Moderate sustained yield potential	-Moderate, but widespread, farming and grazing
3	-Few mills or clusters of fish processing served by small barges, but good surface transport -Raw materials and market predominantly local, although fresh fish market may be interstate	-Small urban center serving local populace -Scattered groups of commercial uses on roads leading to urban center	-Small barges, limited facilities for commercial fishing and pleasure boats -Highway or good public road to no more than one-half of estuary -Some private access elsewhere -Jetties	-Minor clusters of urban/suburban and widespread rural residential -Some vacation/retirement homes	-Scattered enterprises oriented towards tourist trade -Moderate sports fishing and shell fishing -Marinas and moorage facilities	-Small scattered farms oriented primarily towards grazing -Possibly one specialty crop	-Controlled logging with some stand age diversity -High sustained yield potential relative to maximum for area	-Moderate farming and grazing over limited portions of land
2	-Limited facilities for landing local seafood catch which is shipped elsewhere for processing -Very limited facilities for handling wood products, no mills -Transportation source of raw materials and market much as # 3	-Occasional commercial facility	-No dredging or jetties -Limited road access to actual estuarine waterfront, although highway may be in proximity	-One minor cluster of housing -Moderately widespread rural residential -Very limited vacation/retirement housing	-Limited sports fishing -Small private docks or limited public dock facilities	-Little or no farming adjacent to the estuary itself due to existing developments or farming being phased out due to development pressures	-Controlled thinning and limited logging -Rotation greater than 90 years -Moderate to high sustained yield potential	-Limited small farming and grazing
1	-None or local crafts colony	-None	-Limited private or dirt road access	-Very little, mostly precluded by topography	-Little or no commercial facilities oriented to waterfront activities	-Little or no farming due to such factors as topography, expansive sand dunes, etc.	-Very limited to none	-Very low or none

ESTUARY TYPE XII



THE INDIVIDUAL ESTUARIES

INTRODUCTION

THIS REPORT HAS BEEN ORGANIZED TO FACILITATE A GENERAL UNDERSTANDING OF ESTUARIES, AND TO PRESENT SPECIFIC INFORMATION ON EACH ESTUARY. THE PRECEDING SECTIONS HAVE DEALT WITH GENERAL CONCEPTS: THEY HAVE ADDRESSED THE IMPORTANCE OF ESTUARIES, THE SALIENT CHARACTERISTICS OF THOSE PHYSICAL SYSTEMS BY WHICH ESTUARIES HAVE BEEN FORMED AND SHAPED AND THOSE BIOLOGICAL SYSTEMS THEY SUPPORT. A CLASSIFICATION SYSTEM INVOLVING "ESTUARY TYPES" HAS BEEN DEVELOPED AND EXPLAINED IN ORDER TO SUGGEST THE COMMONALITY AND DIFFERENCES BETWEEN THE BIOPHYSICAL FEATURES OF THE ESTUARIES AND TO PROVIDE A CONSISTENT FRAMEWORK FOR UNDERSTANDING THE ENVIRONMENTAL IMPLICATIONS OF MAN'S ACTIVITIES IN AND ABOUT THE ESTUARIES. GENERALIZED PATTERNS OF HUMAN USE THAT NORMALLY OCCUR IN NEAR PROXIMITY TO ESTUARIES HAVE BEEN IDENTIFIED AND CATEGORIZED. THIS HUMAN USE CATEGORIZATION SYSTEM HAS BEEN COMPARED WITH THE BIOPHYSICAL CLASSIFICATION SYSTEM TO DETERMINE THE LEVELS OF HUMAN USE INTENSITY WHICH MAY BE TOLERATED BY EACH ESTUARY TYPE BEFORE ITS BIOPHYSICAL CHARACTERISTICS ARE SUBSTANTIALLY MODIFIED.

ALL OF THE INFORMATION IN THE PRECEDING SECTIONS OF THIS REPORT HAS PURPOSELY NOT BEEN KEYED TO THE SPECIFIC ESTUARIES FOR SEVERAL REASONS: 1) FOR THE SAKE OF BREVITY, IT WAS DECIDED THAT GENERAL CONCEPTS COMMON TO ALL ESTUARIES SHOULD BE PRESENTED AT ONE TIME; 2) THE LACK OF DETAILED DATA ABOUT EACH ESTUARY SHOULD NOT PREVENT THE DERIVATION OF HYPOTHETICAL ESTUARY TYPES AS A MEANS FOR DISCUSSING IMPORTANT ESTUARY PROCESSES AND FOR EXPLAINING SIGNIFICANT DIFFERENCES OCCURRING WITHIN THE 21 ESTUARIES: 3) THE READER WOULD LESS LIKELY BE SIDETRACKED FROM UNDERSTANDING IMPORTANT GENERAL CONCEPTS BY THE POSSIBILITY OF HIS HAVING SPECIAL FAMILIARITY WITH ONE OR MORE ESTUARY TYPE: AND 4) THE GENERALIZED LEVEL OF DISCUSSION IN THE PREVIOUS SECTIONS KEYS WELL WITH THE OCC & DC'S PRIMARY RESPONSIBILITY OF FORMULATING COASTWIDE COASTAL ZONE MANAGEMENT POLICIES, WHICH BY DEFINITION MUST BE GENERAL IN NATURE. THIS SECTION NOW DEALS WITH THE SPECIFICS OF EACH OF THE 21 ESTUARIES. IT IS HERE THE REPORT BEGINS TO FULFILL ITS FUNCTION AS AN INVENTORY BY DETAILING THE RESOURCES AND HUMAN USE CHARACTERISTICS OF EACH ESTUARY.

THE ADVANTAGES OF THE PRECEDING GENERAL SECTIONS OF THIS REPORT AS EXPLAINED ABOVE ARE RETAINED BY RELATING EACH ESTUARY AND ITS GEOGRAPHICAL SUBDIVISIONS (MANAGEMENT UNITS) DIRECTLY TO THE BIOPHYSICAL CLASSIFICATION SYSTEM AND THE CATEGORIES ON THE HUMAN USE CHART. THUS THE DISCUSSION OF EACH INDIVIDUAL ESTUARY IS CONFINED TO IDENTIFYING ITS PLACE WITHIN THE ESTUARY TYPES AND ON THE HUMAN USE CHART. ONLY SIGNIFICANT DIFFERENCES FROM THESE CLASSIFICATION SYSTEMS CRITERIA ARE NOTED. SALIENT PHYSICAL, BIOLOGICAL AND HUMAN USE ELEMENTS ARE DESCRIBED AND IMPORTANT LAND ALTERATIONS ARE NOTED. THESE DISCUSSIONS ARE ACCOMPANIED BY ESTUARINE HABITATS AND LAND USE MAPS AND OTHER ILLUSTRATIONS.

MANAGEMENT UNITS

Each estuary discussed in this section is either described in total or broken down into smaller geographical subdivisions termed "management units". Management units occur within the larger estuaries where the various embayments, tributary arms, sloughs, etc. can be considered distinctly different from the balance of the estuary. The criteria for deciding appropriate management unit divisions are directly related to the estuary type classification system. Biophysical parameters were only one-half of the input used to decide on management unit subdivisions, however. Present levels of human use played a major part in the decision making process. A management unit might at one time have resembled the biophysical characteristics of the estuary in which it is located, but human activities may have drastically altered it so that it bears little resemblance to its previous conditions. The designation of the Skipanon River as a management unit distinct from Youngs Bay is an example of this condition. Relative intensity of human use has played a key role in deciding management units. The very name implies distinct separate areas which will require application of varied management policies and implementation techniques, based in part on the existing level of human activity.

This then is the primary rationale for selecting management units. At the end of each individual estuary discussion that follows there occurs a comparison between the present levels of human use intensity for each management unit and the tolerence level for the estuary type which best relates to the management unit under consideration. This comparison provides a basis for brief consideration of some of the management options which seem appropriate for consideration by policy makers at the local level.

The following table lists the estuary types, a brief description of each, and the estuary management units which most resemble the estuary types.

ESTUARY	DESCRIPTION	MANAGEMENT UNITS
TYPE I	"Blind"/well-mixed estuaries have moderate marine value and low terrestrial biological value. They have a low percentage of eelgrass and tidelands.	Big Creek and Tenmile Creek (Lane Co.)* Elk River Pistol River Sixes River Winchuck River Tenmile & Tahkenitch (Douglas Co.)*
TYPE II	Bar built/well-mixed estuaries have high marine biological value and moderately high terrestrial value. They have a moderate to high percentage of eelgrass and tidelands.	Netarts Bay Sand Lake

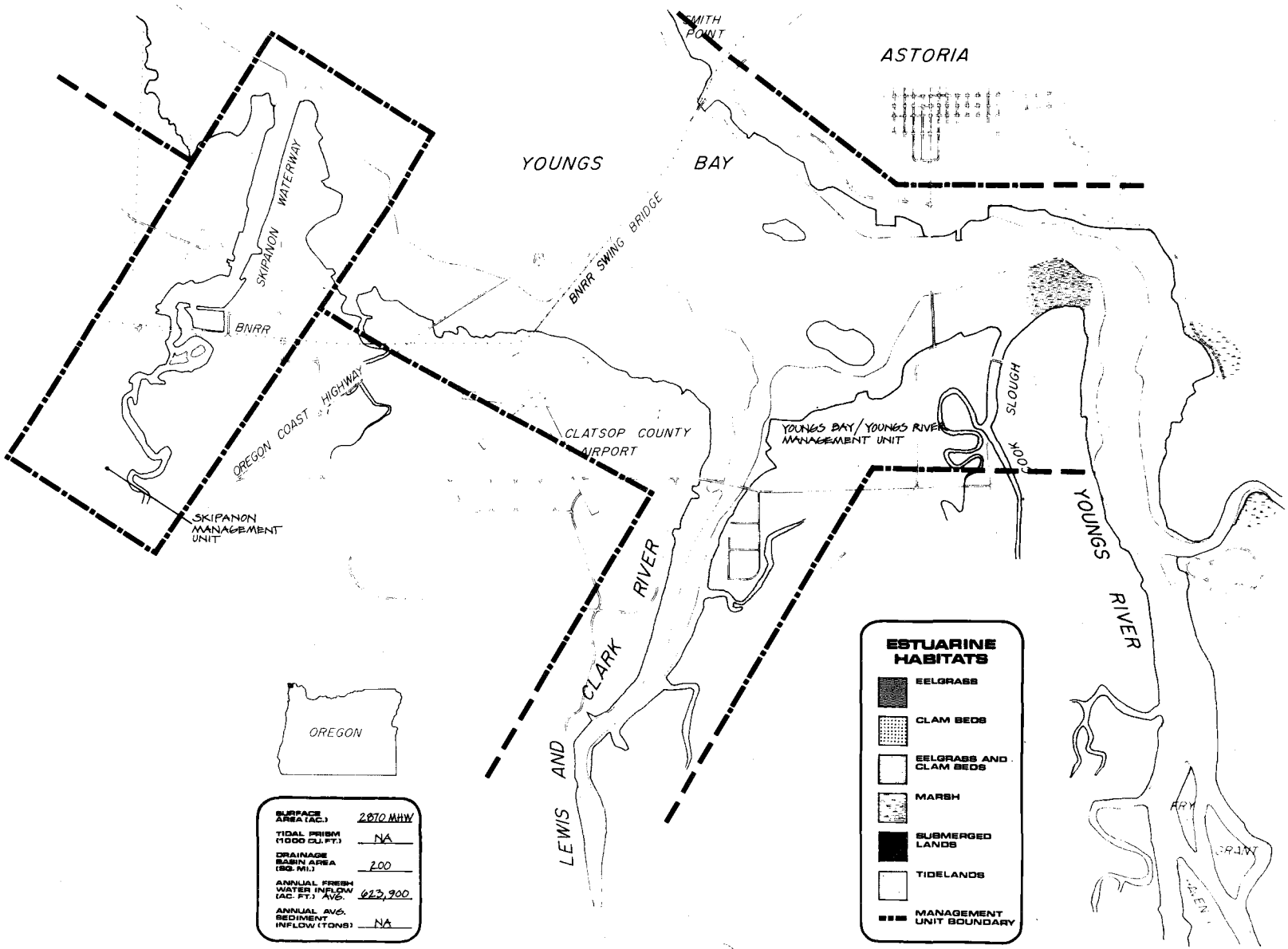
ESTUARY	DESCRIPTION	MANAGEMENT UNITS
TYPE III	Drowned river/well-mixed estuaries have a low marine biological and moderate terrestrial value. They have a low percentage of eelgrass and tidelands.	Beaver Creek* Euchre Creek* Floras Creek System* (Floras, Fourmile, and Morton Creeks)
TYPE IV	Drowned rivers/well-mixed estuaries have low to moderate marine biological value and low terrestrial value. They have a low to moderate percentage of eelgrass and tidelands.	Isthmus and Davis Sloughs Shinglehouse, Coalbank, Pony and Kentuck Sloughs Skipanon
TYPE V	Drowned rivers/well-mixed estuaries have low to moderate biological value and moderate to high terrestrial biological value. They have a moderate percentage of eelgrass and tidelands.	Coos Bay/Coos River
TYPE VI	Drowned rivers/well-mixed estuaries have moderate marine biological value and moderate terrestrial biological value. They have a low percentage of eelgrass and a high percentage of tidelands.	Biggs Cove Catching Slough Lint and Eckman Sloughs
TYPE VII	Drowned rivers/well-mixed estuaries have moderate marine biological value and high terrestrial biological value. They have a moderate to high percentage of eelgrass and tidelands.	McCaffery and Poole's Sloughs North and Haynes Sloughs South Slough and Joe Ney Slough South Slough of the Siuslaw River.
TYPE VIII	Drowned rivers/partially mixed or two layered estuaries have low marine biological value and low or moderate terrestrial biological value. They have a low to moderate percentage of eelgrass and tidelands.	Young's Bay/Young's River (including the Lewis and Clark and Claskanine Rivers and Alder Bay) Necanicum River Chetco River

* These estuaries were not included within the original OCC&DC work program, but have been included here to indicate the need to consider other stream systems within the coastal zone as possibly deserving estuary status for management purposes.

ESTUARY	DESCRIPTION	MANAGEMENT UNITS
TYPE IX	Drowned river/partially mixed or two layered estuaries have low marine biological value and moderate to high terrestrial biological value. They have a moderate percentage of eelgrass and a moderate to high percentage of tidelands.	Little Nestucca Salmon River
TYPE X	Drowned river/partially mixed or two layered estuaries have moderate marine biological value and moderate to high terrestrial biological value. They have a low to moderate percentage of eelgrass and tidelands.	Alsea Bay (including Drift Creek) Coquille River Nehalem Bay
TYPE XI	Drowned river/partially mixed or two layered estuaries have high marine biological value and moderate terrestrial biological value. They have a low to moderate percentage of eelgrass and tidelands.	Nestucca Bay/ Nestucca River Rogue River
TYPE XII	Drowned river/partially mixed or two layered estuaries have high marine biological value and high terrestrial biological value. They have a moderate percentage of eelgrass and tidelands.	Siletz Bay (including Drift and Schooner Creeks) Tillamook Bay, Miami Cove Umpqua River (including Smith River) Yaquina Bay Siuslaw

ESTUARY MANAGEMENT UNIT	CLASSIFICATION
Youngs Bay Management Units:	
Youngs Bay & River, Lewis & Clark River	VIII
Skipanon	IV
Necanicum River	VIII
Nehalem Bay	X
Tillamook Bay Management Units:	
Tillamook Bay, Miami Cove	XII
Biggs Cove	VI
Netarts Bay	II
Sand Lake	II
Nestucca Bay Management Units:	
Nestucca Bay & Nestucca River	XI
Little Nestucca River	IX
Salmon River	IX
Siletz Bay	XII
Yaquina Bay Management Units:	
Yaquina Bay & River, Kings Slough	XII
Pooles & McCaffery Sloughs	VII
Alsea Bay Management Units:	
Alsea Bay & River, Drift Creek	X
Lint & Eckman Sloughs	VI
Siuslaw River Management Units:	
Siuslaw Bay & River, North Fork, Duncan Inlet	XII
South Slough	VII
Umpqua River, Smith River	XII
Coos Bay Management Units:	
Isthmus & Davis Sloughs	IV
Shinglehouse, Coalbank, Pony & Kentuck Sloughs	IV
Coos Bay and River	V
Catching Slough	VI
North and Haynes Sloughs	VII
South Slough & Joe Ney Slough	VII
Coquille River	X
Sixes River	I
Elk River	I

ESTUARY MANAGEMENT UNIT	CLASSIFICATION
Elk River	I
Rogue River	XI
Pistol River	I
Chetco River	VIII
Winchuck River	I


ASTORIA
SMITH POINT
YOUNGS BAY
BNRR SWING BRIDGE
SKIPANON WATERWAY
BNRR
OREGON COAST HIGHWAY
SKIPANON MANAGEMENT UNIT
CLATSOP COUNTY AIRPORT
YOUNGS BAY/YOUNGS RIVER MANAGEMENT UNIT
COOK SLOUGH
YOUNGS RIVER
LEWIS AND CLARK RIVER
OREGON
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
SURFACE AREA (AC.) 2070 MHW
TIDAL PRISM (1000 CU. FT.) NA
DRAINAGE BASIN AREA (SQ. MI.) 200
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG. 623,900
ANNUAL AVG. SEDIMENT INFLOW (TONS) NA
YOUNGS
500 0 1000
2000
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

BIOPHYSICAL ELEMENTS

The Youngs Bay estuary has been separated into two management units: Youngs Bay, Youngs River and Lewis and Clark River comprise the first and the Skipanon River is the second. Very little biophysical data was found from which to evaluate these management units. Analysis based primarily on field observations led to the selection of Estuary Type VIII as best fitting the Youngs Bay management unit and Type IV for the Skipanon.

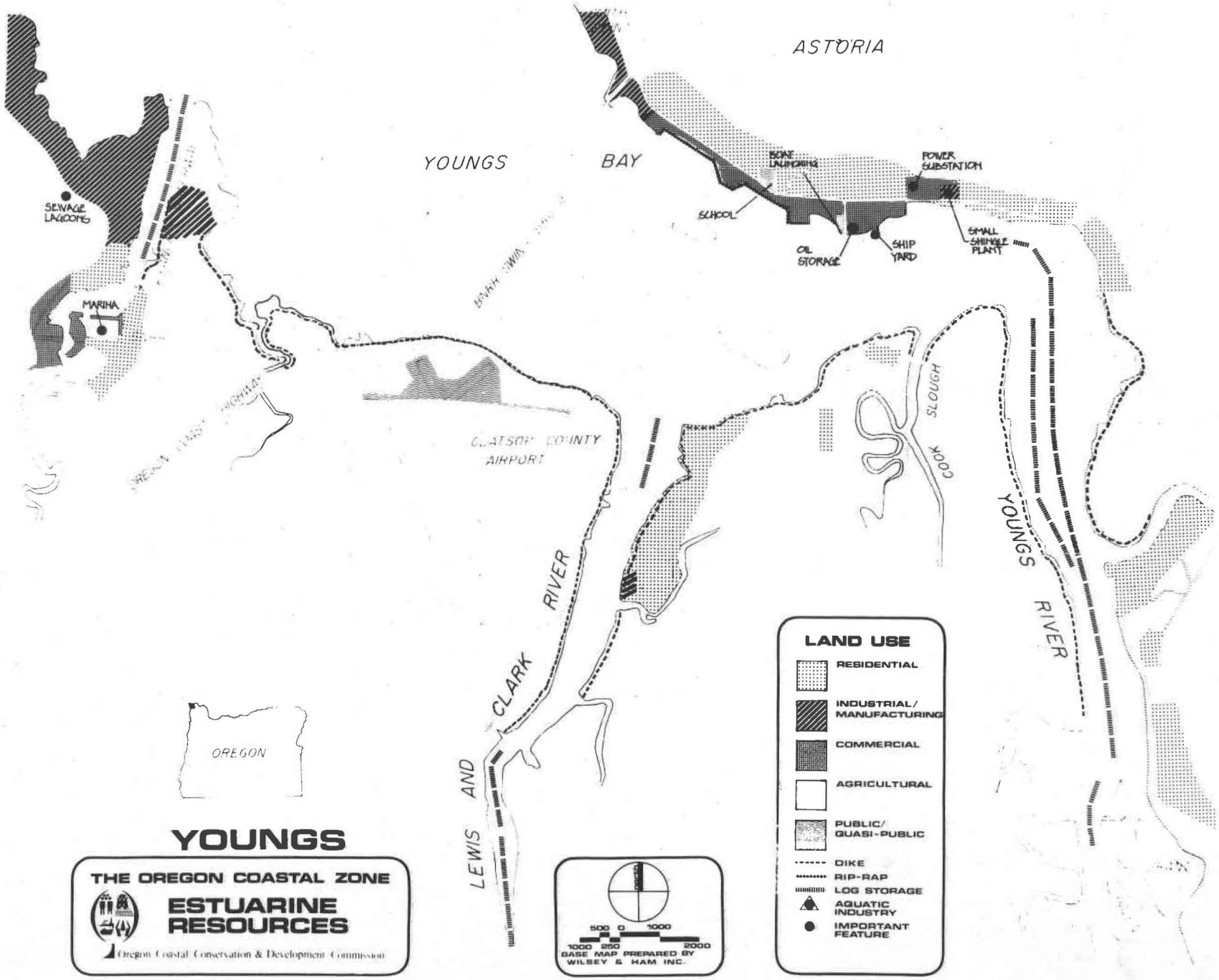
Youngs River and Lewis and Clark River are bordered by broad, flat shorelands (up to 3/4 of a mile wide) which were at one time tide flats and have subsequently developed into marsh lands. Construction of dikes has allowed these areas to be converted to farmland. Youngs River drains a basin 122 square miles in size and has an average recorded flow of 178 cubic feet per second (c.f.s.). Lewis and Clark River drains 62 square miles and stream flows have not been gauged. Landslide topography is common throughout the watersheds of both these river systems. Although no data exists, it is likely that the sedimentation rate in Youngs Bay is rapid due to the extensive human activity and natural characteristics of the waterheds.

The Skipanon Waterway is characterized by low freshwater inflow and intensive human use. Portions of its shoreline are not rip-rapped and bank erosion problems, due primarily to boat traffic, are severe. Wake from commercial navigation is probably the major contributor to turbidity within the estuary.

Information regarding the shellfish populations in the Youngs Bay management unit is not presently available. The upper reaches of the Lewis and Clark River contain widespread potential spawning grounds for anadromous fish and the south fork of the river is heavily used for that purpose.

Data on fin fish populations for the Skipanon River are not available. Field inspection revealed a general lack of shellfish habitats.

The Youngs Bay management unit supports a sizeable waterfowl population (approximately 100,000 waterfowl use days annually) and is heavily populated by small mammals, and fur bearers such as seals and Harbor Seals who make active use of the Youngs Bay system. The Skipanon Waterway is used to a lesser extent by furbearers.


ASTORIA
YOUNGS BAY
BOAT LAUNCHING
POWER SUBSTATION
SCHOOL
OIL STORAGE
SHIP YARD
SMALL SHINGLE PLANT
SEWAGE LAGOONS
MARINA
CLATSOP COUNTY AIRPORT
COOK SLOUGH
YOUNGS RIVER
LEWIS AND CLARK RIVER
OREGON
YOUNGS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission
500 0 1000
1000 250 2000
BASE MAP PREPARED BY WILBEY & HAM INC.
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5				-Urban residential located on Youngs Bay -Scattered suburban and rural residential along Youngs River and Lewis and Clark River				
4		-Astoria serves as regional shopping center -Cluster of commercial facilities along Nehalem Highway -Strip commercial along portions of Young's Bay leading to urban center	-10 foot deep channel from Columbia River to Youngs River and Lewis and Clark River -Good road access to all portions of Youngs Bay/ Youngs River -Limited access to portions of Lewis and Clark River -Rail transport available to Youngs River/Youngs Bay					
3	-Mixed medium sized industrial facilities along Youngs Bay and River, mostly marine oriented, in support of major Columbia River industrial activity -Extensive log storage along portions of Lewis and Clark River -Wood processing plant along Lewis and Clark River				-Small boat moorage and boat launch ramp along Youngs Bay waterfront -Scattered boat ramps along Youngs River and Lewis and Clark River -Scattered tourist commercial along portions of Youngs Bay	-Youngs River and Lewis and Clark River important pasture and dairy lands -Diking has been utilized to reclaim agricultural land		
2								
1								

YOUNGS BAY ESTUARY

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	-Intensive wood products facilities serving inter-state and international markets -Large fish processing plant -Scattered, mixed industrial uses -Large asphalt plant drawing resource from regional base with local market			-Urban/suburban portions of Warrenton located along Skipanon River -Scattered suburban residential outside city limits				
4			-Skipanon Waterway maintained to 30 feet -Rail transport available -Good road acces to both shores of Skipanon River		-Extensive pleasure and sports craft moorage facilities -Scattered tourist commercial			
3		-Cluster of commercial within small urban centers -Scattered tourist commercial						
2						-Little or no farming due to existing development of shore lands		
1								

SKIPANON RIVER ESTUARY
YOUNGS BAY

HUMAN USE ELEMENT

The City of Astoria is situated on a peninsula at the confluence of Youngs Bay and the Columbia River and serves as the county seat and industrial center. Heavy industrial uses such as seafood and wood products processing and manufacturing (cans, machinery, etc.) occur primarily along the Columbia River side of the Astoria peninsula.

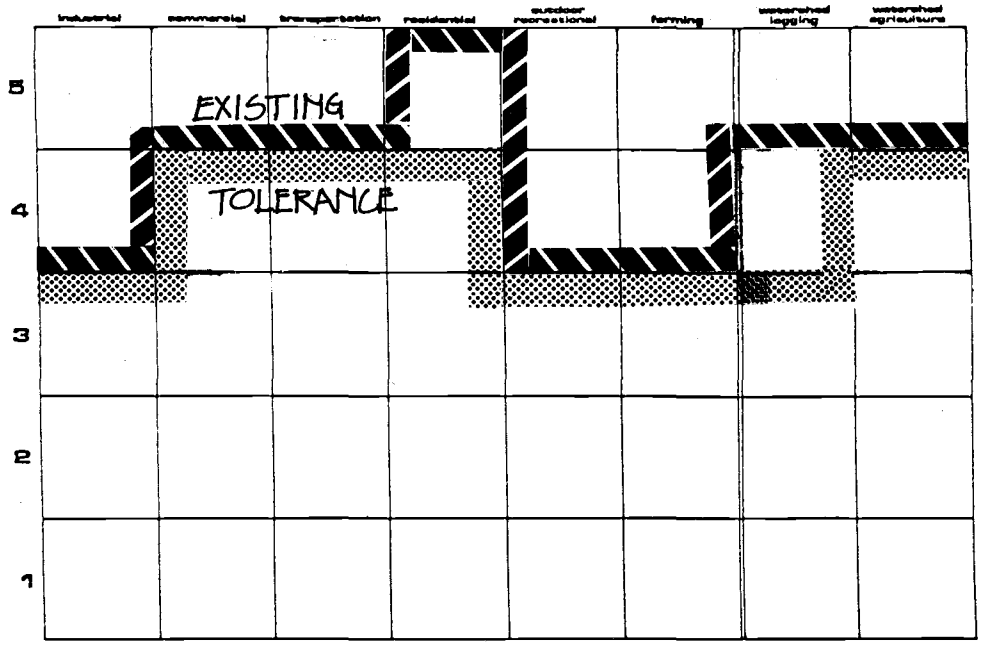
The industrial character of the Youngs Bay area must be considered within the context of industrial uses and industrial development pressures occurring at the mouth of the Columbia River. The possibility of Port expansion at the mouth is being considered due to the difficulty in maintaining a river navigation channel more than 40 feet deep up river to Portland. Should Port expansion at Astoria become a reality, further filling in of estuary tideland to obtain additional land area would probably occur. On the other hand, several socio-political factors operate to limit the potential for industrial expansion where it would be related to the woods products industry. As the manufacturing capacity of existing processing facilities increases, the necessity for new processing facilities decreases. The current economics of log shipments to Japan precludes any short run increase in industrial development to serve this activity. A change in market conditions or legislation to curb log exports would result in increasing local wood products processing to the limits of timber production.

Human activity characteristics and intensity levels for the two Youngs Bay management units are illustrated on the charts on the preceding pages.

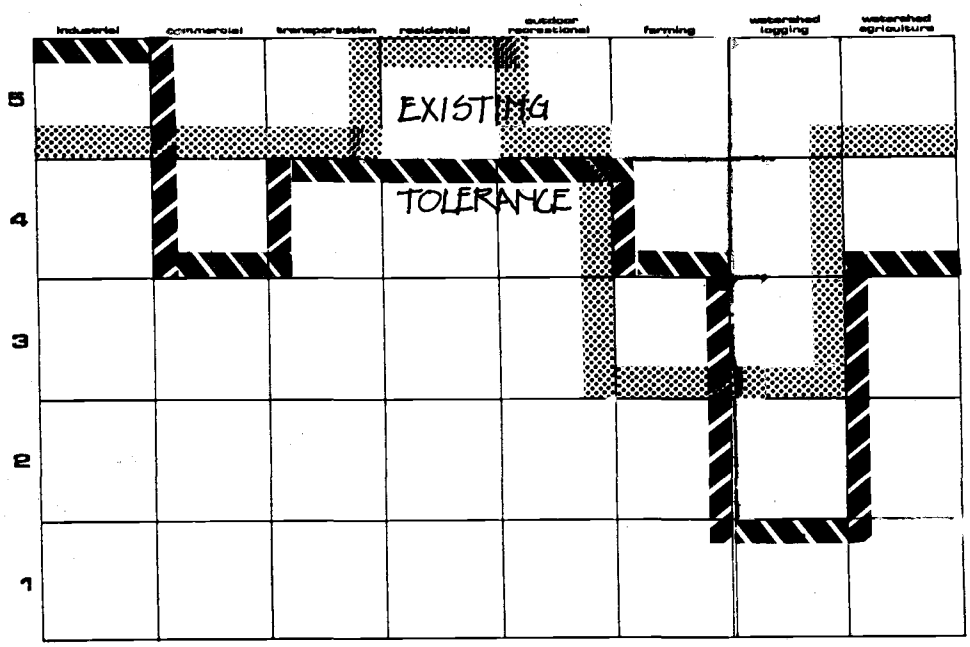
Ten foot deep channels are maintained in Youngs Bay and extend 2 1/2 miles up the Youngs River. A channel project to provide for maintenance of a 10 foot channel 4 1/2 miles up the Lewis and Clark River has been approved. The Skipanon Waterway at the mouth of the Skipanon River is maintained to a depth of 30 feet.

Diking of lands for agricultural purposes has taken place along the Lewis and Clark and Youngs Rivers. Bridges which cross over the estuary include the old Oregon Coast Highway Bridge, the U. S. 101 Bridge, the Youngs Bay Bridge, the U. S. Highway 26 Bridge and a railroad bridge. Inventory of filled lands data is not available for the Youngs Bay estuary.

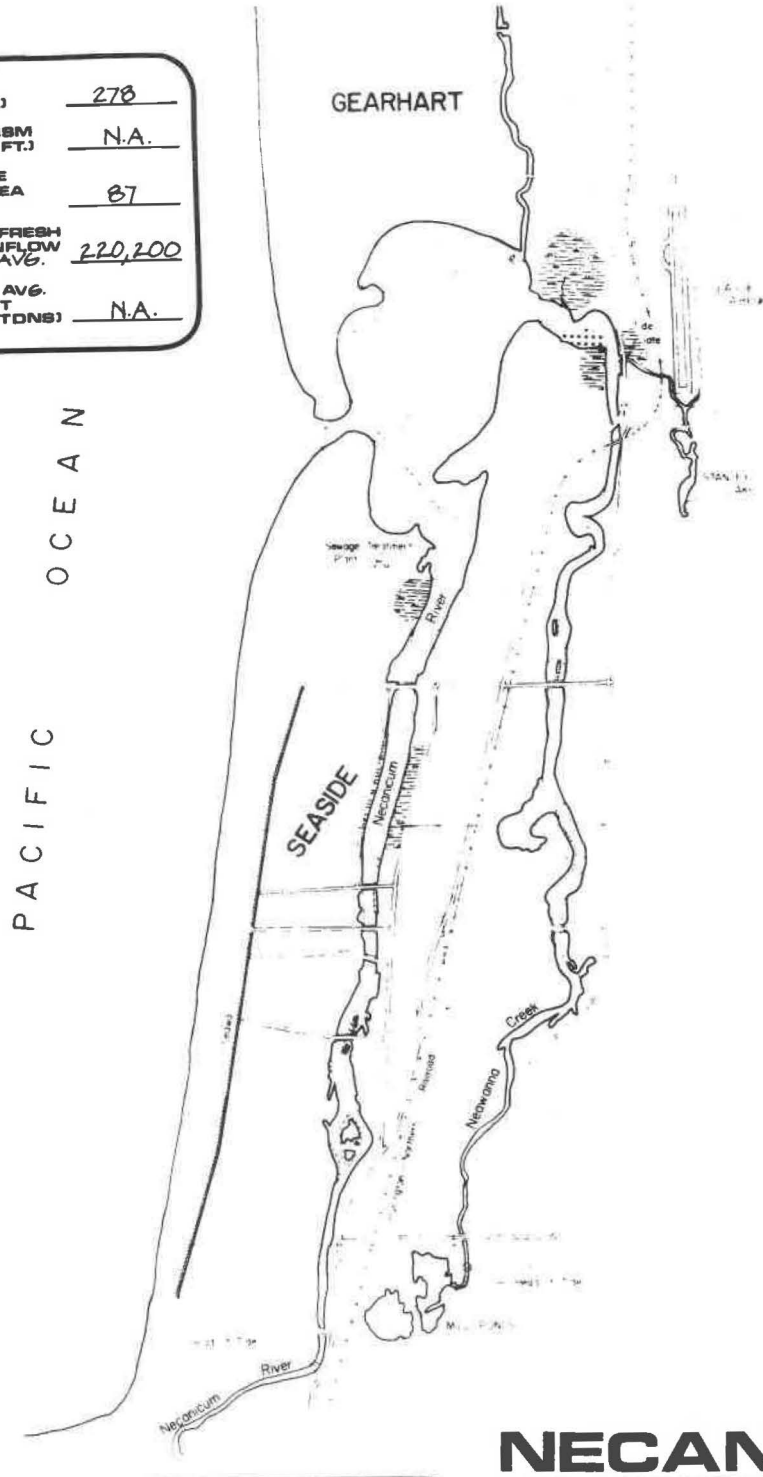
YOUNGS BAY ESTUARY - TYPE VIII



SKIPANON - TYPE IV



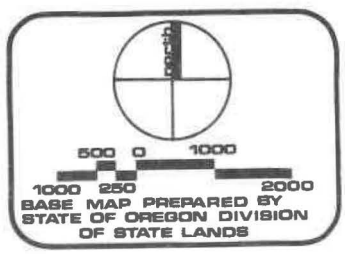
SURFACE AREA (AC.)	278
TIDAL PRISM (1000 CU. FT.)	N.A.
DRAINAGE BASIN AREA (SQ. MI.)	87
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG.	220,200
ANNUAL AVG. SEDIMENT INFLOW (TONS)	N.A.



ESTUARINE HABITATS

- EELGRASS
- CLAM BEDS
- EELGRASS AND CLAM BEDS
- MARSH
- SUBMERGED LANDS
- TIDELANDS
- MANAGEMENT UNIT BOUNDARY

NECANICUM



THE OREGON COASTAL ZONE

ESTUARINE RESOURCES

Oregon Coastal Conservation & Development Commission

NECANICUM RIVER

BIOPHYSICAL ELEMENTS

The entire estuary of the Necanicum River including Neawana Creek conforms with Estuary Type VIII.

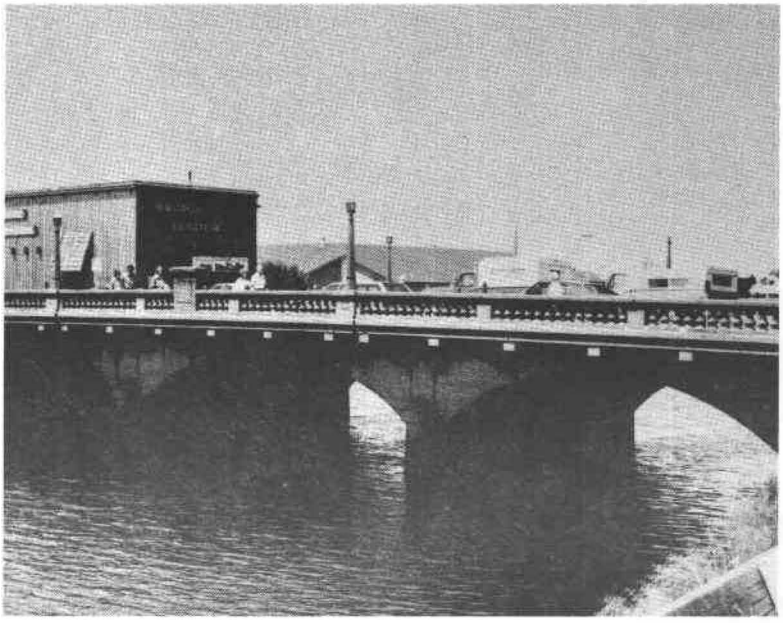
The Necanicum estuary is located on the southern border of the Clatsop Plains, and is confined to the area of sands that have built up as a result of longshore drift and wind transport of Columbia River sediments. Although this description suggests that the Necanicum is bar built, it is classified with drowned rivers because even without the sand build-up, a drowned river would exist farther upstream.

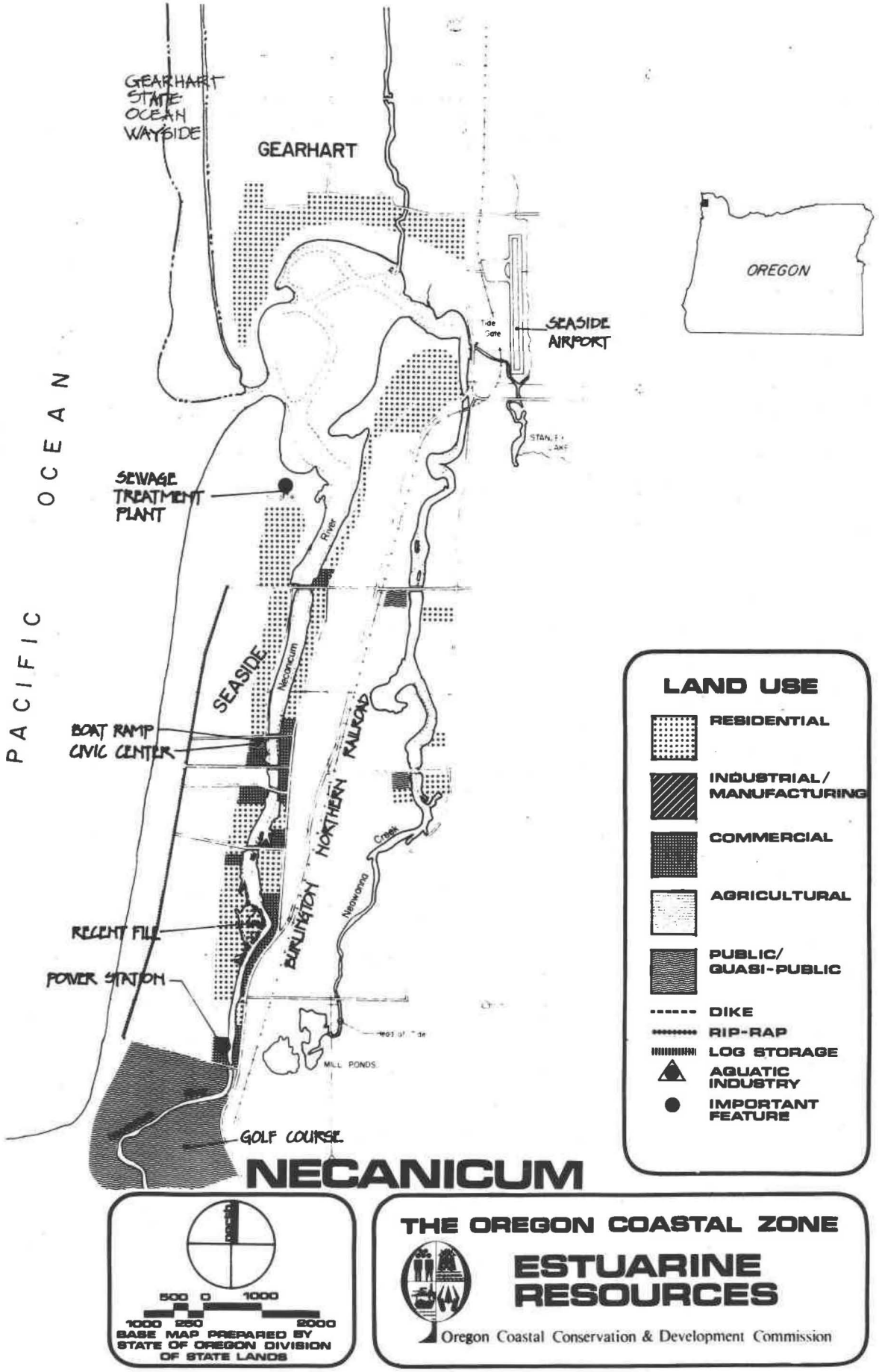
Critical erosion is taking place south of Gearhart near the mouth of the estuary. Since the entire area surrounding the estuary mouth is composed of sand, the wind erosion hazard is great where adequate vegetation is not present to stabilize the sand deposits.

The Necanicum-Neawana drainage system drains an 87 square mile watershed. Due to the sandy substrate, subsurface flow is probably high. A seasonal high water-table (within 6 feet of the surface) exists over much of the area surrounding the estuary. Water quality problems within the basin include low levels of dissolved oxygen and a phosphorous content which exceeds Department of Environmental Quality standards, both of which occur in the Neacoxie River.

The sandy substrate characteristic of the Necanicum estuary provides ideal habitats for clams which are very numerous. Sculpin and flounder are reported taken in the estuary and it has been recommended that all gravel beds be protected, due to their importance as spawning grounds for anadromous fish. Herring are present in the estuary and may spawn in its waters.

Use of the Necanicum estuary by terrestrial wildlife is very limited and detailed data is not available.




GEARHART STATE OCEAN WAYSIDE
GEARHART
OREGON
SEASIDE AIRPORT
Tide Gate
PACIFIC OCEAN
SEWAGE TREATMENT PLANT
River
SEASIDE
Necanicum
BOAT RAMP
CIVIC CENTER
BURLINGTON NORTHERN RAILROAD
Neawanna Creek
RECENT FILL
POWER STATION
MILL PONDS
GOLF COURSE
NECANICUM
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5				-Widespread residential along most portions of estuary and tributaries -Mixed vacation				
4		Mixed small commercial facilities on estuary, some located on fill along river -Intense tourist commercial in Seaside urban center -Mixed tourist commercial Gearhart			-Intensive beach activity oriented toward ocean beach -Motels and golf course located on estuary -Seaside oriented towards intensive tourist commercial			
3			-No estuary or river commercial barge or vessel traffic -Highway 101 runs north-south along estuary -Good access available to most of east-west side of estuary -Rail transport along estuary					
2	-No industry directly on estuary -Seaside supports large wood processing plant and medium fish processing plant which do not utilize estuary					-No farming directly on estuary, due to residential and recreational development		
1								

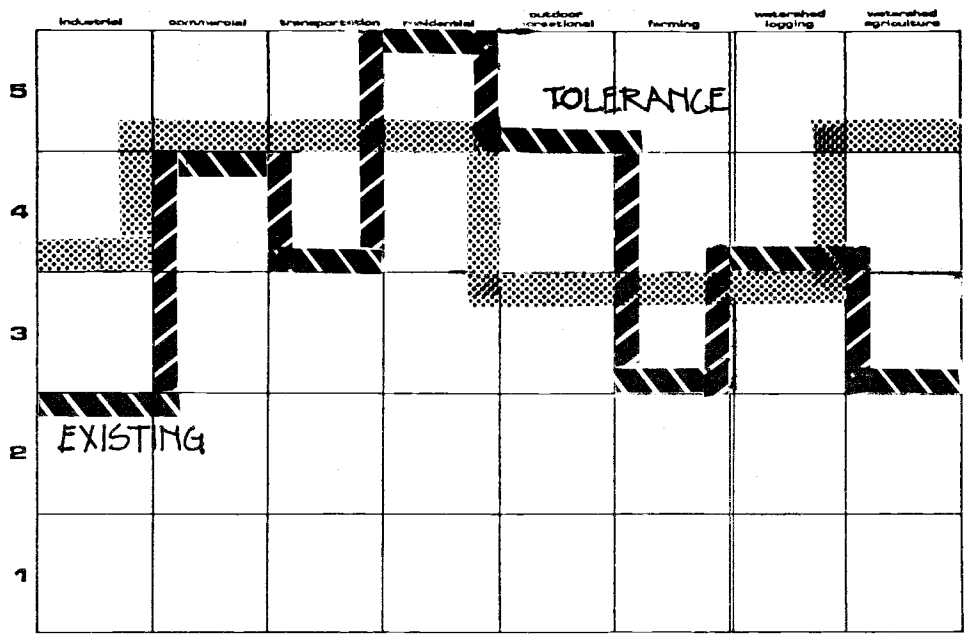
NECANICUM RIVER ESTUARY

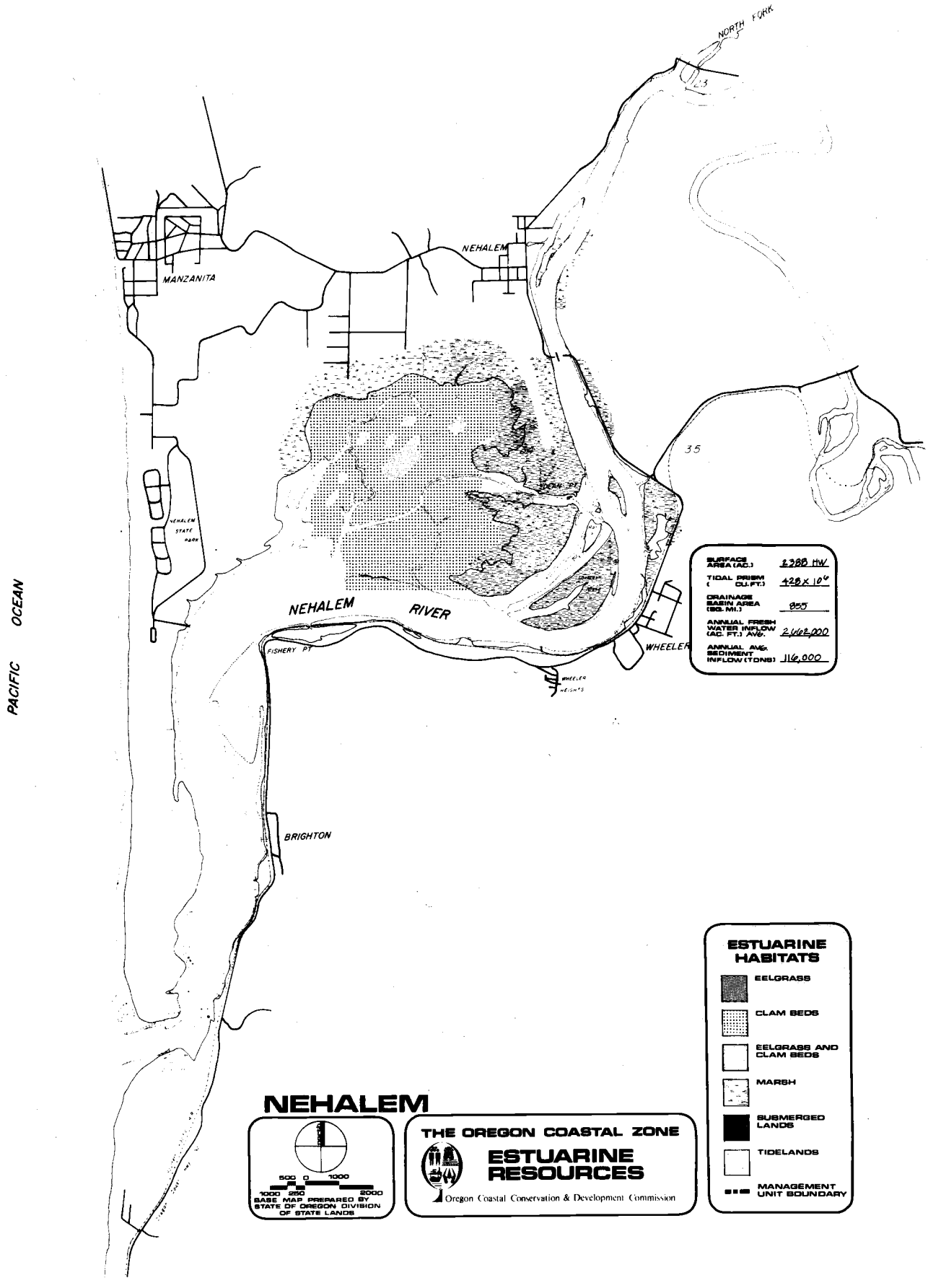
HUMAN USE ELEMENTS

Tourism is a major industry in both Seaside and Gearhart, the two major communities located along the Necanicum estuary. Seaside contains the most intensive recreation oriented tourist commercial district on the Oregon coast, with the possible exception of Lincoln City. Most recreational and commercial facilities are oriented towards the ocean beach, rather than the estuary. Industrial activity at Seaside is also not oriented towards the estuary since the river channel does not provide the necessary width or depth to accommodate water borne transportation. Residential use including vacation home developments provide the most intensive use of the estuary waterfront. The chart on the preceding page indicates existing human use characteristics and levels of intensity of the Necanicum estuary.

The single major physical alteration to the Necanicum estuary has been the extension of the sand spit in the open estuary which began in late 1967. Numerous small fills were seen during field inspection of the river.

NECANICUM RIVER - TYPE VIII




NORTH FORK
MANZANITA
NEHALEM
NEHALEM STATE PARK
NEHALEM RIVER
FISHERY PT
WHEELER
WHEELER HEIGHTS
BRIGHTON
PACIFIC OCEAN
SURFACE AREA (AC.) 2388 HW
TIDAL PRISM (CU. FT.) 428 X 10^6
DRAINAGE BASIN AREA (SQ. MI.) 855
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG. 2,162,000
ANNUAL AVG. SEDIMENT INFLOW (TONS) 116,000
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
NEHALEM
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

NEHALEM BAY

BIOPHYSICAL ELEMENTS

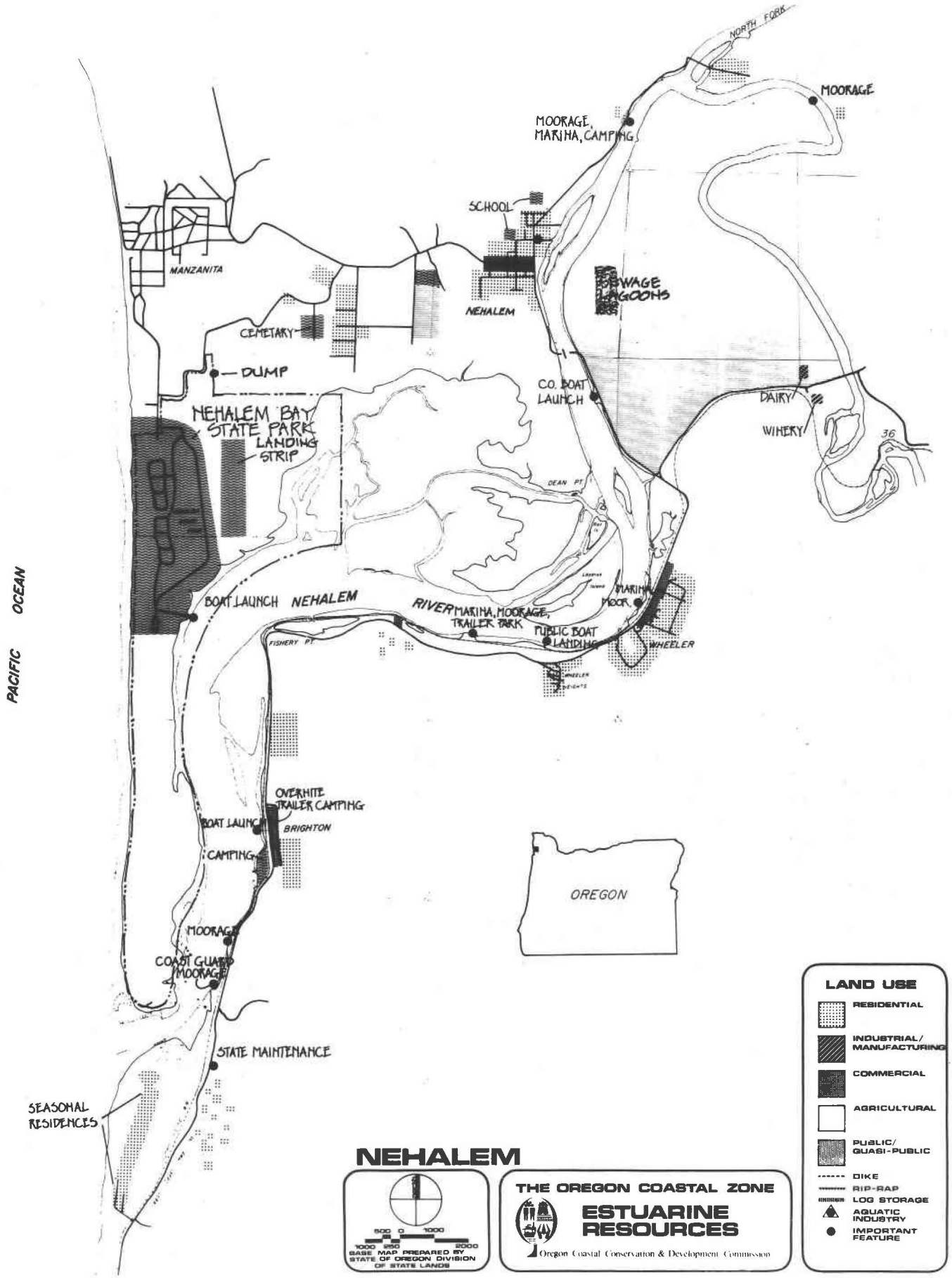
Nehalem Bay is classified as conforming to Estuary Type X.

The Nehalem estuary is moderately large with a surface area of approximately 2,820 acres and a drainage basin of 855 square miles. Average discharge at the mouth of the river is 3,600 c.f.s. A relatively high sediment load of 116,000 tons occurs annually, much of which goes out to sea. Because of other characteristics of the estuary, the sediment which is deposited contributes to filling of the estuary and reduces natural flushing. The high frequency of landslide topography and human activity within the watershed are the major contributors to this high rate of sediment production. Extensive sedimentation has occurred behind the breakwater which is contiguous with the south jetty. Dune sand along the sand spit is only locally stabilized by vegetation. A major water quality problem in the Nehalem estuary relates to the concentrations of coliform in excess of state water quality standards.

Fairly high numbers of anadromous salmonids, as well as starry flounder and sculpin are found in Nehalem Bay. Due to the high freshwater inflow in the bay, only softshell clams are abundant. The eelgrass beds occurring in the estuary are vital to the widges and brants which rest and feed at that site.

The Nehalem Bay provides valuable wildlife habitats supporting a large population of small mammals and furbearers, a great blue heron rookery, band-tailed pigeon, and winter range for big game. The estuary experiences over 330,000 waterfowl use days annually and is one of the few locations on the Oregon coast where bald eagles are frequently sited.

SMALL BOAT BASIN AT NEHALEM BAY


NORTH FORK
MOORAGE
MOORAGE, MARINA, CAMPING
SCHOOL
MANZANITA
NEHALEM
SEWAGE LAGOONS
CEMETARY
DUMP
CO. BOAT LAUNCH
DAIRY
WINERY
36
NEHALEM BAY STATE PARK
LANDING STRIP
DEAN PT
PACIFIC OCEAN
BOAT LAUNCH
NEHALEM RIVER
MARINA, MOORAGE, TRAILER PARK
PUBLIC BOAT LANDING
MARINA MOOR.
WHEELER
FISHERY PT
OVERHITE TRAILER CAMPING
BOAT LAUNCH
BRIGHTON
CAMPING
OREGON
MOORAGE
COAST GUARD MOORAGE
STATE MAINTENANCE
SEASONAL RESIDENCES
NEHALEM
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4					-Angling and clamming popular -Numerous marinas, moorages and boat launching facilities -State park along estuary and ocean			
3		-Small urban centers, Nehalem, Wheeler, serving local population -Mixed tourist-oriented commercial facilities	-Highway 101 travels through Nehalem, Wheeler and Brighton -Rail through Brighton and Wheeler to east -Airport near Nehalem -No barge traffic -Numerous pleasure boat marinas, launches and moorage facilities	-Clustered single-family neighborhoods in Nehalem, Wheeler and Brighton -Scattered rural residential	-Scattered trailer parks, motels and recreational housing	-Active grazing along Nehalem River -Scattered dairy farming		
2	-Limited, small timber and logging operations -Very small commercial fishing value							
1								

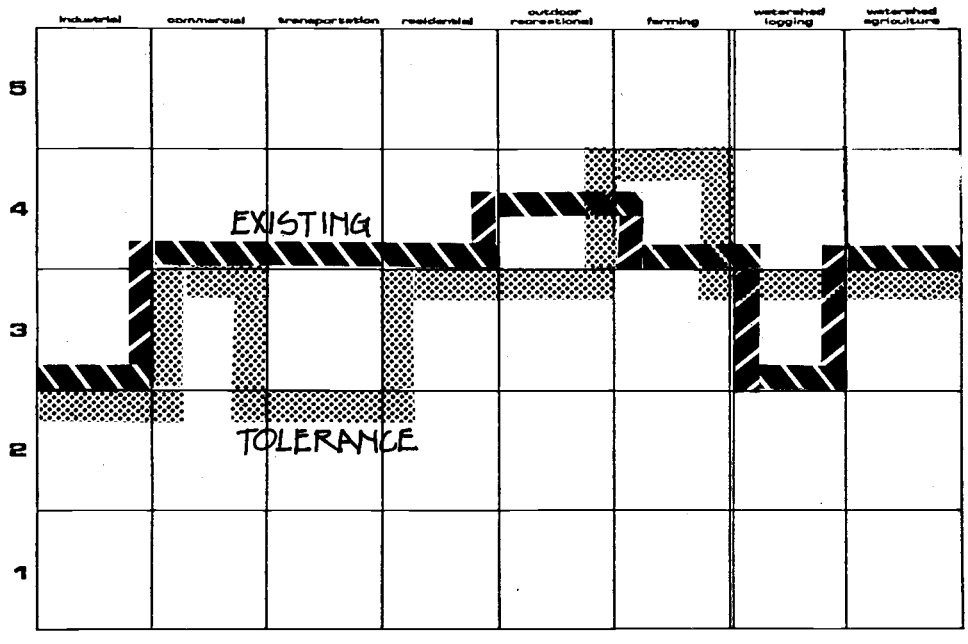
NEHALEM BAY

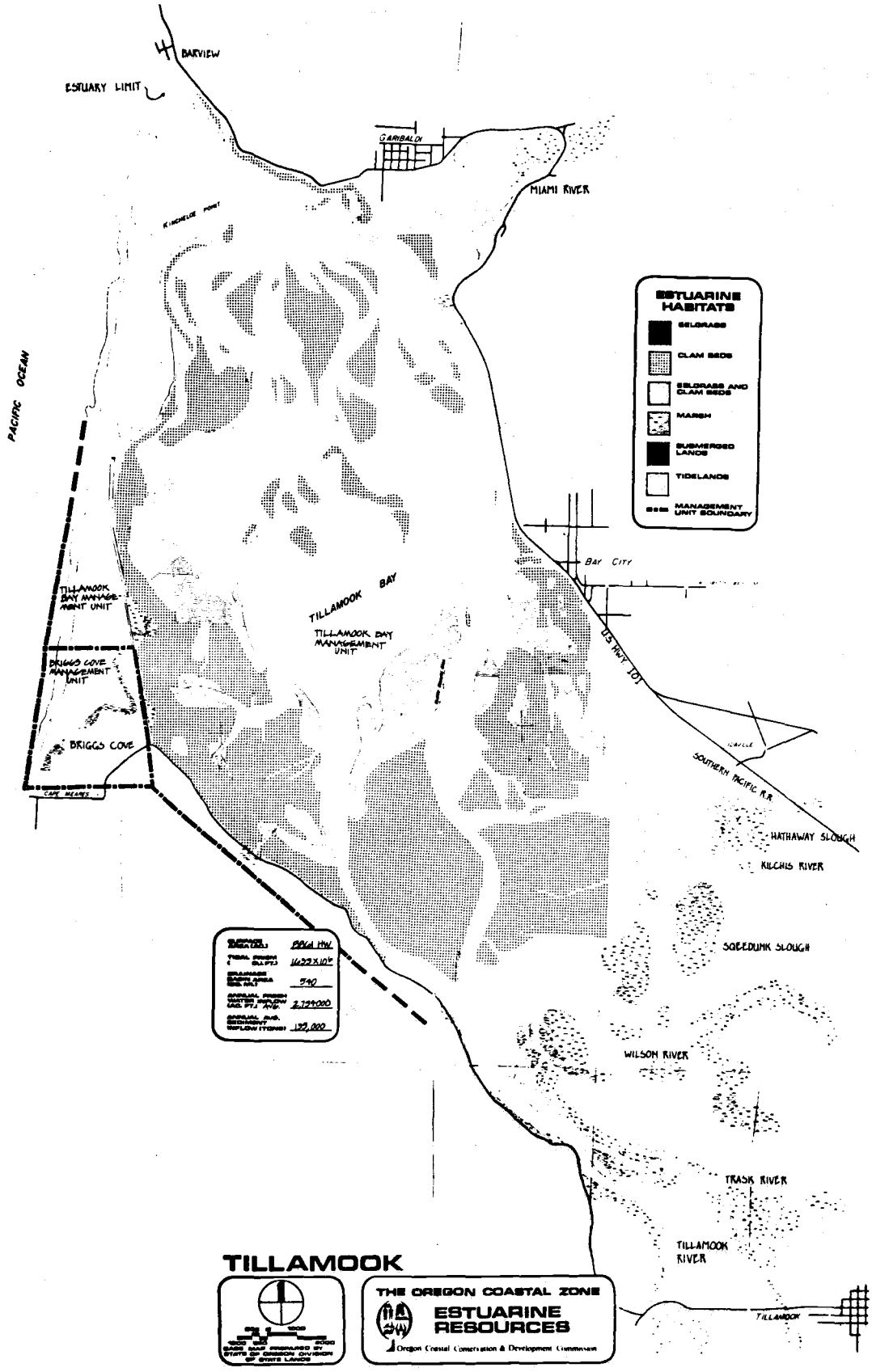
HUMAN USE ELEMENTS

Although the most important economic resource of the Nehalem basin is timber, manufacturing along the estuary is quite limited. The four residential centers in the vicinity of the estuary - (1) Nehalem, (2) Manzanita, (3) Wheeler, and (4) Brighton support a combined population of less than 1,000 persons. Tourism is of major economic value to the local residents. The chart on the preceding page provides an overview of the existing human use characteristics and intensity levels along the Nehalem estuary.

Major physical alterations to the Nehalem estuary include the construction of north and south rubble-stone jetties and an entrance channel, all of which were completed prior to 1920, which have not been maintained recently. The channel has a depth of eight feet and records indicate no recent dredging has occurred. The Inventory of Filled Lands prepared by the State of Oregon reports that only 27.38 acres of landfill are located on submerged and/or submersible land within the estuary. The individual landfills are quite small and provide for residential development, marinas and boat launches.

NEHALEM BAY - TYPE X




BARVIEW
ESTUARY LIMIT
GARIBALDI
MIAMI RIVER
KINCHELOE POINT
PACIFIC OCEAN
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
Bay City
TILLAMOOK BAY
TILLAMOOK BAY MANAGEMENT UNIT
TILLAMOOK BAY MANAGEMENT UNIT
BRIGGS COVE MANAGEMENT UNIT
BRIGGS COVE
CAPE MEARES
U.S. HWY 101
SOUTHERN PACIFIC R.R.
HATHAWAY SLOUGH
KILCHIS RIVER
SQEEDUNK SLOUGH
WILSON RIVER
TRASK RIVER
TILLAMOOK RIVER
TILLAMOOK
TILLAMOOK
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

TILLAMOOK BAY

BIOPHYSICAL ELEMENTS

The Tillamook Bay estuary has been divided into two separate management units, the first is comprised of Tillamook Bay and Miami Cove, while the second includes only Biggs Cove. Tillamook Bay and Miami Cove are categorized as Estuary Type XII and Biggs Cove as Estuary Type VI.

In terms of surface area, Tillamook Bay is the second largest estuary along the Oregon coast with a total area of approximately 8,700 acres. The drainage basin of the bay includes a 540 square mile area.

The sand spit areas of Tillamook Bay are fairly well stabilized and protected from wind erosion except for a large blow out at Rabbit Hollow. Critical erosion areas within the bay occur along Bayocean Peninsula. The peninsula was breached in 1952 causing extensive damage to property and aquatic resources. Mud flats comprise most of the tidelands except along the sand spit and the mouth, where sand flats are more predominant.

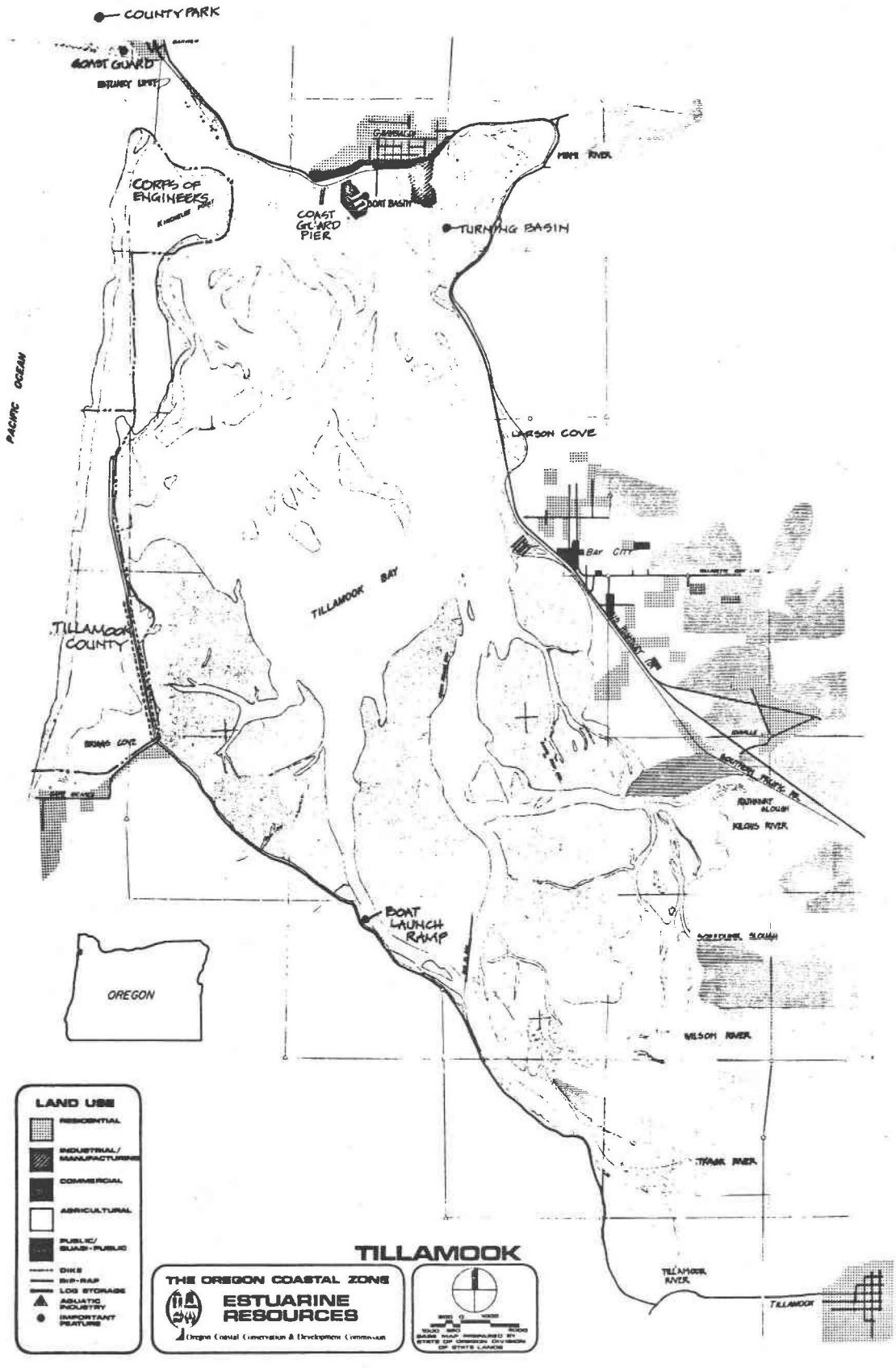
Extensive sediments are deposited in the estuary from an estimated annual river load of 135,000 tons. Filling of the estuary from sedimentation has been rapid and is attributed to a number of factors. Breaching of the spit caused deposition of sand in the bay. Other major factors include logging practices and large forest fires in the watershed which occurred in the late 1930's and early 1940's.

Biggs Cove is a cove that has been diked off from the estuary and ocean. Inflow seawater is controlled by a tidegate. At the time of the field survey conducted for preparation of this report (August, 1974) it contained fresh water at the surface. Dredge spoils and subsequent dune sand accumulation is extensive along Biggs Cove and has been well stabilized by grass, pine and Scotch Broom.

Tillamook Bay is the main oyster producer in the state, although the excessive sedimentation has reduced the tidal prism and hence the bays productivity. Eelgrass beds provide important habitats for the many waterfowl which utilize the bay for feeding and wintering.

The jetties and old groins of the lower bay are important feeding and rearing grounds for perch, rockfish and greenling. Estimated numbers of anadromous fish spawning within the bay tributaries are high in comparison with other estuarine river systems. The bay also provides important spawning grounds for herring. Natural spawning is supplemented by a salmon hatchery and rearing pond on the main Trask River.

Tillamook Bay is one of the most important wildlife areas along the Oregon coast. It supports over 750,000 waterfowl use days annually, including most of the black brant that winter in Oregon. Shorebirds, seabirds and numerous small mammals and seals are common. Bald eagles are also sited occasionally.


COUNTY PARK
COAST GUARD
CORPS OF ENGINEERS
COAST GUARD PIER
BOAT BASIN
TURNING BASIN
PACIFIC OCEAN
LARSON COVE
Bay City
TILLAMOOK BAY
TILLAMOOK COUNTY
BOAT LAUNCH RAMP
OREGON
WILSON RIVER
TILLAMOOK RIVER
TILLAMOOK
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ SEMI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
TILLAMOOK
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4	-Wood processing plant and fish processing plants located on estuary in Garibaldi -Shellfish (oyster) processing plants scattered along shoreline -Large wood processing mills located within Tillamook	-Tillamook serves as regional trade center, but commercial facilities not close to estuary -Tourist commercial located on waterfront in Garibaldi -Bay City and Garibaldi have convenience facilities to meet local needs	-Jetties are currently being expanded to relieve hazardous bar crossing conditions -Channel dredged 11-15 feet to Miami Cove -Small boat basin at Garibaldi -East-west & north-south highways -Rail and truck transport available	-Urban/suburban residential neighborhoods in Garibaldi, Bay Ocean and Tillamook -Widely scattered residential along other portions of estuary	-Small boat basin with active charter service in Garibaldi -Tourist commercial in Garibaldi -Scattered boat ramps and launching facilities -Clamming, fishing and crabbing popular recreation activities	-Active farming precluded from estuary shorelines due to topography, except in South bay area -Dairying of great importance in valleys -Extensive diking		
3								
2								
1								

TILLAMOOK BAY

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3				-Suburban cluster of residential housing in Cape Meares -Scattered residential along Bay Ocean Road				
2								
1	-No industrial activity	-No commercial activity	-Good road access to one-half of Biggs Cove -No navigation available from estuary due to dike		-Minimum recreational facilities oriented towards Biggs Cove	-No farming due to topographic limitations		

BIGGS COVE
TILLAMOOK BAY

HUMAN USE ELEMENTS

Tillamook Bay has until recently been the north coast regional center of lumber production with its greatest income being derived from forest products. Due to a recent decrease in the market for lumber products, and the inability to process smaller logs, several mills located on the estuary recently ceased operation. The channel will probably not be maintained until such time as commerce starts up again. The potential timber in the Tillamook burn area is beginning to regain economic value and the wood products industry along the estuary may stabilize if modern facilities are developed which are capable of utilizing smaller trees.

Agriculture, primarily dairying, is of major economic importance, and could expand if land area were available. Attempts have been made to introduce specialty types of vegetable crops within the valley, and these crops are competing with the dairy industry for the supply of available land. Although lesser amounts of land are utilized for pasture land than was true in the past, the productivity of the dairy industry has increased. While dairy and pasture land agriculture are decreasing along most of the Oregon coast, the economic importance of this industry stabilizes its position in the Tillamook Valley and allows it to successfully compete with other types of development for available land resources. Harvesting of aquatic resources is limited in importance primarily to oysters and crabs.

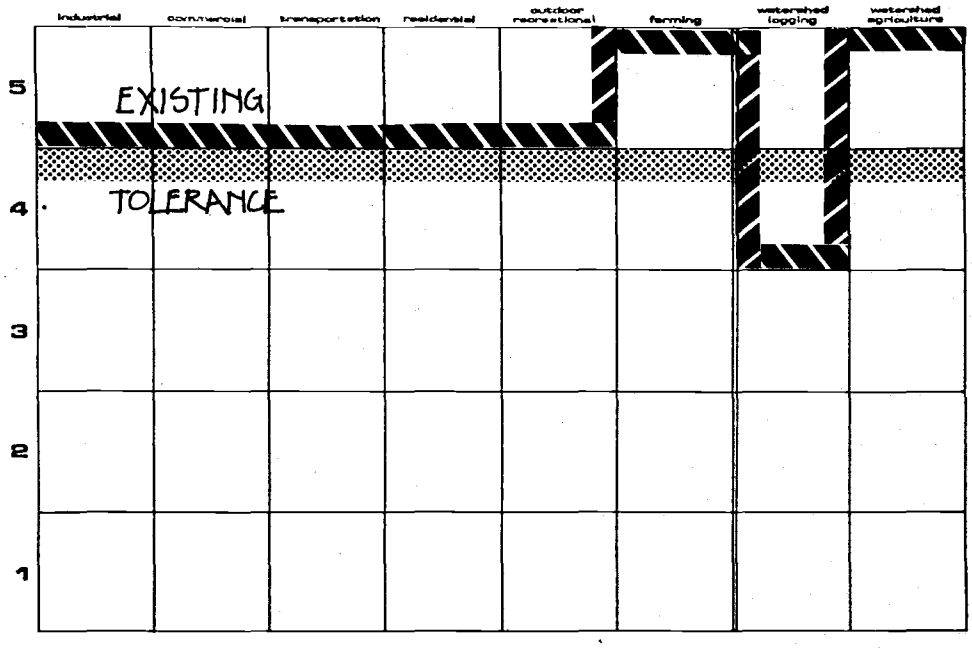
Recreation is the third ranking industry in terms of productivity and is growing rapidly. Recreational boating and fishing are expected to increase upon completion of the on-going jetty improvements. Tourist-commercial facilities are located in the three major population centers along the bay - Garibaldi, Bay City and Tillamook.

The human use characteristics and intensity levels of Tillamook Bay and Miami Cove and Biggs Cove are shown in the preceding charts.

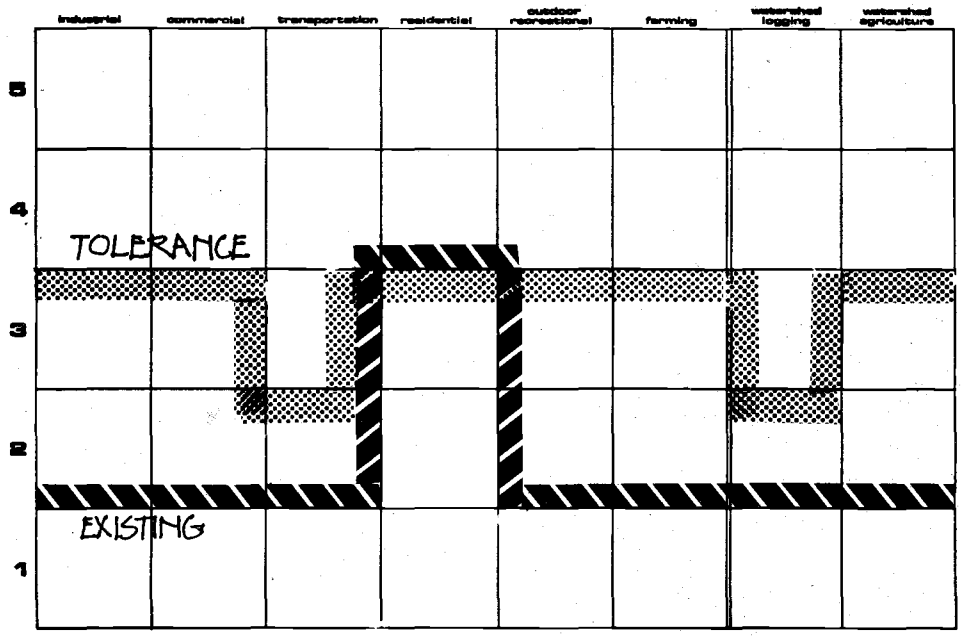
Constructed alterations to the Tillamook estuary include the north and south jetty, a channel through the bar to Miami Cove, a small boat basin at Garibaldi and a dike to close the breach in the Bayocean Peninsula. Present channel dredging activities total approximately 57,000 cubic yards annually. The entrance and channel and turning basin near Miami Cove are maintained to a depth of 11 to 15 feet, although the authorized depth is 18 feet.

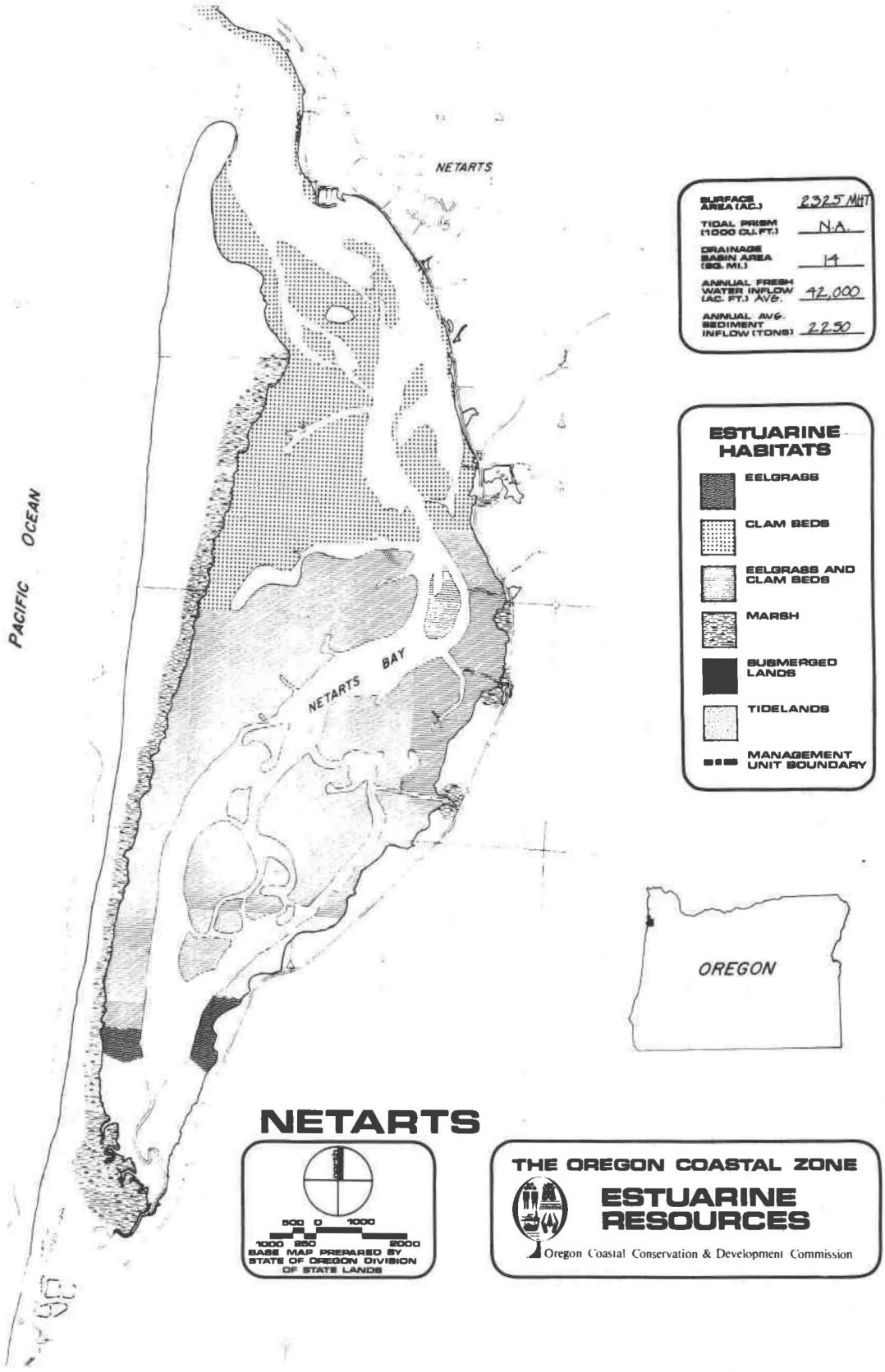
The Tillamook Bay estuary contains 102.63 acres of landfill on submerged and submersible land. The great majority of these landfills were constructed from 15 to 50 years ago, and are generally industry oriented with no particular emphasis on navigation. The largest filled area is located along the Garibaldi waterfront, and presently is utilized for a small boat basin, fish processing plants and wood products mills. An additional oyster processing plant at Bay City is constructed on fill and pilings.

TILLAMOOK BAY - TYPE XII



BIGGS COVE - TYPE VI




NETARTS
PACIFIC OCEAN
NETARTS BAY
SURFACE AREA (AC.) 2325 MHT
TIDAL PRISM (1000 CU. FT.) N.A.
DRAINAGE BASIN AREA (SQ. MI.) 14
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG. 42,000
ANNUAL AVG. SEDIMENT INFLOW (TONS) 2250
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
OREGON
NETARTS
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

BIOPHYSICAL ELEMENTS

Netarts Bay is classified as a Type II Estuary.

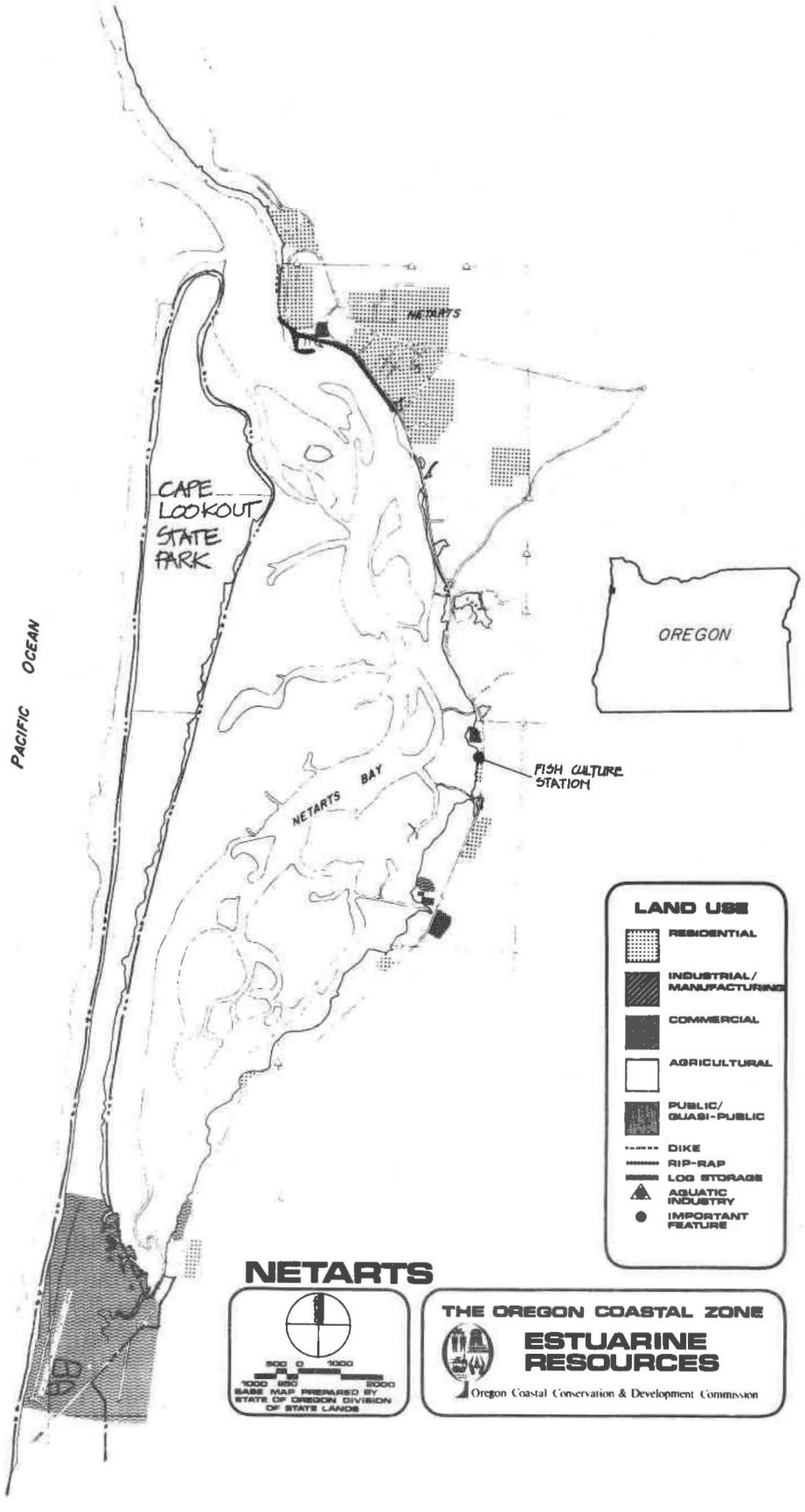
Netarts Bay is moderate in size with a surface area of approximately 2,300 acres. Its watershed area, however, is very small, comprising only 14 square miles. Twelve small creeks flow into the estuary. Mud flats are extensive in comparison with other estuaries of its type and they grade to sand flats near the estuary mouth.

The sand spit which encloses the Netarts estuary is well stabilized by vegetation and if progressive accumulation and stabilization continue, it is likely that the estuary will eventually be permanently closed off from the sea at the north end. Erosion is rapid along the south portion of the spit, however, and if this trend continues a new opening to the sea may be formed.

Removal of the surface soil and vegetation layer on stabilized dunes has created some landsliding and surface erosion problems within the Netarts estuary basin. Although the tributaries to the estuary probably do not carry a large load of sediments, they are not easily flushed into the ocean. The sedimentation rate in the estuary thus remains high.

Netarts Bay is the last remaining estuary in which native oysters grow naturally and it has good potential for commercial oyster cultures. However, since the Netarts Bay oysters are infected with oyster drill, they cannot be transported from the area for processing, for fear of spreading the disease to other estuaries. High numbers of gaper and cockle clams are presently harvested by recreationists. The estuary provides excellent herring spawning and rearing grounds, and perch and greenling are taken by anglers in moderate numbers. The eelgrass beds located in the bay are an extremely important supply of winter feed for waterfowl.

Netarts Bay supports over 300,000 waterfowl use days annually, and is especially important as a wintering area for black brant. Large populations of small mammals and furbearers are present and the estuary shorelands provide excellent big game winter range. The large, undisturbed bar at Netarts Bay, is perhaps, the best example of a dune ecosystem in Oregon.


NETARTS
CAPE LOOKOUT STATE PARK
PACIFIC OCEAN
NETARTS BAY
FISH CULTURE STATION
OREGON
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
NETARTS
500 0 1000
1000 1500 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3				-Residential neighborhood in Netarts along bay -Scattered residential along road to Cape Lookout State Park	-Cape Lookout State Park borders south of estuary -Small County Park located on estuary -Small boat basin -Crabbing, clamming and fishing receive recreation use			
2		-No barging or water-borne transportation -Small boat basin -No rail transport -Paved road along east side of estuary to Cape Lookout State Park	-Limited scattered commercia along bay -Small commercial facility located close to Cape Lookout State Park			-Scattered grazing east of road to Cape Lookout. None along estuary		
1	-No industrial activity							

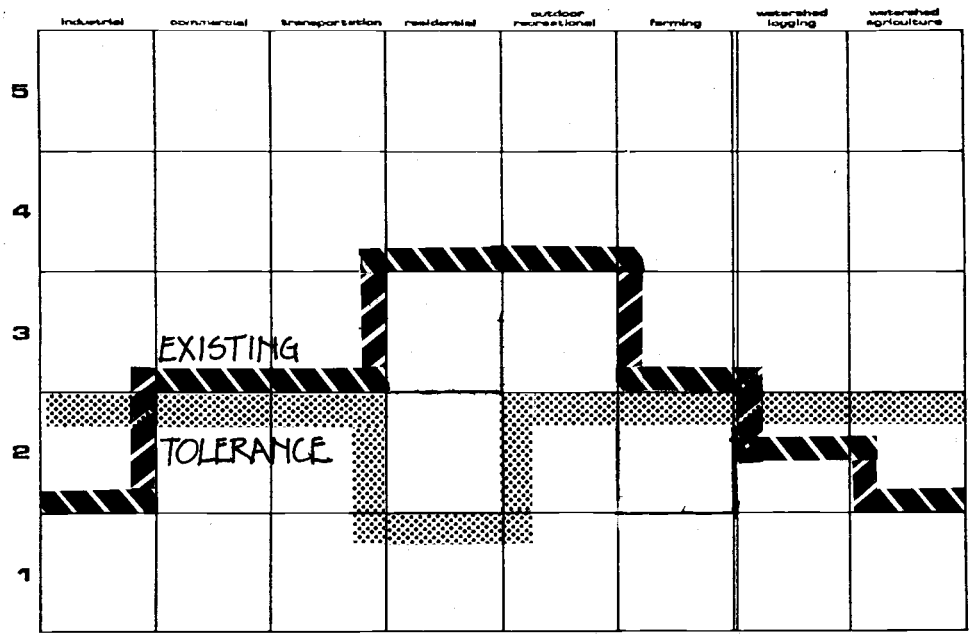
NETARTS BAY

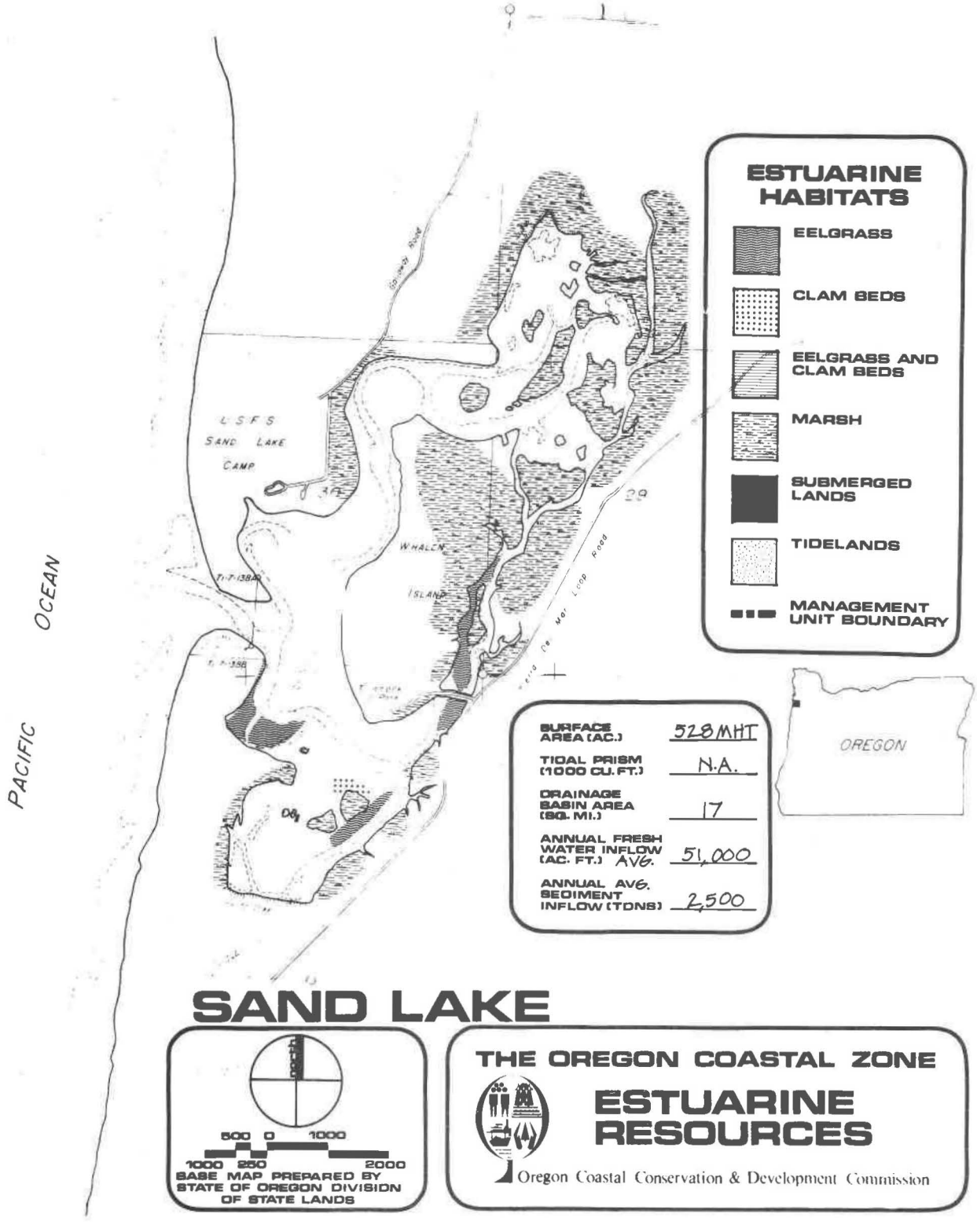
HUMAN USE ELEMENTS

Human activities adjacent to the Netarts Bay estuary are limited to recreational uses and permanent and vacation housing. The only community along the estuary is the small town of Netarts located at the north end of the estuary; Cape Lookout State Park borders the estuary to the south. A description of the existing human uses and intensity levels relating to the Netarts estuary is contained in the preceding chart on page 98.

The single physical alteration to the Netarts estuary reported in the Inventory of Filled Lands, has been a small, 5.0 acre landfill for the marina at the north end of the bay. Tillamook County presently operates the boat launch and public parking area located on the landfill. The road along the east bank of the estuary was constructed upon fill in order to provide bank stabilization. Riprap has been placed along these portions of the shoreline to prevent erosion of the fill.

NETARTS BAY - TYPE II




ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
OREGON
SURFACE AREA (AC.) 528 MHT
TIDAL PRISM (1000 CU. FT.) N.A.
DRAINAGE BASIN AREA (SQ. MI.) 17
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG. 51,000
ANNUAL AVG. SEDIMENT INFLOW (TONS) 2,500
PACIFIC OCEAN
U.S.F.S. SAND LAKE CAMP
WHALEN ISLAND
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

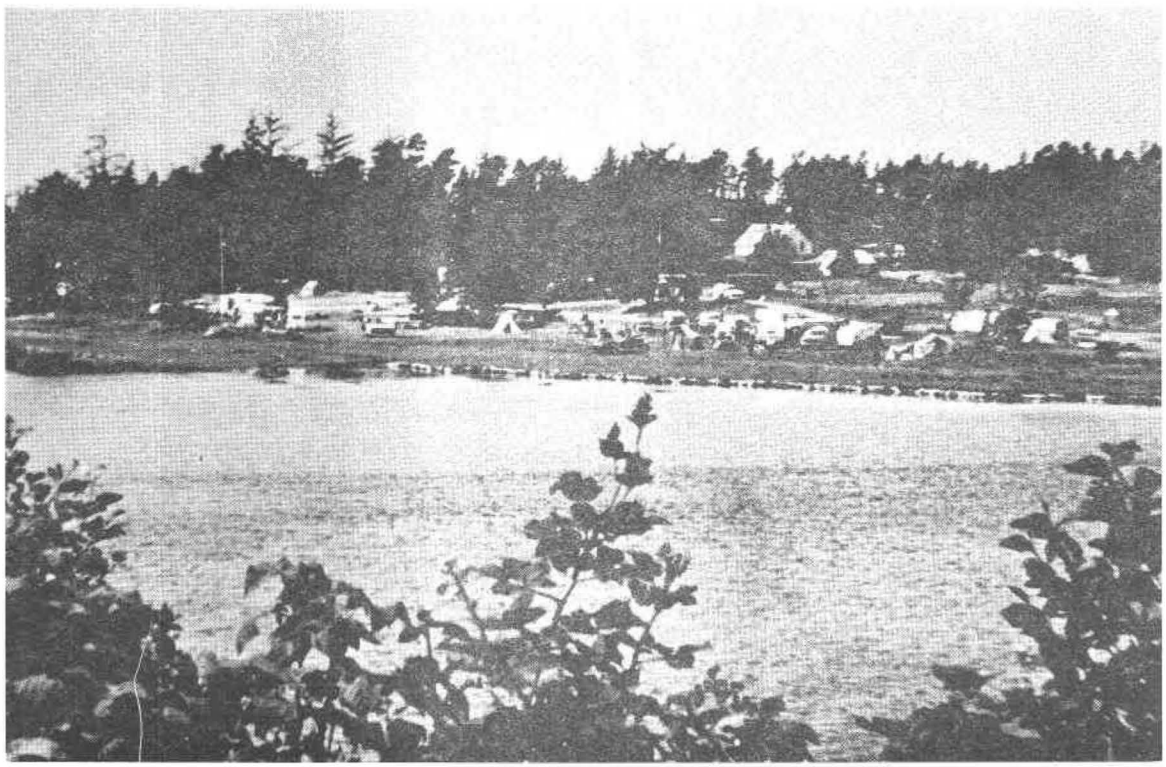
SAND LAKE

BIOPHYSICAL ELEMENTS

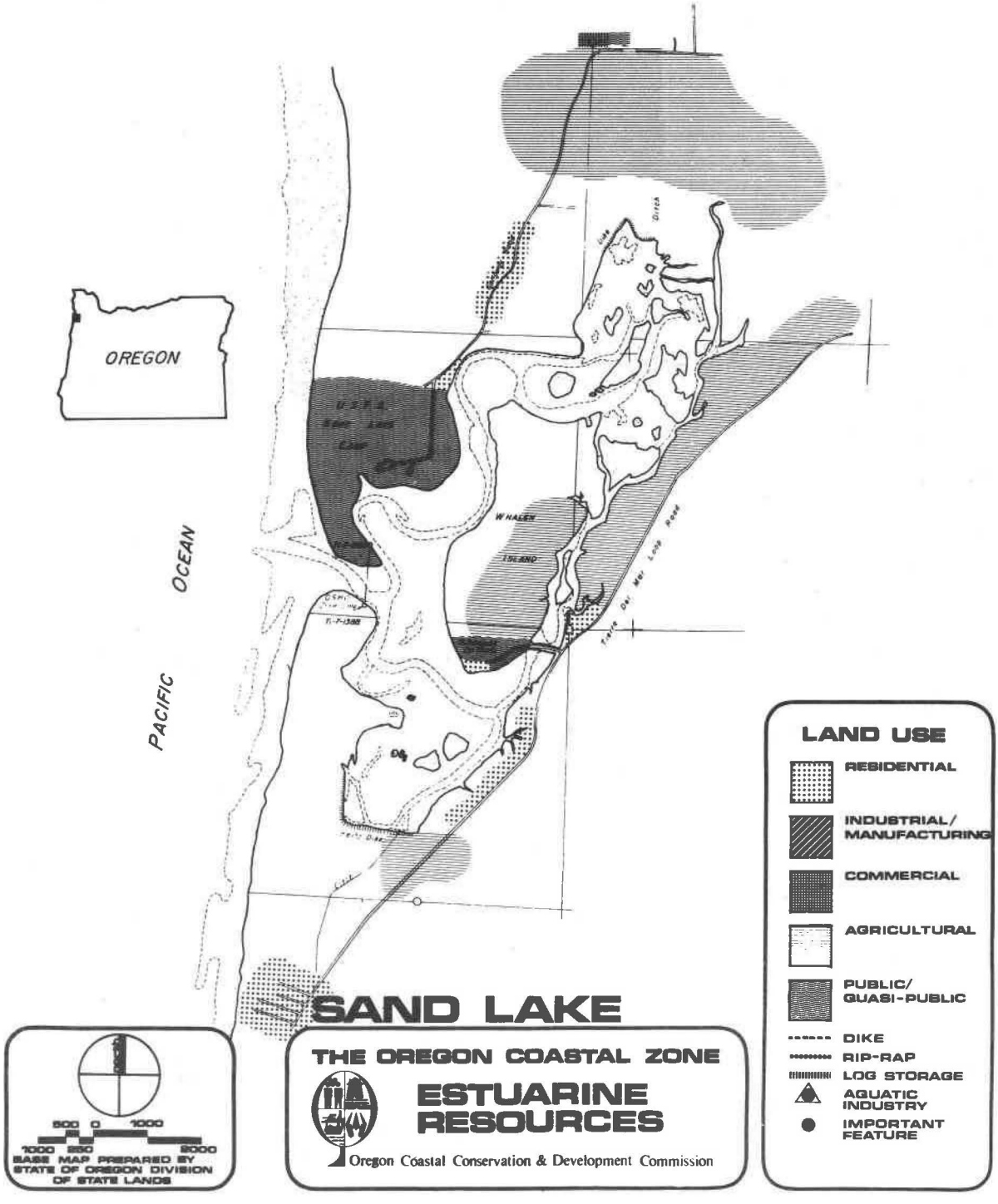
Sand Lake is classified as a Type II Estuary.

Sand Lake is relatively small with a surface area of approximately 550 acres and a watershed of 17 square miles. Sand is the predominant sediment in the estuary bottom and sand spits extend from both the north and south to enclose the estuary. Some of this sand is well stabilized by forest vegetation, however much of it remains subject to the effects of wind, slope failure and tidal action.

The Sand Lake estuary has abundant ghost shrimp and crabs but relatively few mud shrimp. Sea-run cutthroat, flounder and staghorn sculpin provide excellent shoreline fishing. The sandy nature and immense wetlands of this site are unlike any other estuary in Oregon, and provide valuable habitats for ducks, geese and shorebirds.



RECREATION FACILITIES ALONG SAND LAKE ESTUARY


OREGON
PACIFIC
OCEAN
SAND LAKE
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
500 0 1000
1000 250 5000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3			-County road access to most portions of estuary -No dredging or jetties -Dike for road construction		-2 public campgrounds (U.S.F.S. and Tillamook County) which are heavily used -Boat launch facility	-Scattered small farms oriented primarily towards grazing -Diking for maintenance of pasture lands		
2				-Moderately widespread rural residential housing				
1	-No manufacturers, industry or commercial fishing	-No commercial activity		n				

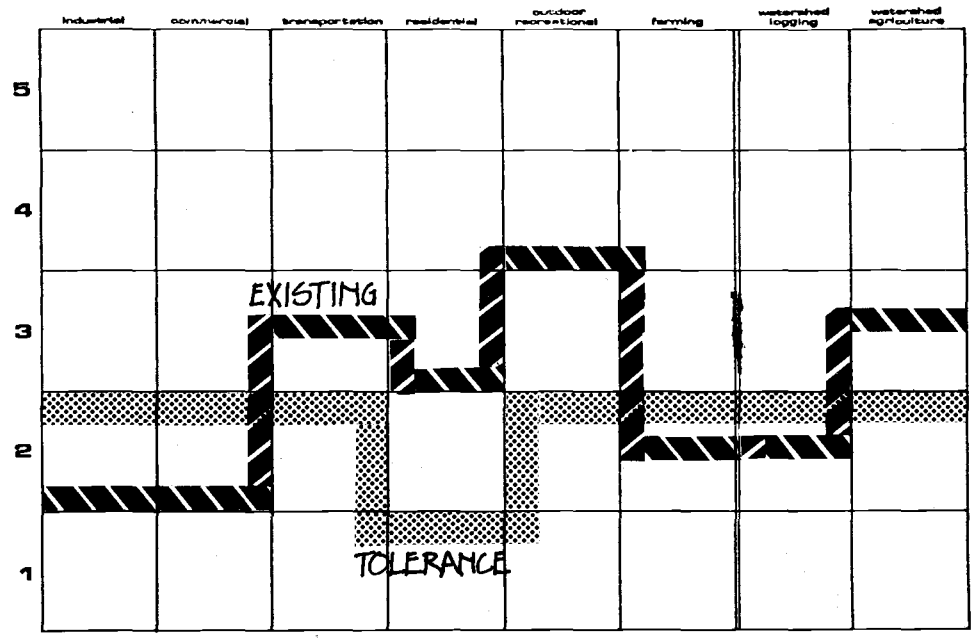
SAND LAKE ESTUARY

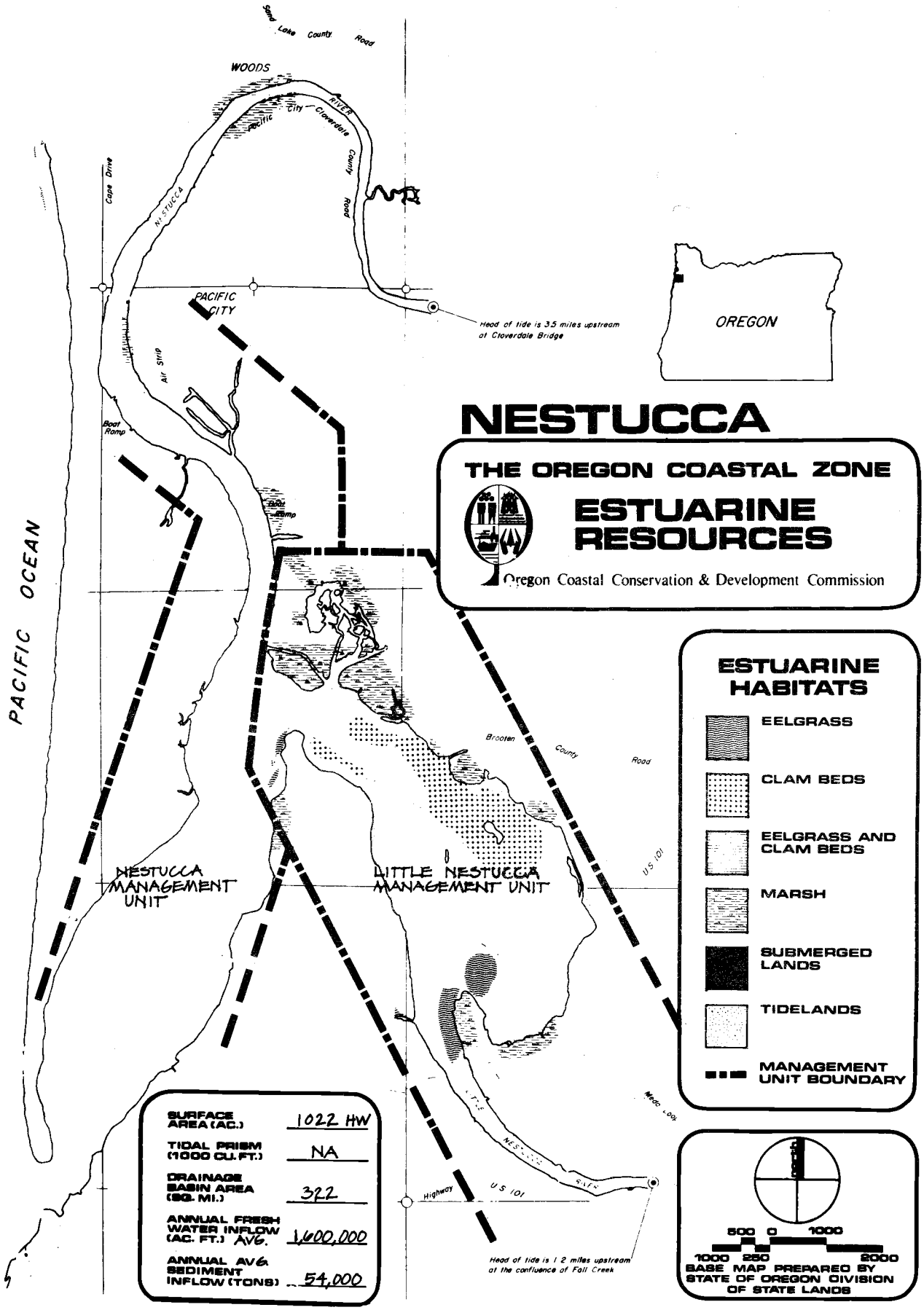
HUMAN USE ELEMENTS

The major use of the Sand Lake estuary is for recreational purposes. Two public camp grounds are located along the estuary and the ocean side sand dunes are heavily used by recreational vehicles. Existing activities are described in the chart on page 104.

The only man made alterations to the Sand Lake estuary consist of three dike type structures. One of these structures is a portion of the county road which provides access to Whalen Island. A second dike located along the northern shore was constructed for flood control. The third dike, commonly known as Beltz Dike, was constructed along the southern shore to extend the limits of grazing land. The Whalen Island Dike has constricted tidal flows and has resulted in a significant marsh accretion in the north-east side of the bay.

SAND LAKE ESTUARY - TYPE II




NESTUCCA
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission
OREGON
PACIFIC OCEAN
WOODS
Sand Lake County Road
Cloverdale County Road
NESTUCCA RIVER
Cape Drive
PACIFIC CITY
Air Strip
Boat Ramp
Head of tide is 3.5 miles upstream at Cloverdale Bridge
Brooten County Road
US 101
NESTUCCA MANAGEMENT UNIT
LITTLE NESTUCCA MANAGEMENT UNIT
LITTLE NESTUCCA RIVER
Highway US 101
Head of tide is 1.2 miles upstream at the confluence of Fall Creek
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
SURFACE AREA (AC.) 1022 HW
TIDAL PRISM (1000 CU. FT.) NA
DRAINAGE BASIN AREA (SQ. MI.) 322
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG. 1,600,000
ANNUAL AVG. SEDIMENT INFLOW (TONS) 54,000
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS

NESTUCCA BAY

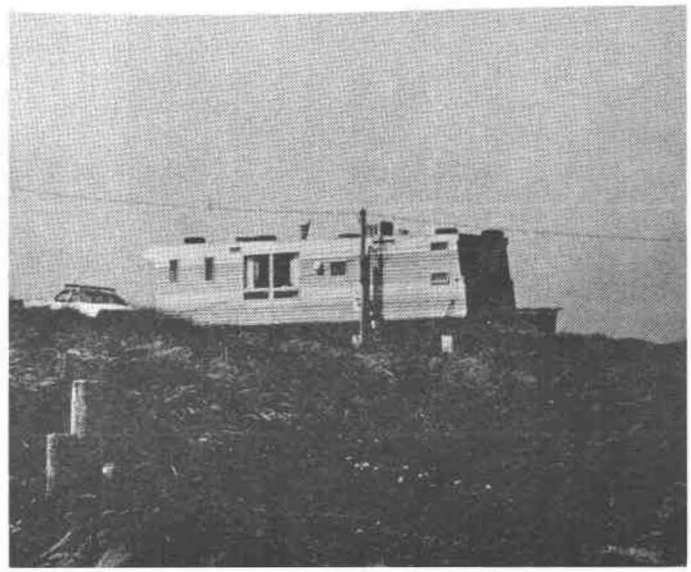
BIOPHYSICAL ELEMENTS

The Nestucca estuary has been separated into two management units due to its varying biophysical characteristics. Nestucca Bay and River fall within Estuary Type XI, while the Little Nestucca River is within Estuary Type IX.

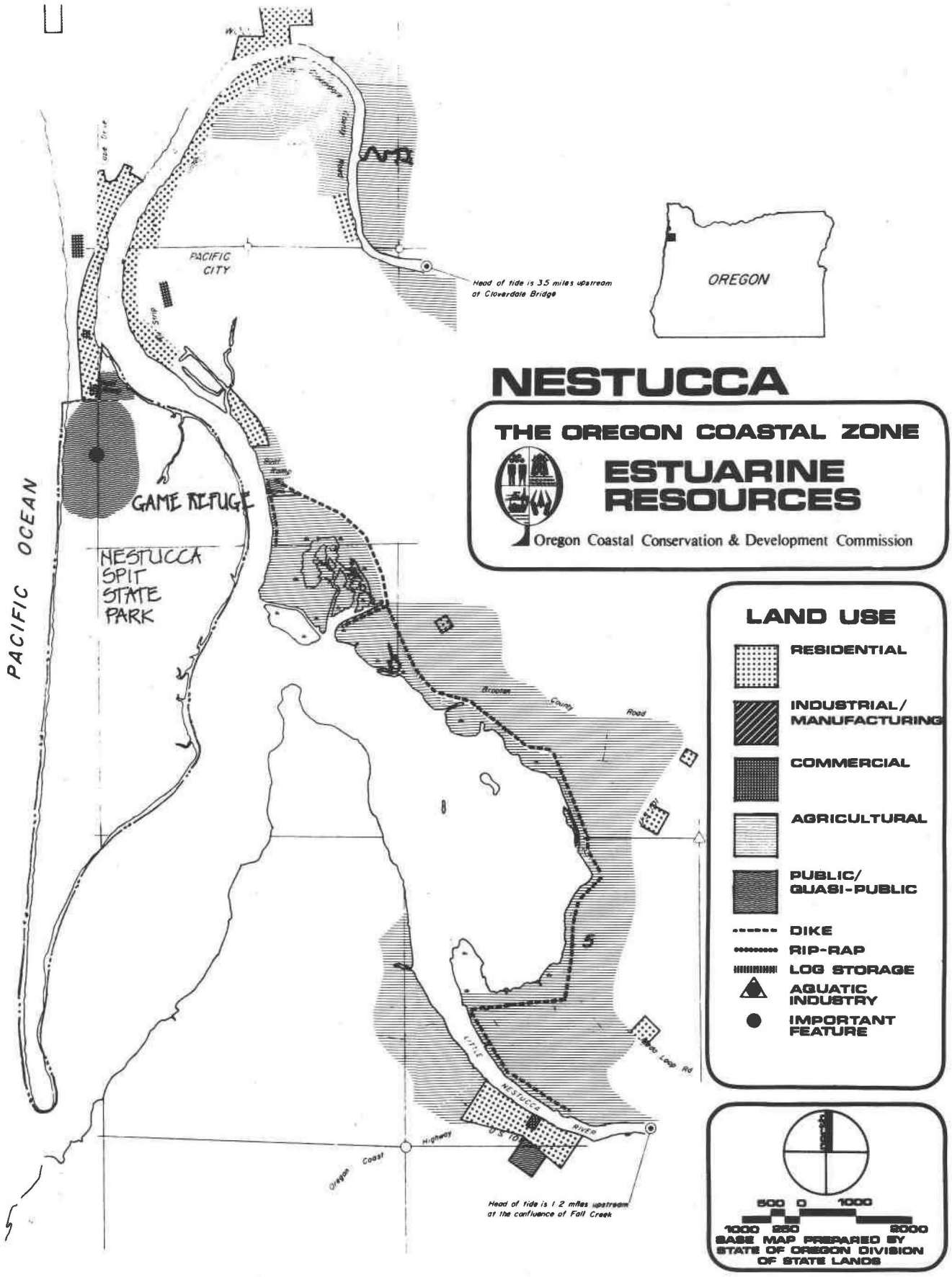
Nestucca Bay is a rather small estuary, but the Nestucca River drains from a watershed area of 259 square miles. Normal flow at the mouth of the river is estimated at 1,540 c.f.s. Sand moved by wind and littoral drift periodically blocks a portion of the estuary mouth causing severe flooding within the estuary. Along the river banks east of Pacific City (3.5 miles from the estuary mouth) there are active, as well as inactive, landslides. 54,000 tons of sediment are deposited in Nestucca Bay each year from its tributary river systems.

The Little Nestucca River has a 59 square mile drainage basin. Some stream bank erosion is currently occurring where the river enters the Nestucca Bay, although riprap has partially controlled the loss of soil.

Excellent runs of salmon, steelhead and cutthroat trout are found in the Nestucca and Little Nestucca Rivers; perch and flounder are also fairly abundant. The high freshwater content of the estuary limits the clam population to softshells in both rivers and the bay. Siltation from watershed logging and agriculture threatens the productivity of the estuary by reducing the depth and altering the flushing rates and circulation patterns. The Little Nestucca River and portions of the bay include important eelgrass beds which are sidely used by waterfowl. In addition, the Oregon Wildlife Commission maintains a hatchery on Three Rivers which is a tributary to the Nestucca. A bald eagle nest was found on the Little Nestucca River



VACATION HOUSING LOCATED ON PACIFIC CITY SAND SPIT


NESTUCCA
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission
OREGON
PACIFIC CITY
Head of tide is 3.5 miles upstream at Cloverdale Bridge
PACIFIC OCEAN
GAME REFUGE
NESTUCCA SPIT STATE PARK
Brooten County Road
Oregon Coast Highway
Head of tide is 1.2 miles upstream at the confluence of Fall Creek
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4						-Extensive grazing and dairy agriculture use along east side of estuary -Limited diking		
3		-Strip-tourist commercial located on Highway in Pacific City -Scattered tourist commercial adjacent to Kiwanda Shores, oriented towards ocean		-Minor clusters of sub-urban residential in Pacific -Significant vacation housing along ocean front	-Numerous boat ramps and launching facilities -Excellent cutthroat trout and salmon fishing -Strip tourist commercial in Pacific City			
2	-Scattered very small fish and lumber plants -No activity directly on the estuary		-No dredging or jetties -Limited road access to actual estuarine water-front -Small airfield in Pacific City					
1								

NESTUCCA BAY

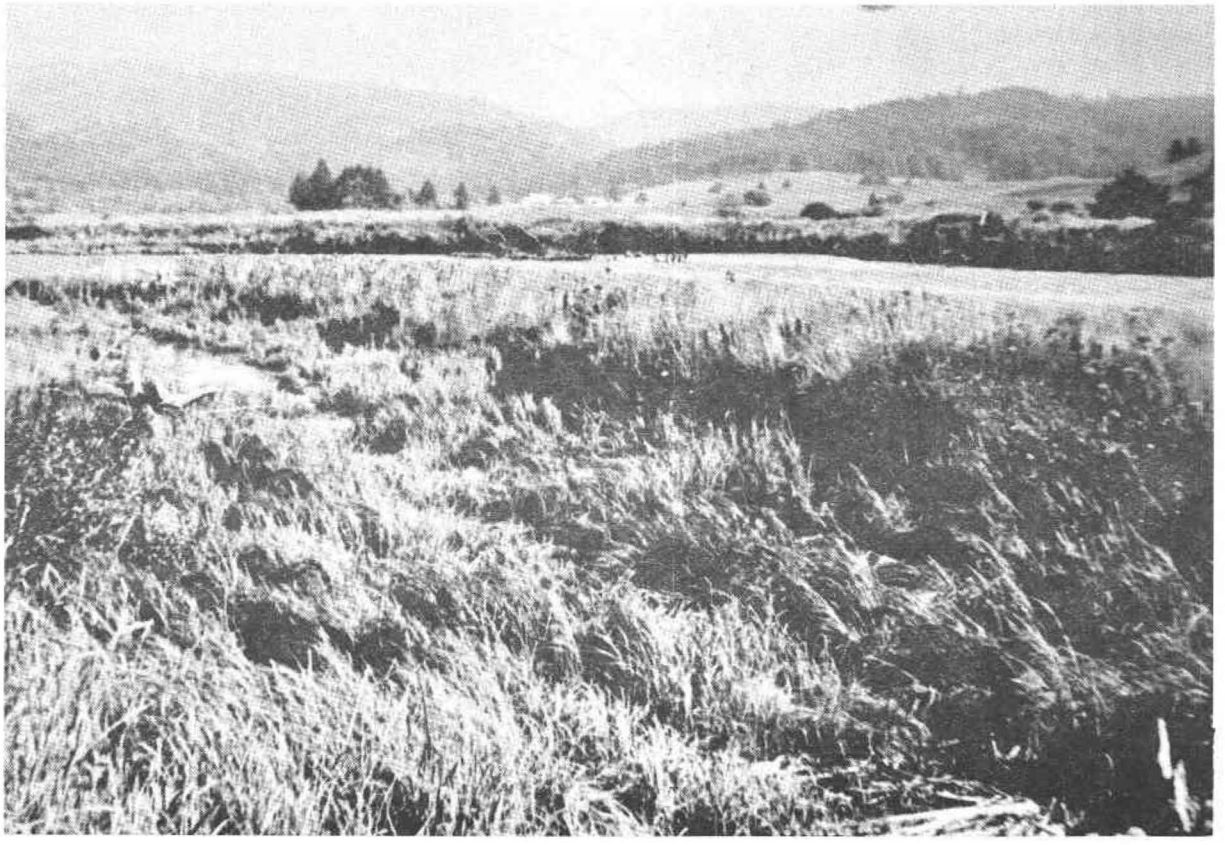
	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4						-Moderate pastureland and grazing along shoreline -Diking to provide for increased agricultural use		
3								
2					-Boathouse and small camping area located on estuary -Excellent salmon, and cutthroat trout runs			
1	-No industrial activity	-No commercial activity	-Limited road access to estuary shorelines	-Limited scattered rural residential				

LITTLE NESTUCCA ESTUARY

HUMAN USE ELEMENTS

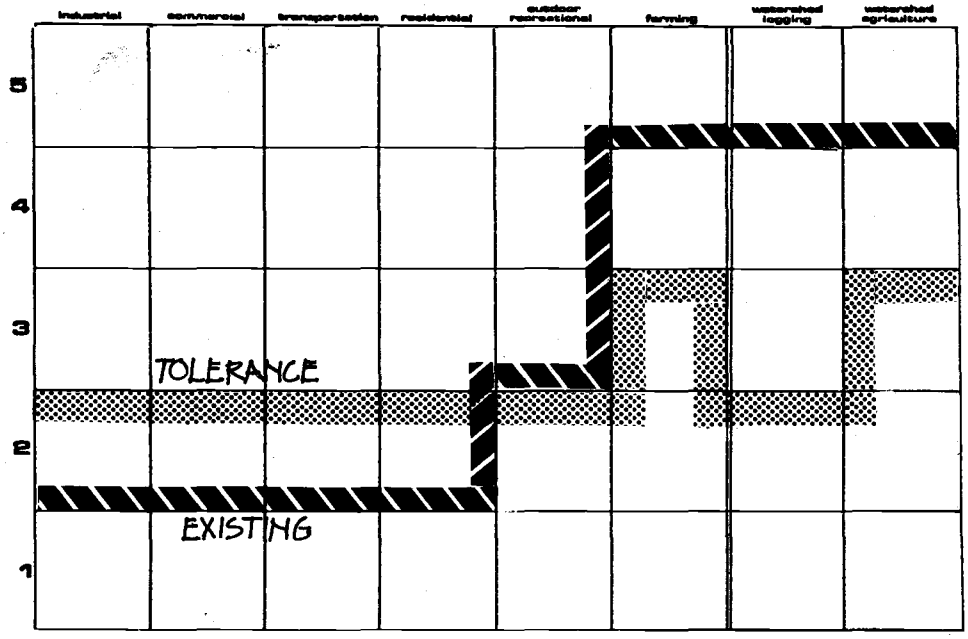
The major shoreline use of the Nestucca estuary is agricultural, and dairy pasture land is prevalent along the eastern shore of the bay. The town of Pacific City is located 5 miles upstream from the mouth and is the only significant residential community along the estuary shoreline. Significant vacation housing has been constructed on the sand spit west of Pacific City and as far north as Kiwanda Shores, however, these developments are primarily oriented toward the ocean. The human use charts on pages 110 and 111 describe the level of activity along the shorelines of the two management units within the Nestucca estuary.

Alterations to this estuary system have been limited to individual landfills covering less than one acre. Most of these fills were constructed for the purpose of erosion control on residential property, and for providing boat launch facilities.

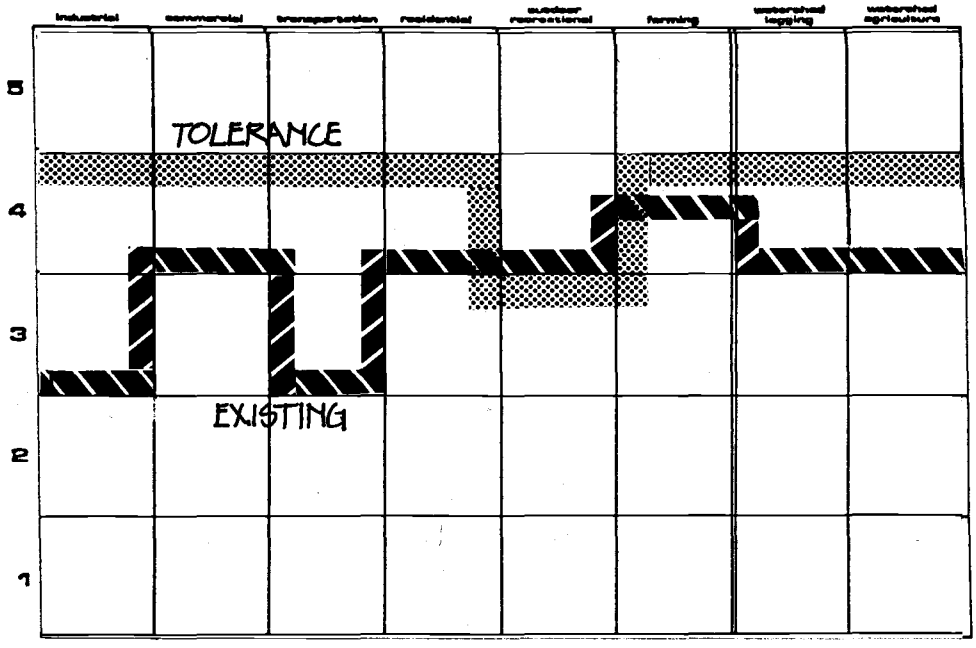


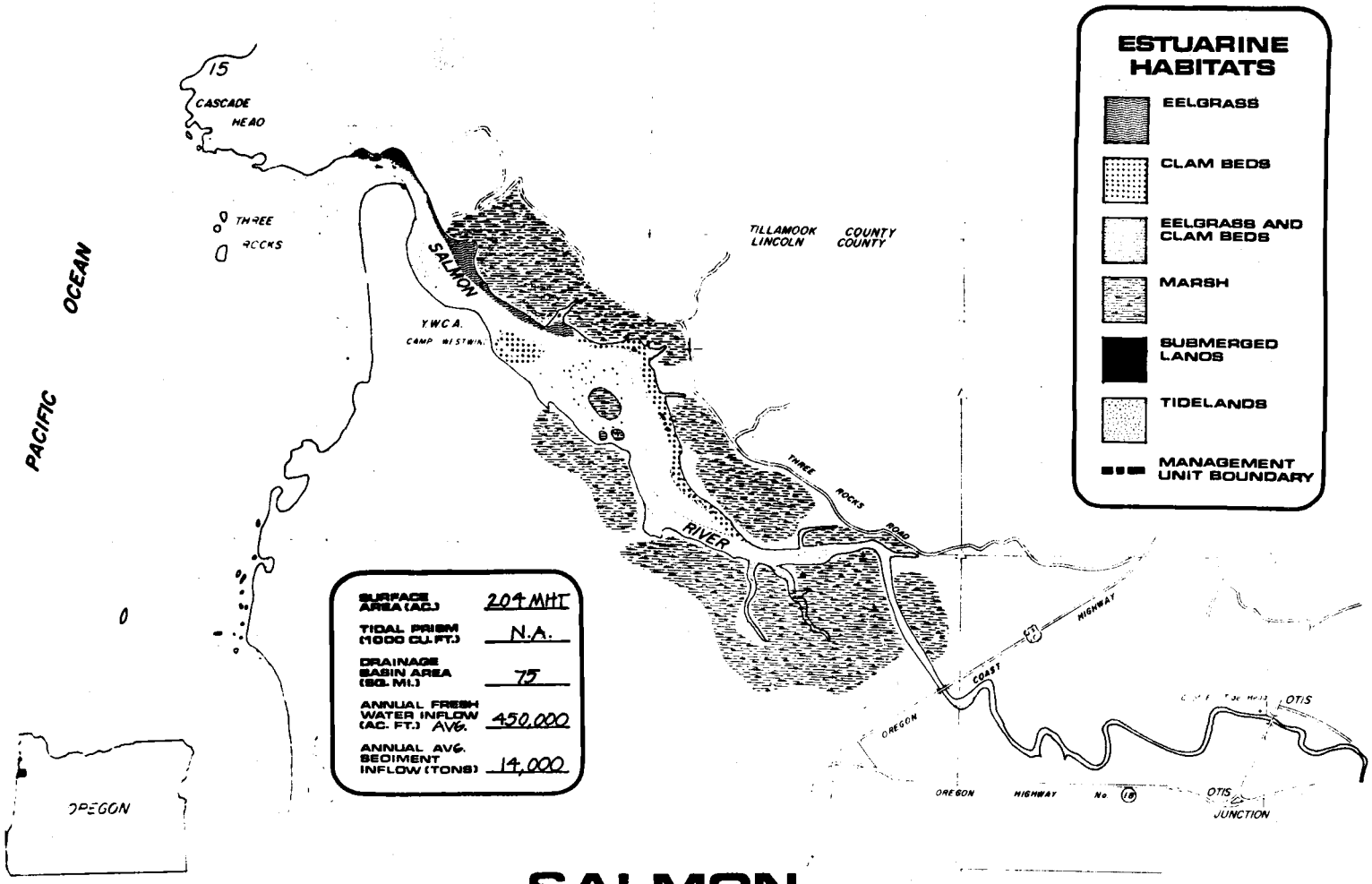
MATURE HIGH MARSH ALONG NESTUCCA RIVER

LITTLE NESTUCCA - TYPE IV

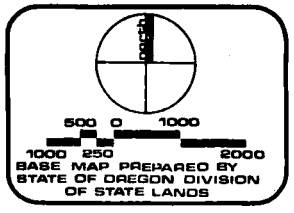


NESTUCCA BAY - TYPE XI





SALMON



THE OREGON COASTAL ZONE

ESTUARINE RESOURCES

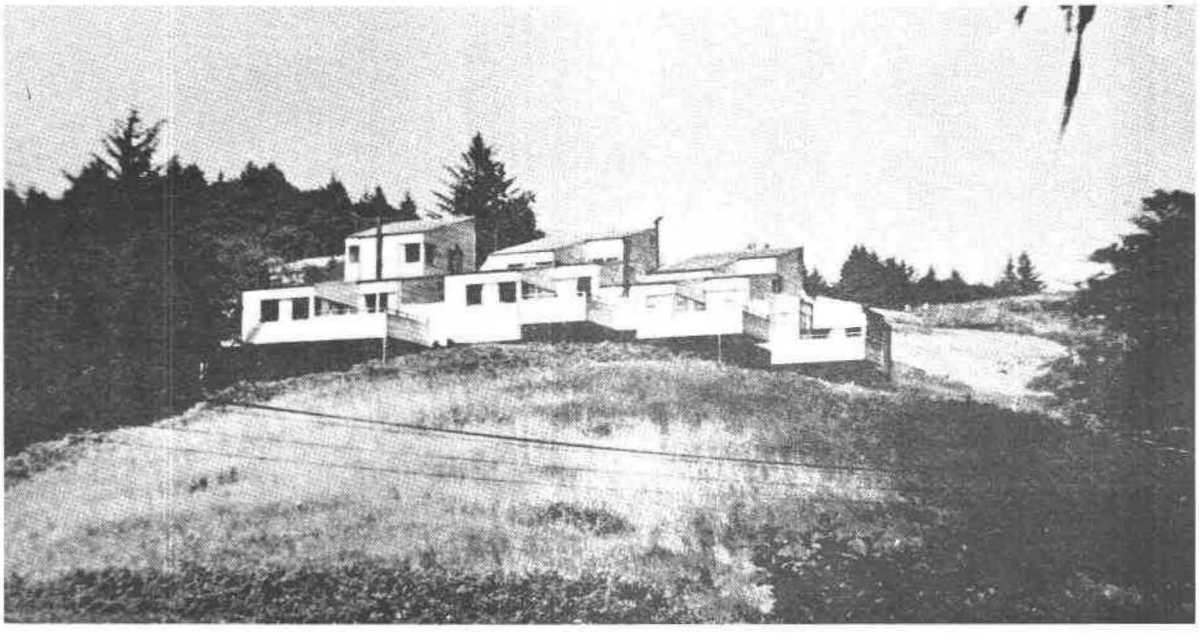
Oregon Coastal Conservation & Development Commission

BIOPHYSICAL ELEMENTS

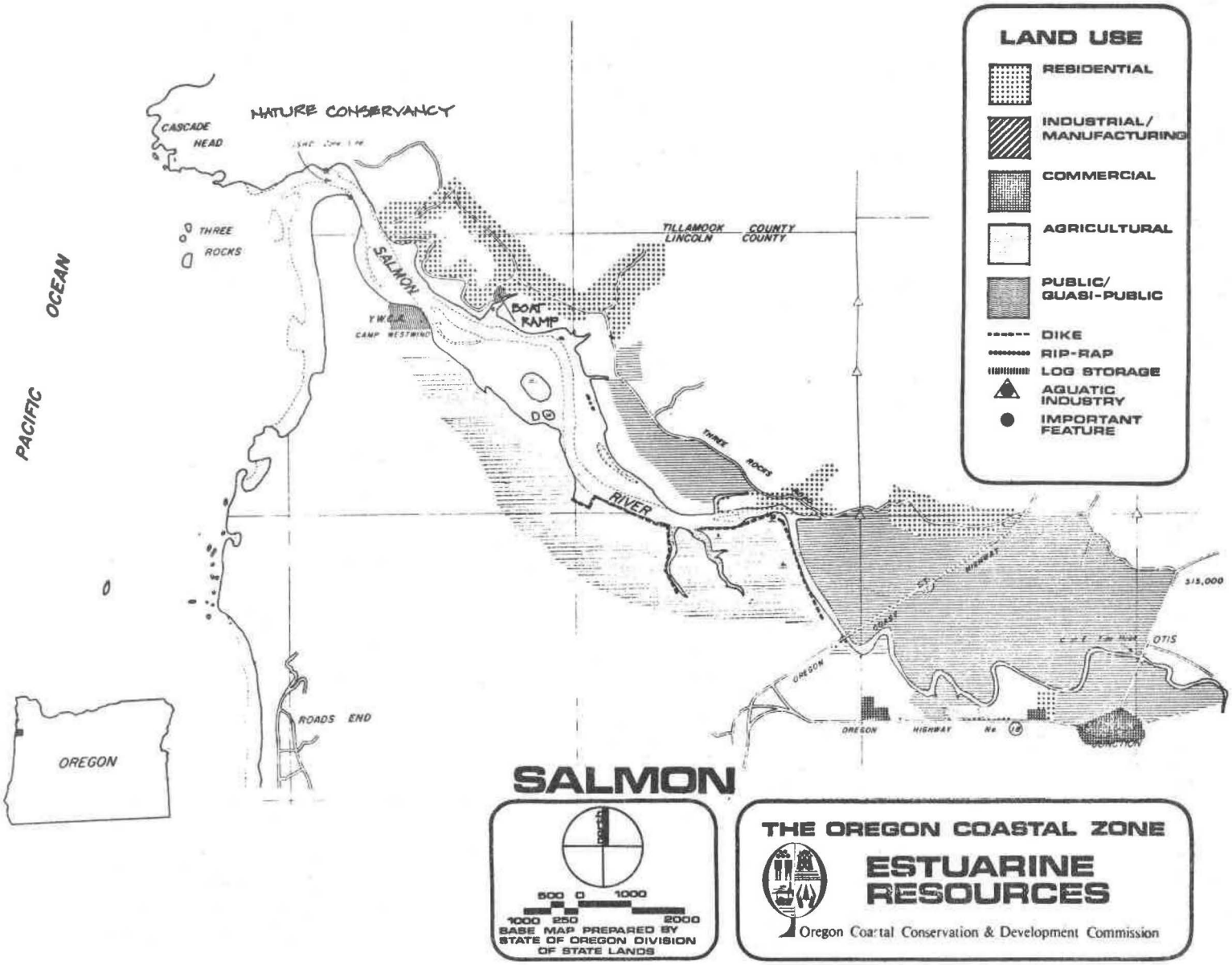
The Salmon River is classified as a Type IX Estuary

The Salmon River estuary occupies approximately 270 acres, and is small in relationship to other Oregon estuaries. It is one of the most pristine estuaries on Oregon's coast line. A sand spit which is only partially stabilized lies south of the mouth and critical erosion of this spit is occurring on its seaward side. To the north of the estuary rise the steep, rocky cliffs of Cascade Head. Limited, non-critical erosion is occurring along these cliffs. Water quality problems are associated with the summer low flows of the Salmon River.

Flounder, perch, softshell clams and anadromous fish are reportedly taken by anglers in the Salmon River estuary. The unique intertidal zone offers a high scientific research value. Although the Salmon River estuary does not support a large waterfowl population, in comparison with other type IX estuaries, it does maintain great wildlife species diversity. This estuary is one of few in Oregon visited on a regular basis by the relatively rare California Sea Lion. A great blue heron rookery is thought to be located on the Salmon River.



RECREATIONAL HOUSING ON HILLTOP ABOVE SALMON RIVER


LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
NATURE CONSERVANCY
CASCADE HEAD
THREE ROCKS
PACIFIC OCEAN
SALMON
RIVER
BOAT RAMP
TILLAMOOK COUNTY
LINCOLN COUNTY
THREE ROCKS
ROADS END
OREGON
OREGON HIGHWAY No. 18
OTIS
515,000
OREGON
SALMON
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4					-YWCA Camp along south shore of estuary -Nature conservancy area along north shore -Pixieland, intensive commercial-recreational play land -Well used boat ramp			
3		-Commercial cluster at Otis Junction, tourist-oriented -Large commercial-tourist facility at Pixieland		-Small residential areas at Three Rocks, Otis Junction and Rose Lodge -Scattered residential along north shore of estuary -Mobile home lot sales along estuary and 101 -Pixieland, mobile home lot sales		-Moderately widespread grazing and pastureland along Salmon River -Dairy on hillside above estuary		
2			-No jetties, dredging or commercial use of waterways -Large boat ramp near mouth -Highway 101 north-south route -Highway 18 east-west route -No road access to mouth of estuary					
1	-3 small (less than 20 employees) logging contractors							

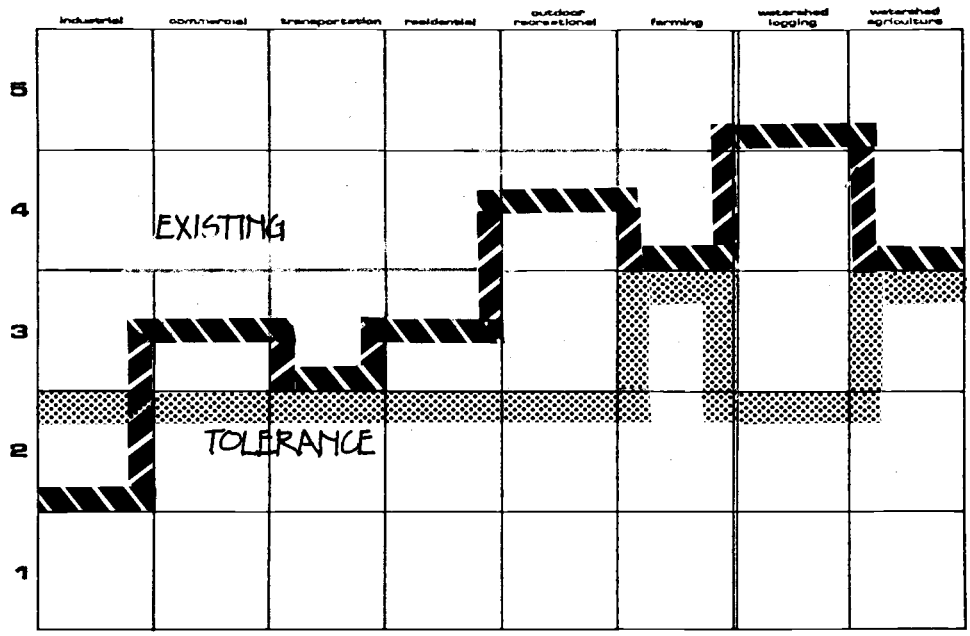
SALMON RIVER ESTUARY

HUMAN USE ELEMENTS

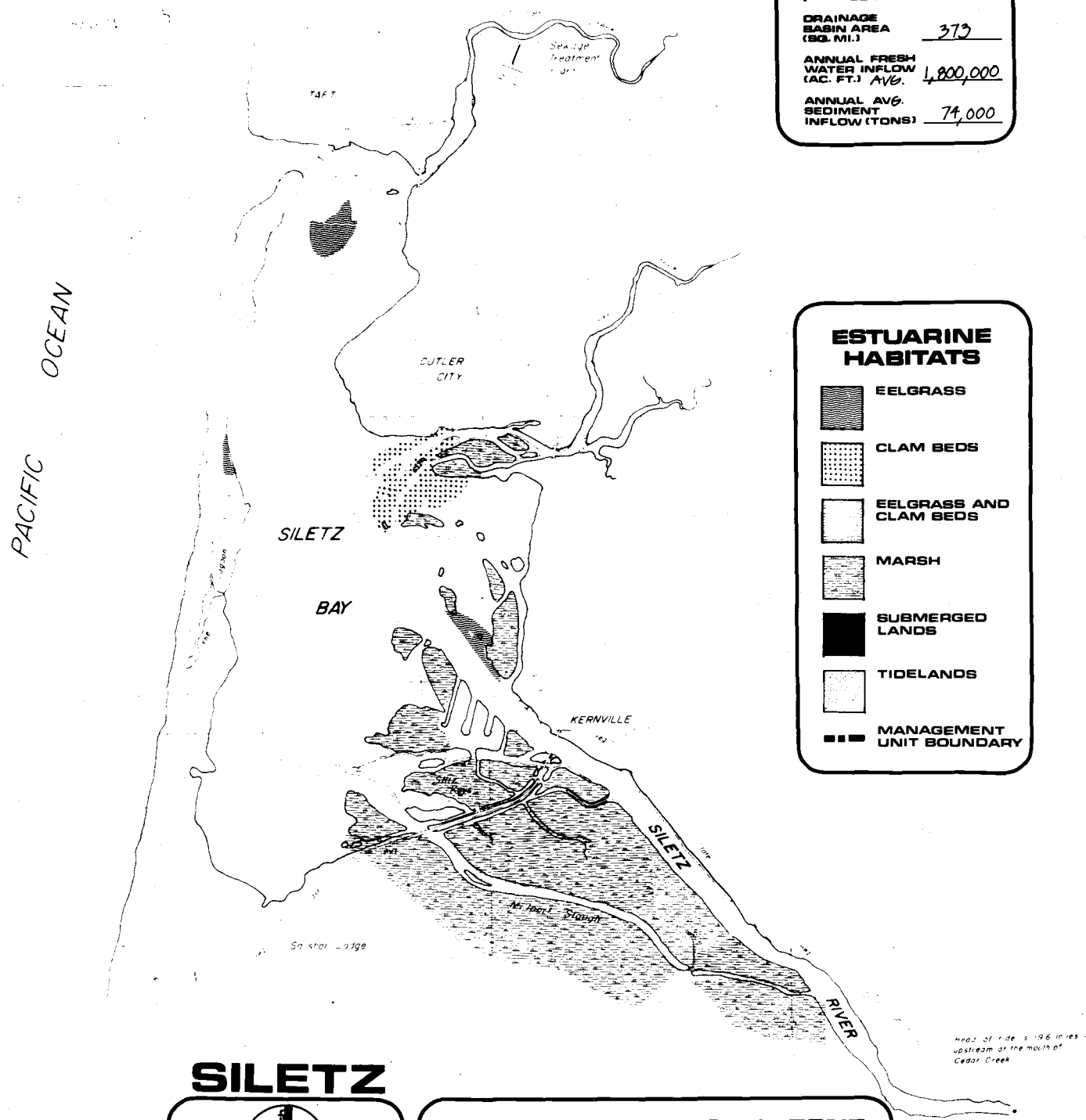
Recreation and agriculture make up the most intensive use of the estuary shorelands. Extension of the Suislaw National Forest to include undeveloped portions of the estuary shorelands from the mouth to Otis is currently undergoing congressional review. The mouth of the estuary is bordered by a YWCA camp on the south side and the Cascade Head Nature Conservancy site on the north side. The area east of Cascade Head is the site of a newly constructed resort-vacation home development featuring an art and ecology center. Recreational home and trailer site sales are prevalent along much of the Salmon River. An amusement park is being removed from along Highway 18. The use chart on the preceding page illustrates the intensity of human activity currently existing on the Salmon River estuary.

Physical alterations to the natural estuarine system have been limited to a .12 acre landfill utilized for a public boat ramp and parking area, and the removal of rocks downstream from Three Rocks near the mouth. Also, there has been substantial diking of marsh lands west of 101.

SALMON RIVER ESTUARY - TYPE IX



SURFACE AREA (AC.)	1187 MHT
TIDAL PRISM (CU. FT.)	350×10^6
DRAINAGE BASIN AREA (SQ. MI.)	373
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG.	1,800,000
ANNUAL AVG. SEDIMENT INFLOW (TONS)	74,000



SILETZ

NORTH

500 0 1000

1000 250 2000

BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS

THE OREGON COASTAL ZONE

ESTUARINE RESOURCES

Oregon Coastal Conservation & Development Commission

BIOPHYSICAL ELEMENTS

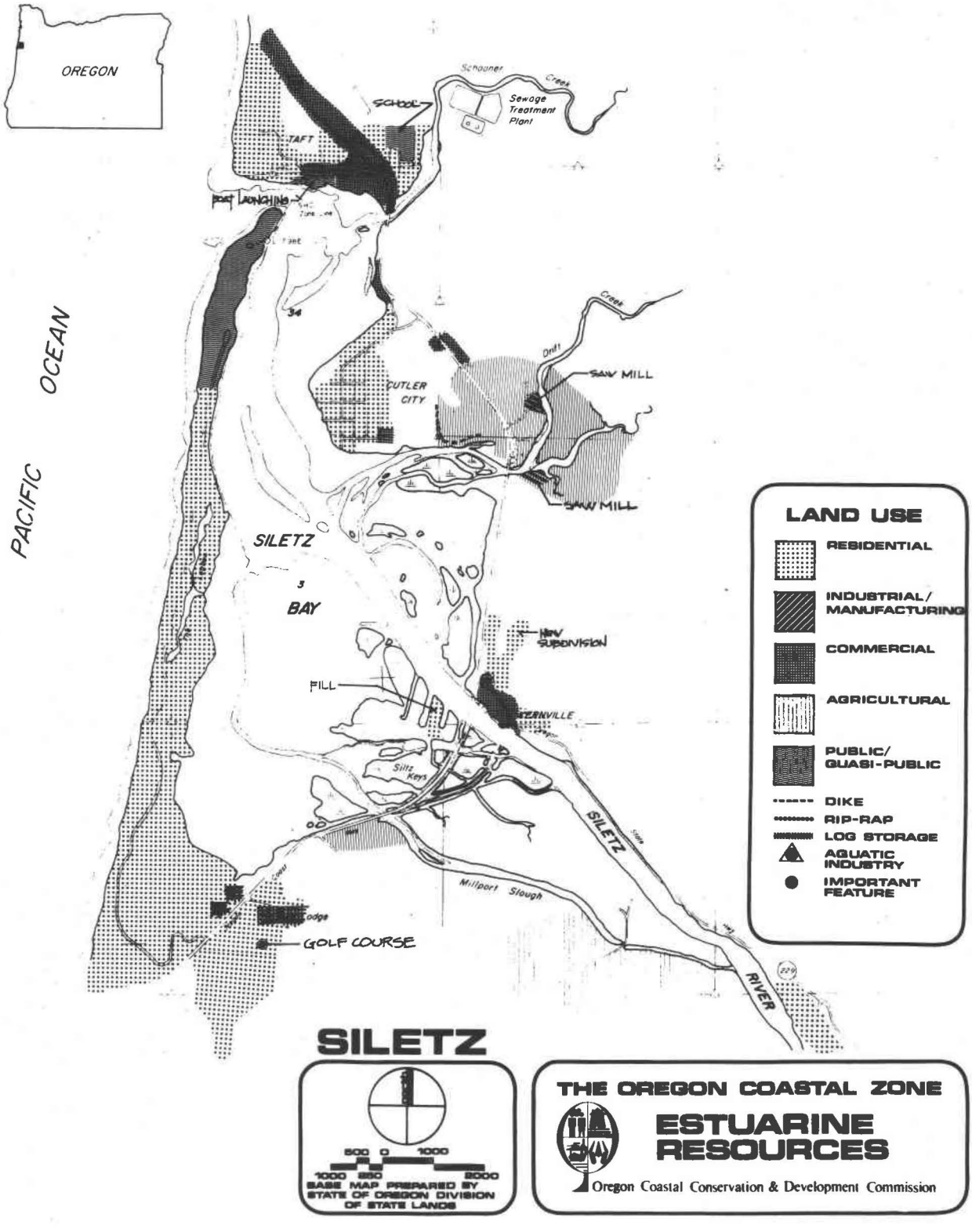
Siletz Bay is a Type XII Estuary.

The Siletz River estuary covers an area of approximately 1,160 acres and is moderate in size. The bay has a drainage basin of 373 square miles. The major fresh water inflow originates from the Siletz River which has an annual average discharge of 1,500 c.f.s. Discharge at the mouth of the bay includes inflow from Drift and Schooner Creeks, and is estimated at approximately 2,000 c.f.s. Due to the gentle gradient of the local topography, there are no extensive floodplains.

Sand along the Siletz sand spit has been stabilized in part by the planting of grass, however, this type of stabilization is effective only in preventing wind erosion. Residences have been constructed on the sand spit and are periodically threatened by storm waves.

Although commercial fishing in the Siletz is of very low value, the Siletz River System provides spawning grounds for more spring chinook and summer steelhead than any other stream of the mid-coast basin. Coho, sea-run cutthroat, staghorn sculpin, shiner perch and starry flounder also provide good sports fishing.

RESIDENCES AND RIPRAP ALONG SHORE OF SILETZ BAY


OREGON
PACIFIC OCEAN
SILETZ BAY
SCHOOL
Sewage Treatment Plant
TAFT
BOAT LAUNCHING
CUTLER CITY
SAW MILL
SAW MILL
NEW SUBDIVISION
FILL
Siltz Keys
Millport Slough
SILETZ RIVER
Lodge
GOLF COURSE
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
SILETZ
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4		-Strip tourist commercial in Cutler City and Taft -Limited tourist commercial in Kernville -Tourist commercial facilities at Salishan Lodge		-Major urban/suburban neighborhoods in Cutler City and Taft -Significant vacation home construction on Siletz Sand Spit -Scattered rural residential along upper reaches of Drift and Schooner Creeks -Significant recreational residential developments along tide water above Highway 101	-Moderate fishing in bay, limited by angler access -Nine boat launches and extensive use by pleasure boaters -Extensive tourist commercial in Taft and Cutler City -Golf course, resort at Salishan			
3			-Good road access to major portion of estuary, excluding upper reaches of Drift and Schooner Creeks -Scattered boat landings -No water borne transportation within estuary -Highway 101 runs north-south with causeways blocking tide channels					
2	-Scattered wood processing plants not located on estuary shorelands					-Widely scattered agriculture oriented towards grazing -Residential development is phasing out agricultural use of land		
1								

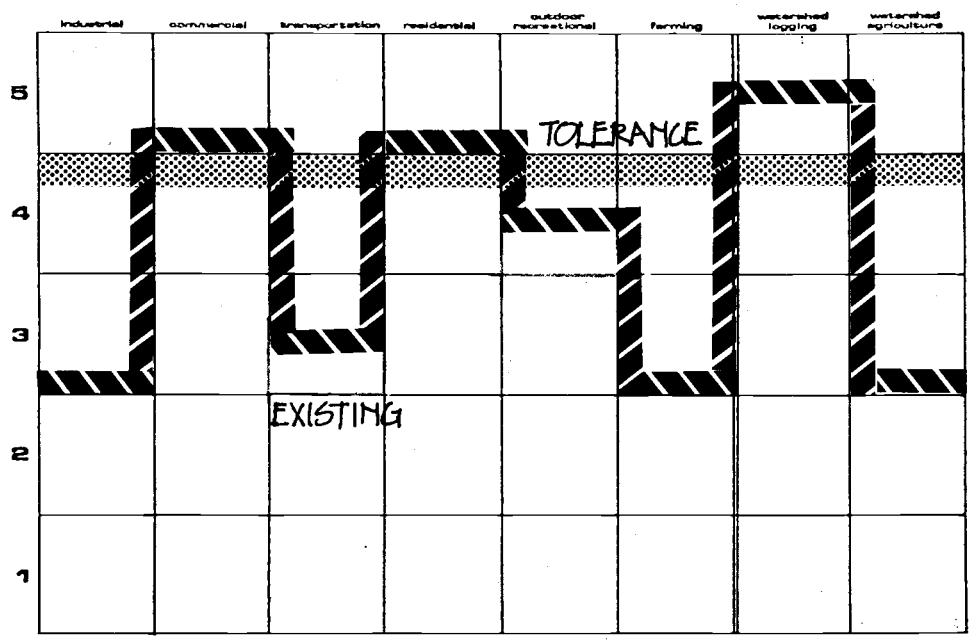
SILETZ BAY

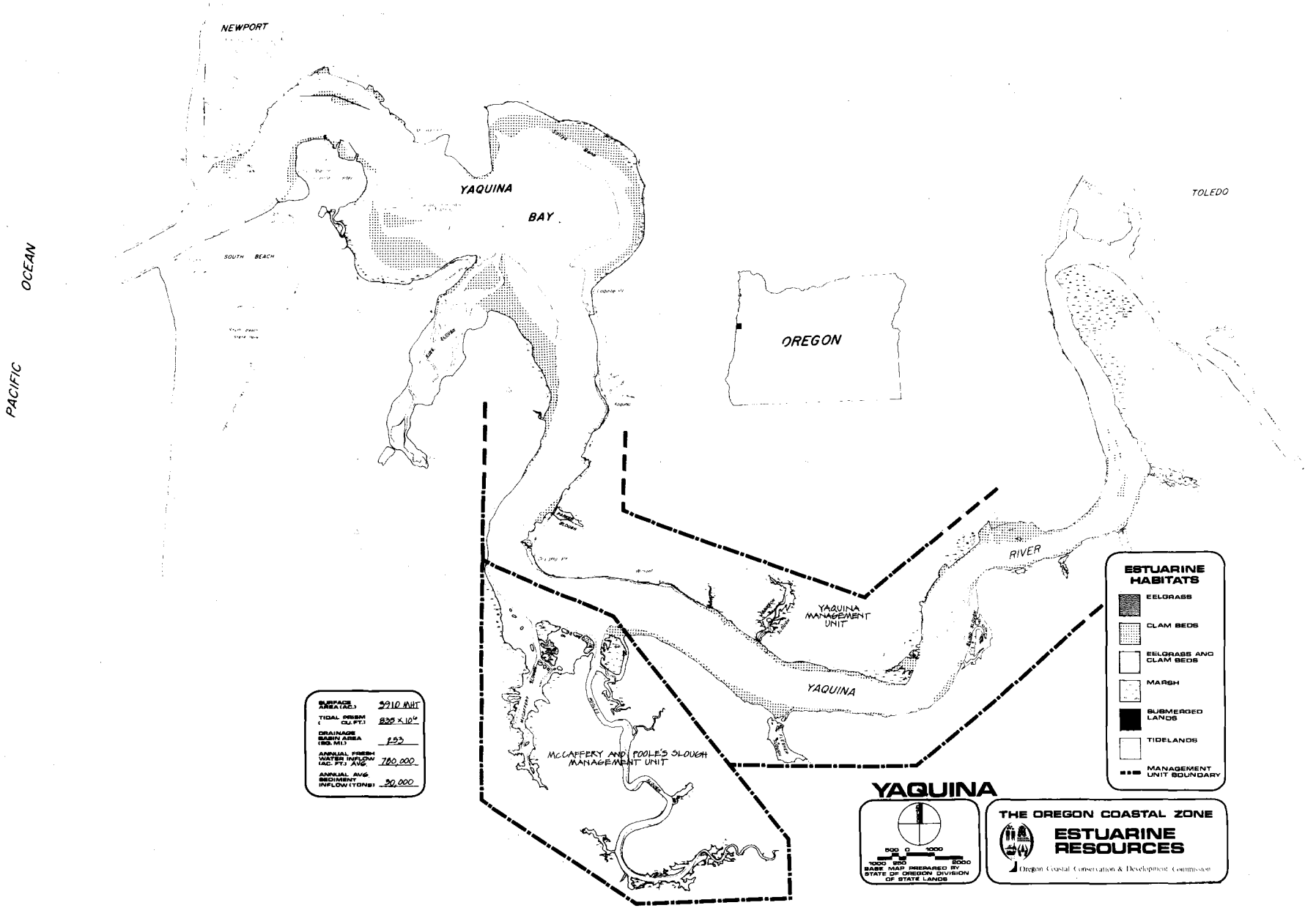
HUMAN USE ELEMENTS

Tourism is of major economic importance along the Siletz River estuary. Much existing farmland has been purchased for recreational development. Although clamming and commercial fishing formerly provided income to the area, siltation of the estuary has limited those activities. A proposal for construction of jetties at Taft is being discussed, and might increase the flushing action of the river and reduce the siltation of the bay. This jetty construction, however, has been found not economically feasible by the Army Corps of Engineers. The intensity and nature of human activities within the Siletz estuary is illustrated in the chart on page 124.

The Inventory of Filled Lands prepared by the State of Oregon lists only two acres of landfill in the Siletz estuary. Uses of these landfills include highway and road construction, a boat ramp and a log dump facility. In addition to the two acres, landfill has been placed on the mud flats to provide for vacation homes. The extent of this fill is unrecorded.

SILETZ BAY - TYPE XII




NEWPORT
YAQUINA
BAY
SOUTH BEACH
PACIFIC OCEAN
OREGON
TOLEDO
RIVER
YAQUINA MANAGEMENT UNIT
YAQUINA
McCAFFERY AND POOLE'S SLOUGH MANAGEMENT UNIT
SURFACE AREA (AC.) 5910 MHT
TIDAL PRISM (CU. FT.) 825 x 10⁶
DRAINAGE BASIN AREA (SQ. MI.) 253
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG. 780,000
ANNUAL AVG. SEDIMENT INFLOW (TONS) 30,000
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
YAQUINA
500 0 1000
1000 500 0 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

BIOPHYSICAL ELEMENTS

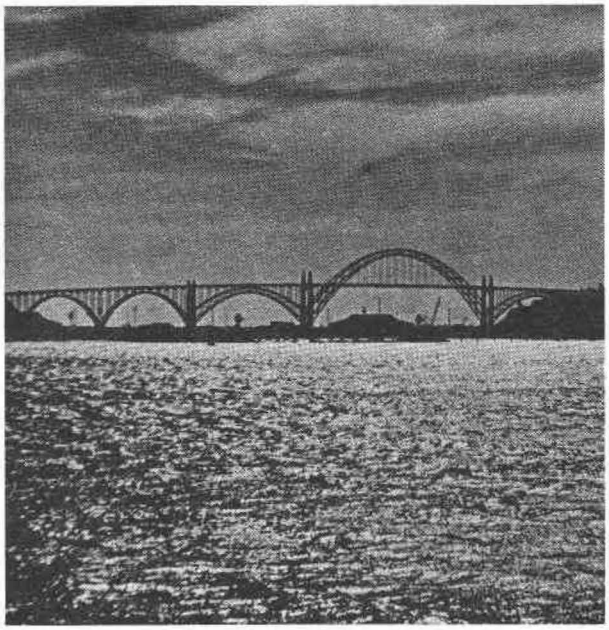
Due to differing biophysical characteristics, the Yaquina Bay estuary has been separated into two management units, the first containing Yaquina Bay and River and Kings Slough which are categorized as an Estuary Type XII. The second unit includes Pooles and McCaffery Sloughs which fit Estuary Type VII.

Yaquina Bay has a surface area of approximately 4,200 acres and a drainage basin of 253 square miles. The average fresh water inflow into the estuary has been estimated at approximately 1,000 c.f.s. The stream gradient is fairly low and 19 miles of tidewater lands are subject to flooding.

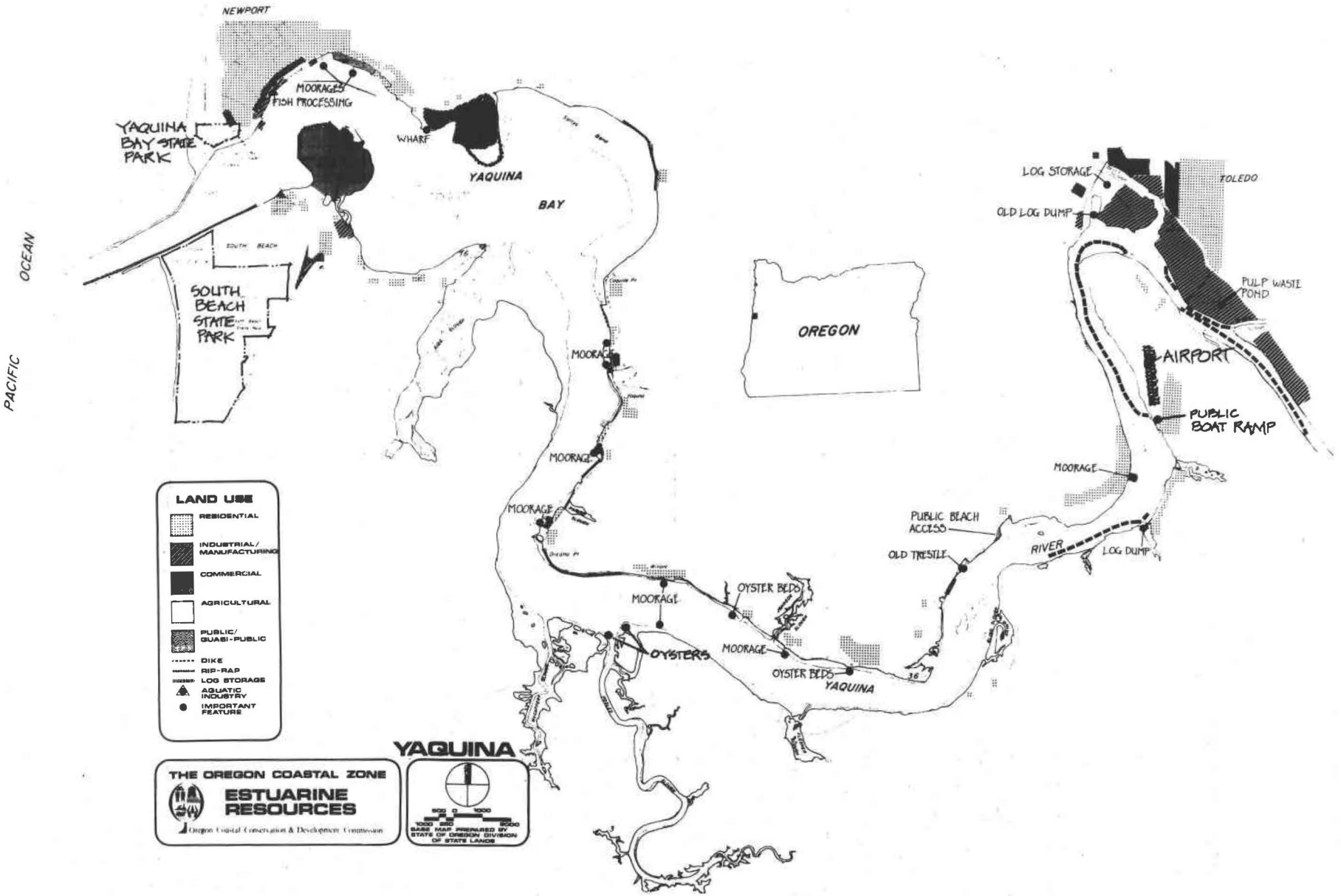
Approximately 30,000 tons of sediment enter the estuary annually. Erosion of the soils and rock units within the drainage basin is rapid during periods of high rainfall. Since dune sand mantles the marine terraces and other shorelines near the estuary, wind erosion and deposition are active where vegetative cover has not stabilized the sand.

McCaffery and Pooles Sloughs are small and are characterized by flat, low shorelands which are subject to periodic flooding. Sedimentation has been rapid and a delta extending out into the Yaquina River has formed between the two sloughs. Landslide topography surrounds much of the perimeter of both sloughs.

Oysters are presently produced commercially and the estuary has the potential for a four-fold increase in their production. Anadromous fish, flounder, perch and herring are important biological residents. Cockle, gaper and softshell clams are taken in extremely high numbers within the bay. Yaquina Bay estuary supports mammals and big game. Yaquina Bay is the most important wintering are for black brant in the mid-coast area.



HIGHWAY 101 CROSSING YAQUINA BAY


NEWPORT
MOORAGES
FISH PROCESSING
YAQUINA BAY STATE PARK
WHARF
YAQUINA
BAY
OCEAN
PACIFIC
SOUTH BEACH
SOUTH BEACH STATE PARK
MOORAGE
MOORAGE
MOORAGE
OREGON
LOG STORAGE
TOLEDO
OLD LOG DUMP
PULP WASTE POND
AIRPORT
PUBLIC BOAT RAMP
MOORAGE
PUBLIC BEACH ACCESS
OLD TRESTLE
RIVER
LOG DUMP
OYSTER BEDS
MOORAGE
OYSTERS
MOORAGE
OYSTER BEDS
YAQUINA
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
YAQUINA
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	-Toledo is center of lumber processing for mid-coast basin. Maintains two large mills and numerous small -Newport is center of commercial fishing for mid-coast basin and supports intensive fish processing -Log storage and shipping -Recreation -No industrial activity on King's Slough	-Newport serves as trade center for nearby coastal towns. Strip commercial along Highway 101 -Strip commercial along Highway 101 in South Beach -Intensive tourist-commercial along Newport waterfront -No commercial activity along King's Slough			-Intense tourist commercial along Newport waterfront -Numerous moorages and boat launches -Sports fishing important, many charter services -Yaquina Bay State Park -Small boat launch facility on King's Slough -Small boat basin at South Beach			
4			-Jetties, 30 foot channel dredged to harbor, 10' foot channel to Toledo -Turning basin, small boat basin with breakwater -Rail from Toledo to the east -Highway 101 through Newport and South Beach. Good access north side of estuary, limited on south	-Urban residential at slight distance from estuary in Newport and Toledo -South Beach neighborhoods not along estuary -Scattered residential on north shore -Scattered residential on accessible portions of south shore -Scattered rural residential along west shore of King's Slough				
3								
2								
1						-Scattered farming (grazing) along minor portions of estuary		

YAQUINA BAY

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3								
2								
1	-Limited oyster harvesting	-No commercial activity	-Limited private and county access roads	-Widely scattered rural residential	-No boat launches or other recreational facilities	-Widely scattered grazing		

POOLES AND MCCAFFERY SLOUGHS
YAQUINA BAY

HUMAN USE ELEMENTS

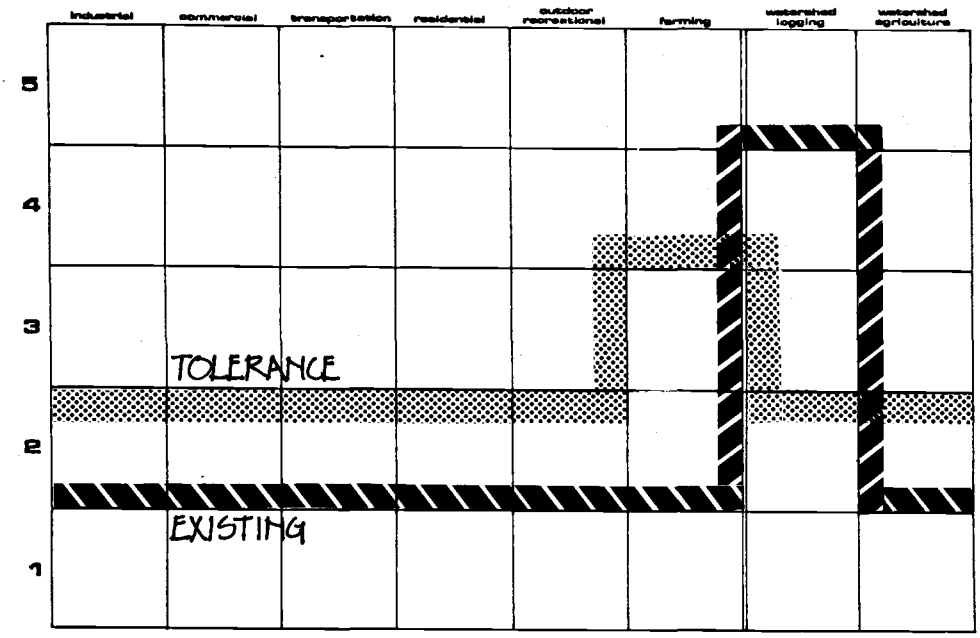
Yaquina Bay is a major industrial estuary and serves as the center for lumbering and commercial fishing for the entire mid-coast basin. Recreation is becoming an increasingly important industry and is presently the fastest growing segment of the local economy. Newport is the regional center for the commercial fishing industry, while Toledo fulfills that role in lumber processing. The Yaquina Bay Development Plan, completed in 1972, contains the following guidelines for estuary development: 1) encourage the development of commercial fishing, fish processing, marine recreation and tourism, 2) preserve the fragile estuarine resources, 3) rehabilitate the bayfront emphasizing commercial fishing, 4) develop South Beach emphasizing marine recreation and tourism, and 5) diversify the Toledo industrial base. If these policy guidelines are implemented it is apparent that Yaquina Bay will experience increased economic development. The human use charts on the preceding page illustrate the existing intensity of activities in the Yaquina Bay, Yaquina River and Kings Slough management unit of the Yaquina estuary.

Pooles and McCaffery Sloughs presently experience virtually no human activity as illustrated in the human use chart on page 131. These two sloughs have received natural estuary sanctuary designations and further action awaits appropriations of the necessary state matching funds.

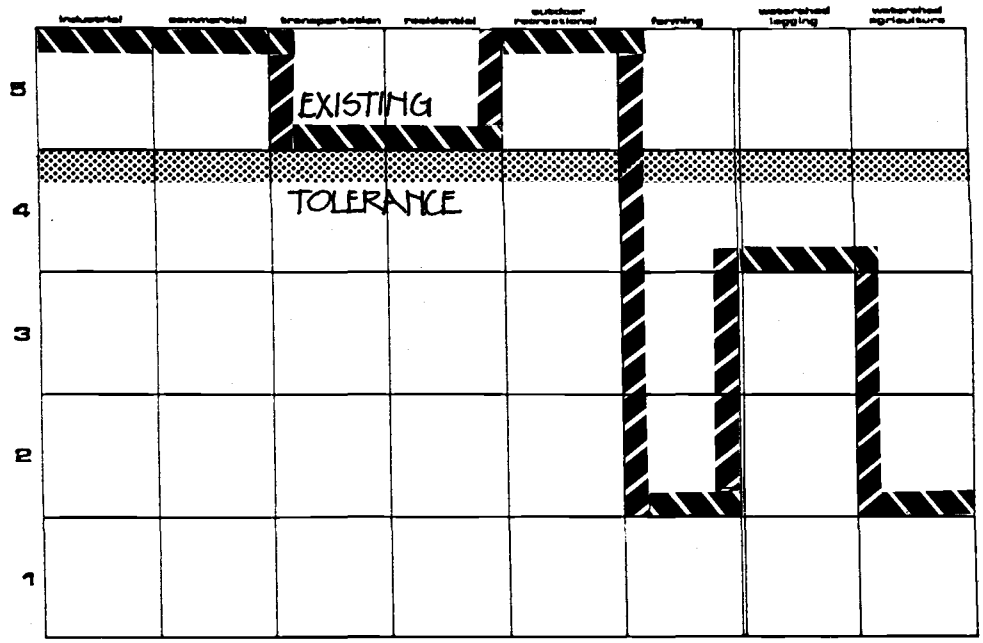
Jetties, channels, turning basins and small boat basins have all been constructed within the Yaquina estuary. The north and south jetties have recently been repaired and extended, and a spur jetty and five groins have been constructed along the channel side of the south jetty. Presently the 400 foot wide channel entrance is dredged to 40 feet, while the channel to the Newport harbor is maintained at a depth of 30 feet. A turning basin and small boat basin are also located within the Newport harbor. A 200 foot wide, 18 foot deep channel extends from Newport to Yaquina, where it lessens to 150 feet in width and 10 feet in depth until it reaches Toledo. The channel from Toledo to the turning basin at Olalla Creek is maintained to a depth of 10 feet. In addition to the above alterations, 2 levees with tidegates and bulkheads were constructed along the north bank of the Yaquina River in 1948. The average amount of dredging done in the Yaquina estuary is approximately 190,000 cubic yards annually.

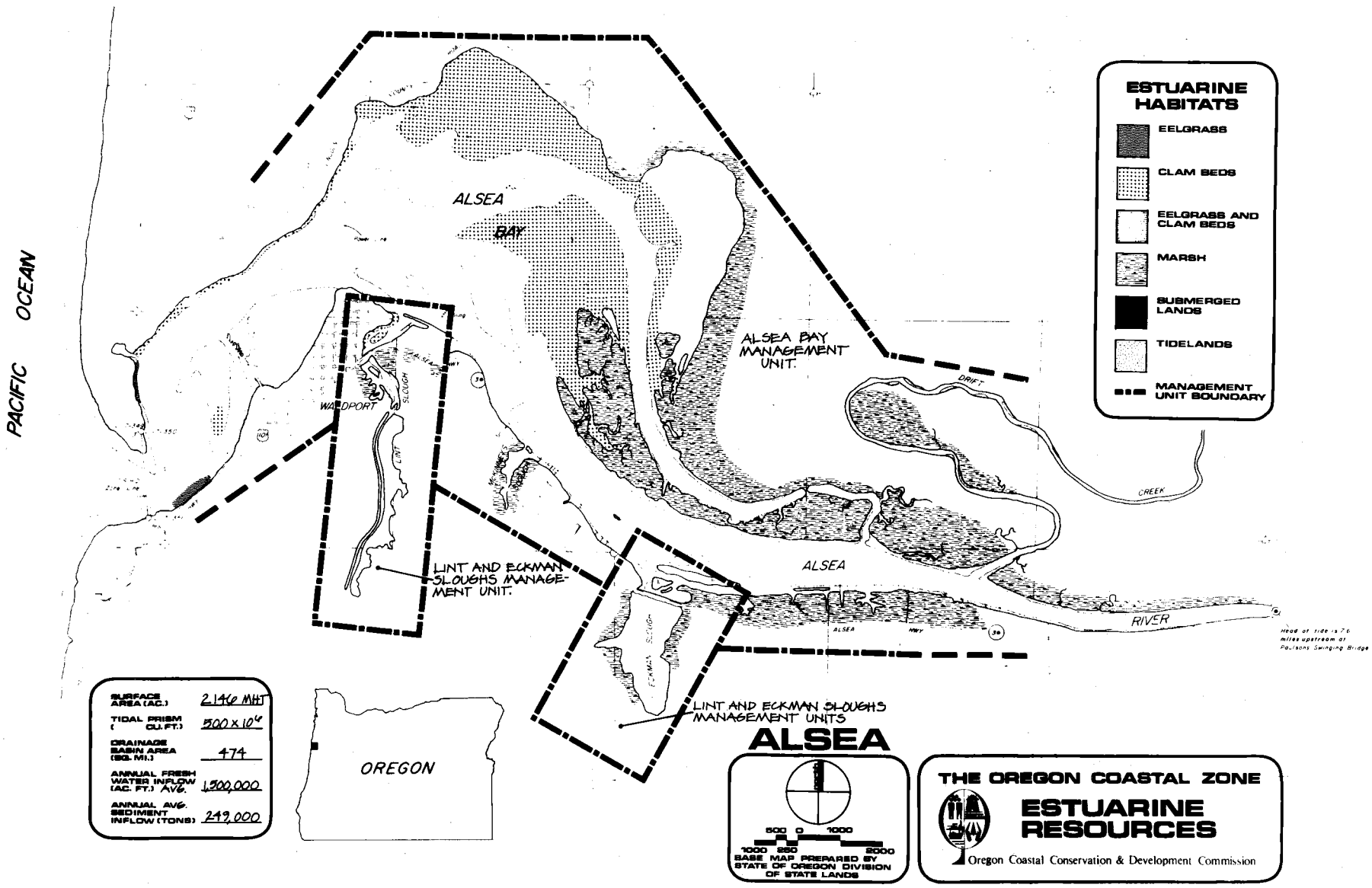
The Inventory of Filled Lands reports that 253 acres of landfill occur within the Yaquina estuary. Approximately 55 acres of the total landfill area were constructed on submerged land, while the remaining 198 acres were constructed on tidelands. Major uses of the landfill areas include moorages, docks, log storage and the Oregon State University Marine Science Center.

POOLES & MC CAFFERY SLOUGHS - TYPE VII



YAQUINA BAY - TYPE XII




PACIFIC OCEAN
ALSEA BAY
ALSEA BAY MANAGEMENT UNIT.
WALDPORT
LINT SLOUGH
LINT AND ECKMAN SLOUGHS MANAGEMENT UNIT.
ECKMAN SLOUGH
LINT AND ECKMAN SLOUGHS MANAGEMENT UNITS
ALSEA
RIVER
DRIFT
CREEK
ALSEA HWY
Head of tide is 7.6 miles upstream at Paulsons Swinging Bridge
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
SURFACE AREA (AC.) 2,146 MHT
TIDAL PRISM (CU. FT.) 500 x 10^6
DRAINAGE BASIN AREA (SQ. MI.) 474
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG. 1,300,000
ANNUAL AVG. SEDIMENT INFLOW (TONS) 249,000
OREGON
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
ALSEA
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

ALSEA BAY

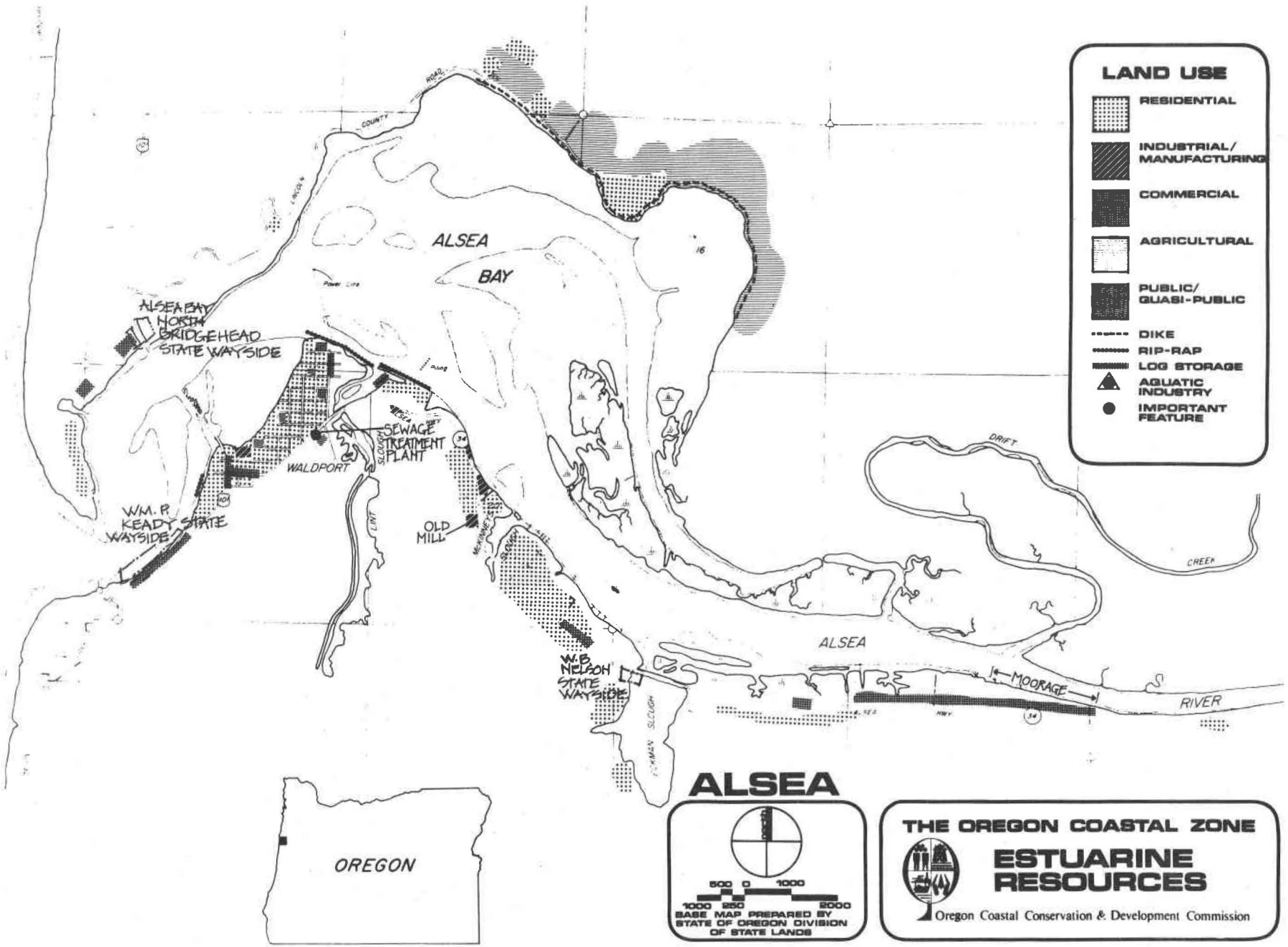
BIOPHYSICAL ELEMENTS

The Alsea estuary has been divided into two management units due to differing biophysical characteristics of portions of the estuary. The first management unit contains Alsea Bay and River and Drift Creek, and is a Type X Estuary. The second management unit includes Lint and Eckman Sloughs which are Type VI Estuaries.

Alsea Bay is a moderately large estuary covering an area of approximately 2,200 acres, and drawing from a drainage basin of 474 square miles. The average discharge of the Alsea River and Drift Creek is estimated at 2,000 c.f.s. Although the surface of the north sand spit which extends partially across Alsea Bay is fairly well stabilized by vegetation, seaward erosion of the spit is critical. Mud flats comprise most of the tidelands in the interior of the bay, while sand flats are characteristic of the mouth of the bay.

Both Lint and Eckman Sloughs have small drainage basins and low fresh water input during most of the year. Eckman Slough is blocked by a tidegate and was being maintained as a fresh water lake at the time of the field survey in August, 1974. The groundwater table is seasonally high in the area bordering the sloughs and old landslide topography is present in both drainage basins.

The Alsea estuary shows higher runs of fall chinook, coho, and winter steelhead than any other Oregon estuary system. In addition, perch and flounder are also taken in significant numbers. Herring utilize the bay for breeding and spawning grounds and the bay maintains a high potential for oyster production. Alsea Bay is notable for its watering areas for band-tailed pigeon and great blue heron rookeries. Alsea Bay receives significant use by waterfowl, particularly during fall migration.



PACIFIC OCEAN

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4		-Strip commercial in Waldport and small portion of Highway 101 along estuary -Small cluster "old-town" commercial along water-front -Scattered tourist commer-cial, moorages, etc. along Alsea River			-Urban neighborhood in Waldport -Scattered suburban and rural residential housing along Alsea River. South shore more intensely devel-oped than north shore			
3			-No dredging or jetties -Highway 101, north-south through town -East-west route Highway 36 to Corvallis, provides good access to south shore -Many small moorage facil-along river banks.	-Scattered tourist commer-cial in Waldport with clusters of tourist com-mercial (moorages, trailer parks, boat launches) along Alsea River -Salmon fishing very popular -Agate hunting, clamming & crabbing receive heavy use				
2	-No industry located on estuary -Industrial use at bay limited to log towing, although no use in recent times -Old mill located at Waldport					-Scattered grazing along north and south shore of estuary and river		
1								

ALSEA BAY

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3			-Boat basin dredged in Lint Slough -Road access to all of Eckman Slough	-Urban residential along Lint Slough within Waldport -Very scattered residential outside of town on Lint Slough -Scattered rural residential on Eckman Slough	-Small marina facility, Lint Slough -Tackle and bait shop. Rental area, Lint Slough -Sports fishing popular			
2		-Marina and fishing service on Lint Slough -Small cluster commercial facilities on Lint Slough -No commercial activity along Eckman Slough						
1	-No industrial activity					-No farming or grazing due to topography and other physical features.		

LINT SLOUGH AND ECKMAN SLOUGH
ALSEA BAY

HUMAN USE ELEMENTS

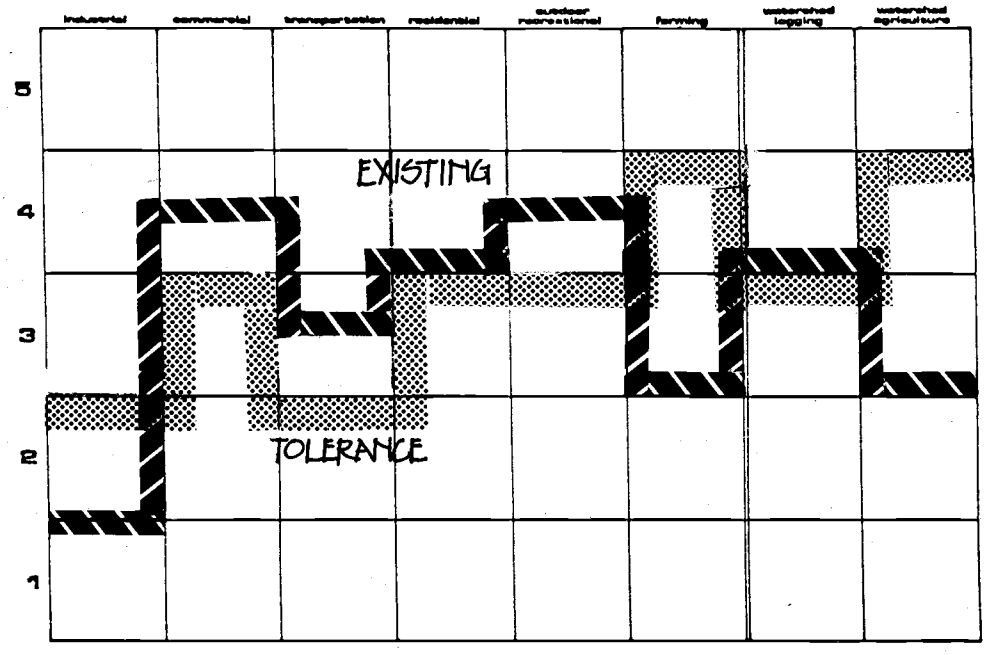
A few minor industrial developments occur in Waldport, the major town located on the Alsea estuary. No facilities are located directly on the estuary. The sole industrial use of the river system is log towing, which has not occured in recent times. Recreation plays an important role in the area's economy, with salmon fishing generating a large portion of the total recreational income. As the Alsea River channel within the estuary changes location, maintenance of navigation channels has not been undertaken. At present, facilities to accommodate a commercial fishing fleet are not available. The chart on the preceding page illustrates the intensity of human activity along the Alsea estuary.

A project providing for a breakwater, an entrance channel and a small boat basin at Waldport has been proposed. If constructed these would be the first major physical alterations to the estuary, since it contains no jetties and is not currently dredged. A portion of the river channel along the south side of the estuary was dredged in 1948.

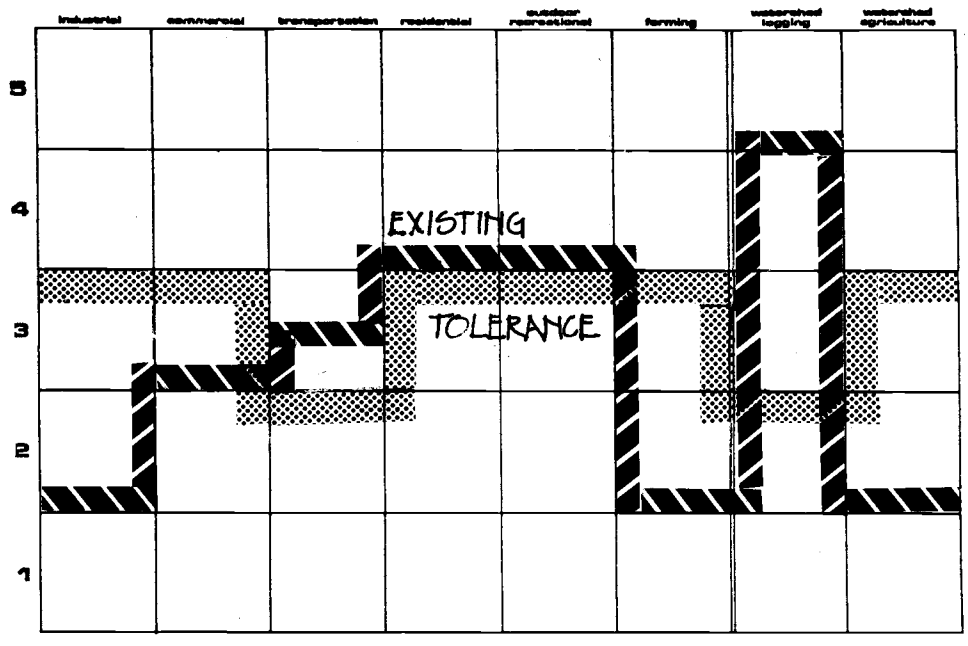
The Inventory of Filled Lands prepared by the State of Oregon indicates that a total of 25 acres of landfill occur on tidelands in Alsea Bay. All of the fill lies on submersible land; there is no fill in submerged land. Marine oriented recreation benefits from the fills due to the construction of a marina and boat ramps on the landfill. Other uses include a school and numerous residences.

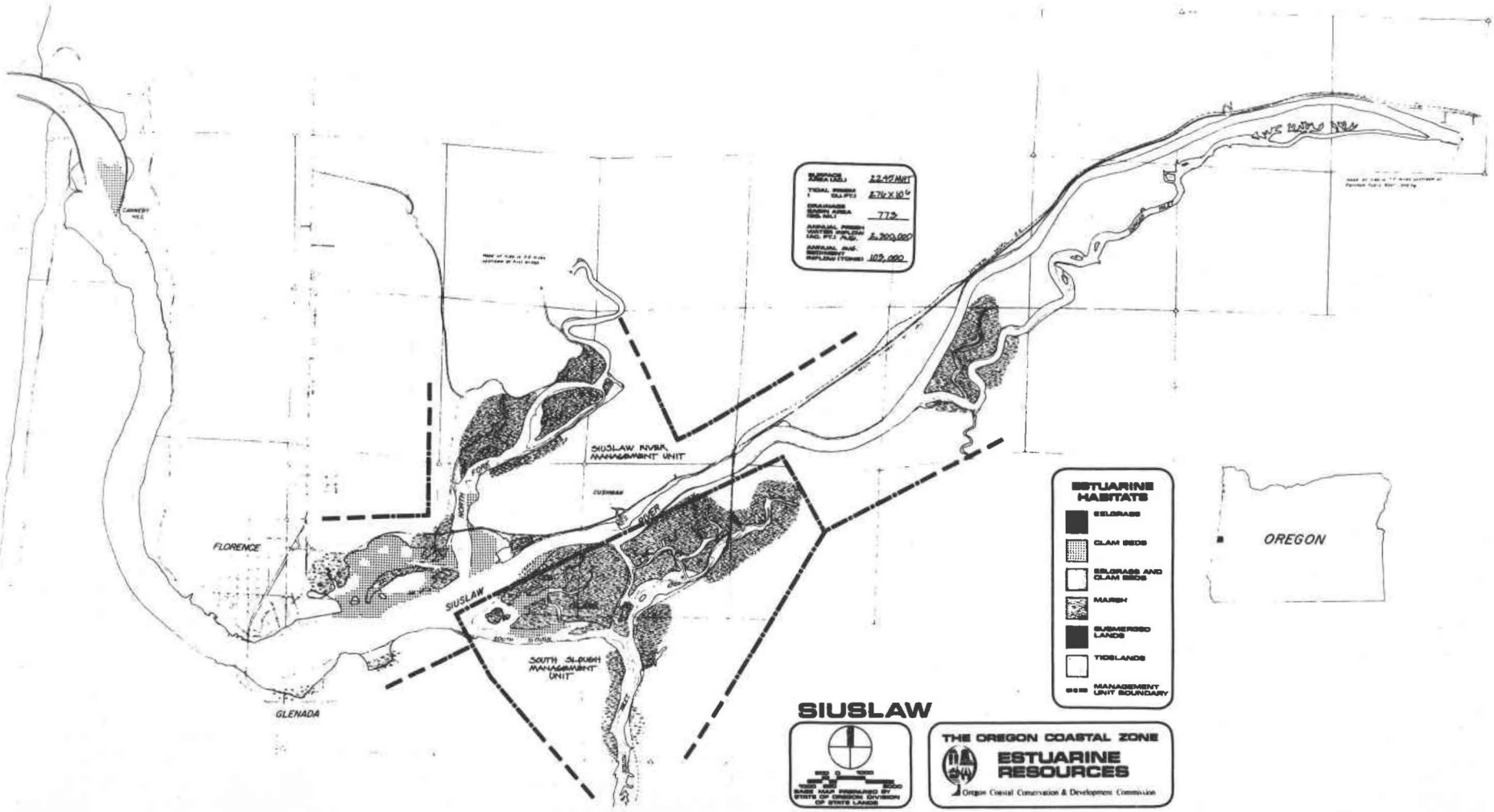
MOTEL LOCATED ON NORTH SAND SPIT AT ALSEA BAY

ALSEA BAY - TYPE X



LINT AND ECKMAN SLOUGHS - TYPE VI




PACIFIC OCEAN
FLORENCE
GLENADA
SIUSLAW
NORTH FORK
SIUSLAW RIVER MANAGEMENT UNIT
SOUTH SLOUGH MANAGEMENT UNIT
SURFACE AREA (MI.) 22.47 MI²
TIDAL PRISM (CU.FT.) 8.76 X 10⁶
DRAINAGE BASIN AREA (SQ. MI.) 775
ANNUAL FRESH WATER INFLOW (AC. FT.) MEAN 3,300,000
ANNUAL AVG. SEDIMENT INFLOW (TONS) 105,000
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
OREGON
SIUSLAW
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

SIUSLAW RIVER

BIOPHYSICAL ELEMENTS

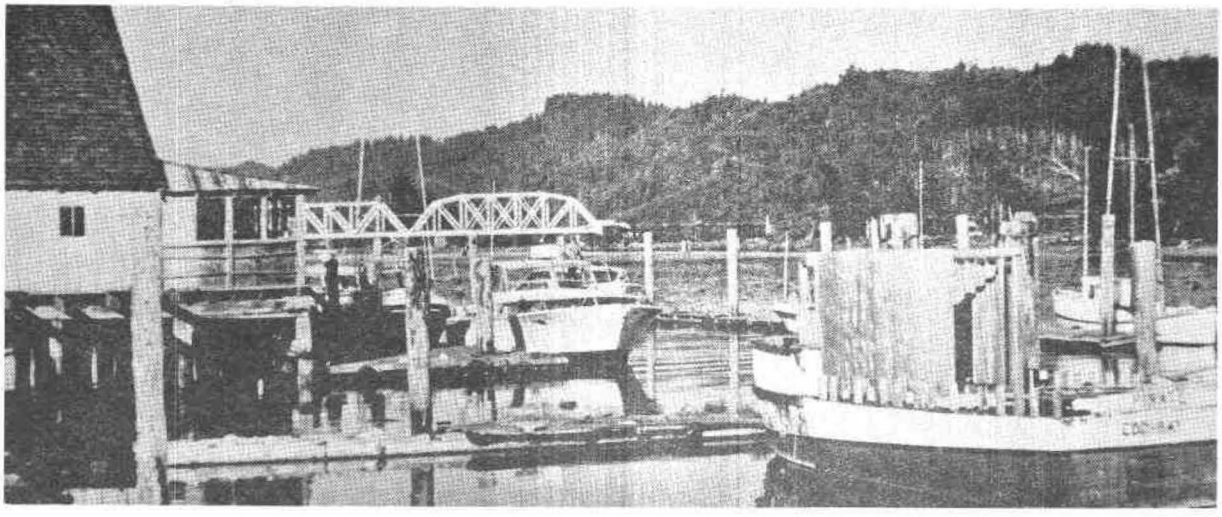
Due to diverse physical characteristics, the Siuslaw River estuary has been divided into two management units. The first management unit includes the Siuslaw River and Bay, the North Fork and Duncan Inlet all of which belong in Estuary Type XII. The South Slough of the Siuslaw has been placed in Estuary Type VII.

The Siuslaw River estuary is moderately large having an area of approximately 1,780 acres. The estuary drains 773 square miles. Normal river flow at the mouth is estimated at 3,150 c.f.s. Sand spits north and east of Florence are not well stabilized in terms of wind and stream erosion. Stream erosion is critical near the mouth of the estuary.

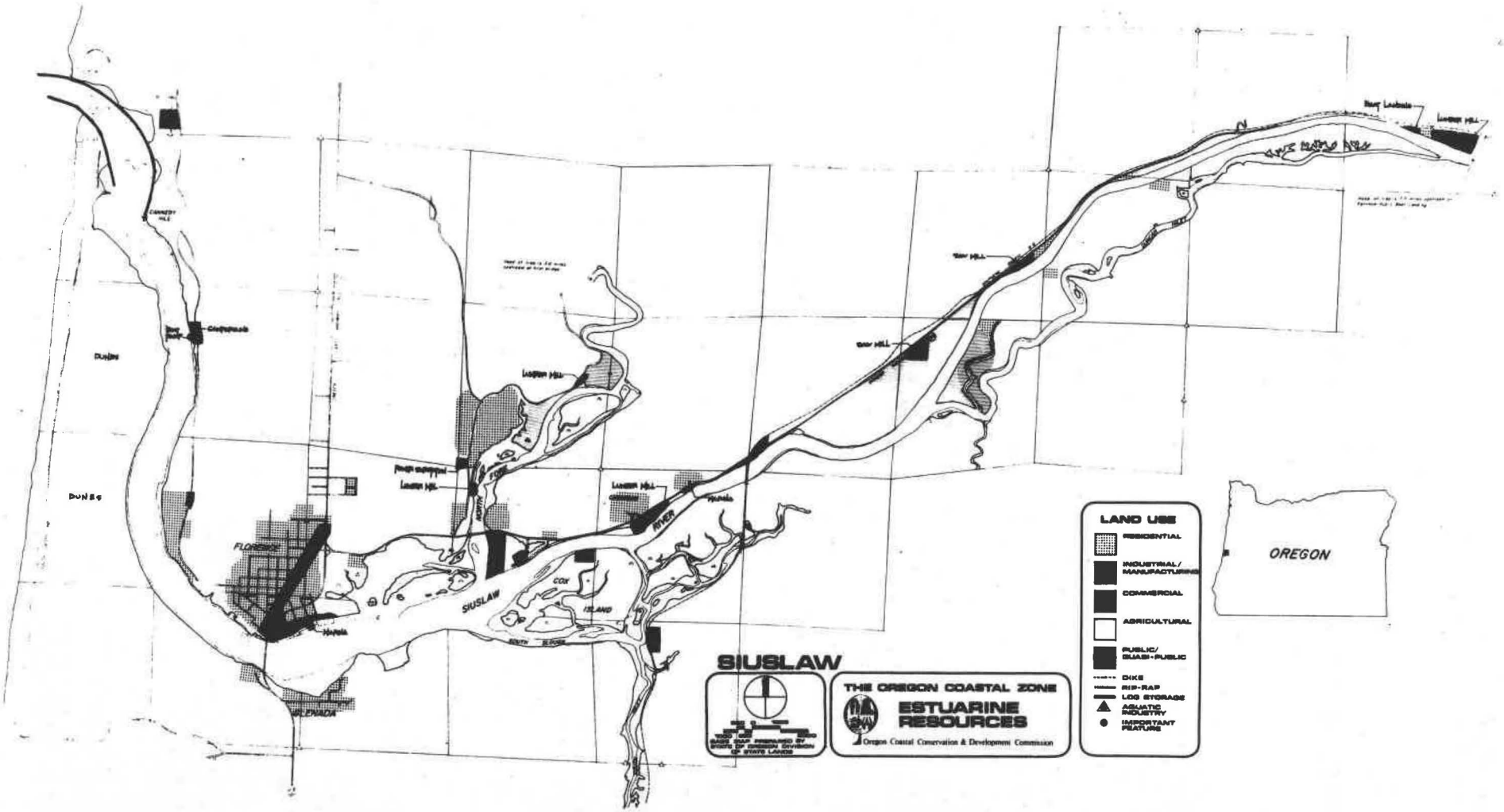
The sedimentation rate within the estuary is high, and has been estimated at 103,000 tons annually. Shortages of spawning gravels within the river system is considered a serious problem by the Oregon State Game Commission.

The physical characteristics of the South Slough are consistent with the definition of an Estuary Type VII.

Flounder, sea perch, sea-run cutthroat trout, blueback and salmon are important fish populations within the Siuslaw River estuary and small herring spawning grounds are evident. The production of softshell clams is very high. The Siuslaw River and Bay exhibit the most diverse marshes within Oregons estuaries. Scarce data is available on the terrestrial biology of the Suislaw estuary system, although ospreys and eagles are known to exist.



MARINE FACILITIES ALONG THE SIUSLAW RIVER


PACIFIC OCEAN
DUNES
DUNES
FLORENCE
SIUSLAW
RIVER
COX
ISLAND
SOUTH SLOUGH
NORTH FORK
LAUREL HILL
TAW HILL
SIUSLAW
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ SEMI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
OREGON

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4	-3 lumber processing mills up river on Siuslaw -Numerous small towing and small marina oriented industries -No fish processing facilities -Processed lumber products barged to regional and interstate markets -Log storage	-Strip commercial along Highway 101 in Florence -Tourist commercial along Florence waterfront -Motel/restaurant complex on waterfront in Glenada -One marina on north bank between Florence and estuary mouth -Scattered commercial in Cushman vicinity	-Jetties, channel maintained to 16 feet to Florence -Turning basin at Florence -Navigable channel to Cushman -North-south and east-west highways -Rail transport available to Cushman -Good access to one-half of estuary	-Major urban/suburban residential in Florence -Suburban cluster in Glenada -Significant vacation home construction west of Florence -Widely scattered residential on North Fork -Scattered residential on mainstream		-Widely scattered, small grazing area -Topography precludes intensive agricultural use -Many diked marshes		
3					-Mixed tourist-strip commercial in Florence -Tourist commercial along Florence waterfront -Numerous marinas, boat ramps, etc. -Good sports fishing, clamming -Good recreational access and use to north & south jetties -N.R.A. Dunes			
2								
1								

SIUSLAW RIVER ESTUARY

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3								
2			-Limited road access to South Slough -Rail transport available -Shallow channel available for water borne transport					
1	-No active industrial on South Slough	-No active commercial on South Slough		-No residential use	-No pleasure boat facilities	-No active farming due to topography and inaccessibility		

SOUTH SLOUGH
SIUSLAW RIVER ESTUARY

HUMAN USE ELEMENTS

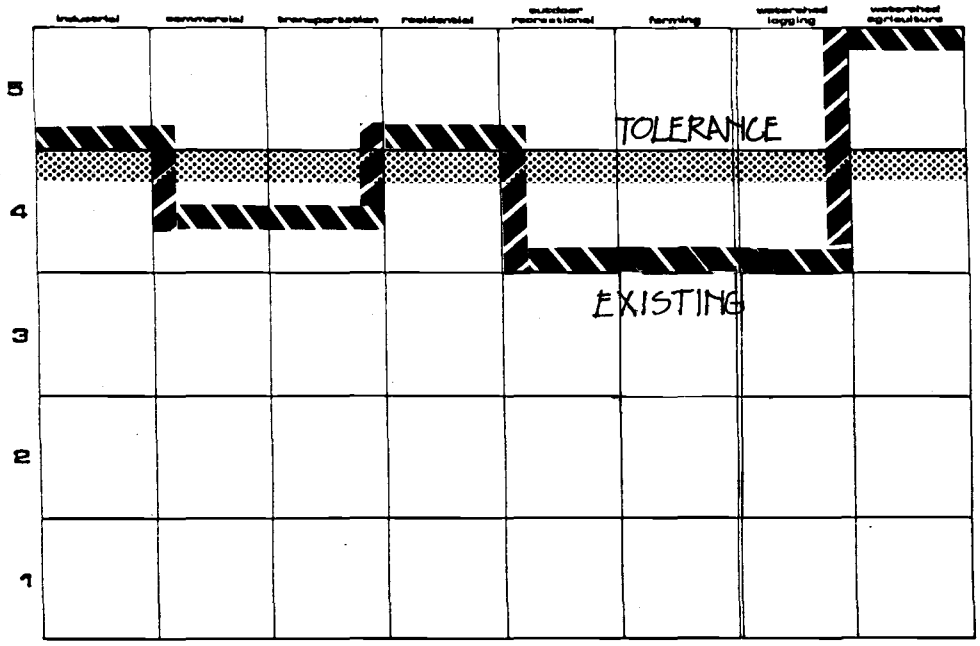
Forest products production is the mainstay of the Siuslaw region, although the mills are located upstream near Cushman and Mapleton. Only small industries are located in the main shoreline town of Florence. No significant changes are foreseen in either the supply of logs or the level of output and employment of the regions mills. The local commercial fishing industry at Florence is limited to small fish landings, and is overshadowed by the other harbors along the coast. Although Florence has a fish buying station, there are no processing facilities. Public officials in Florence are not committed to promoting increasingly intensive economic development along the estuary shoreline. There is a desire to utilize the limited shoreline resources for industry that is water-related, and to expand the economic base within moderate boundaries.

The existing levels of human activity are illustrated in the charts on the preceding pages for the two management units contained within the Siuslaw River estuary.

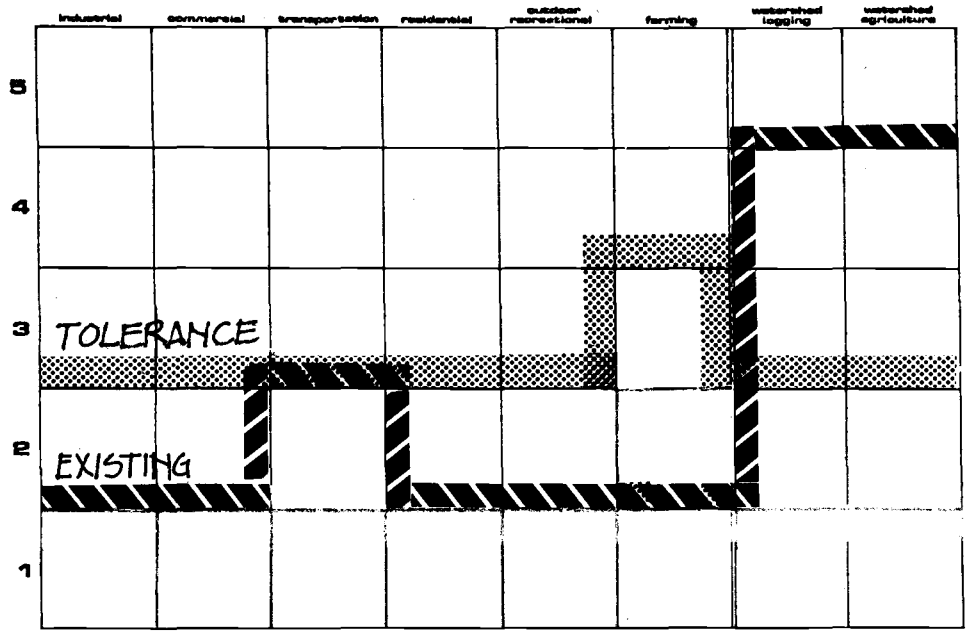
Salt marsh diking, construction of an entrance channel, 2 rubble-mounded jetties and a river channel extending up Siuslaw Bay to the railroad bridge have been the major physical alterations to this system. The entrance channel is currently maintained to 18 feet and the river channel to 16. A turning basin and small boat basin have been constructed at Florence. Dredging records indicate that an average of 82,000 cubic yards of sediment are removed from the system annually. In addition, at the mouth of the estuary, a bulkhead line has been constructed to keep the waterline open to the public for recreational use.

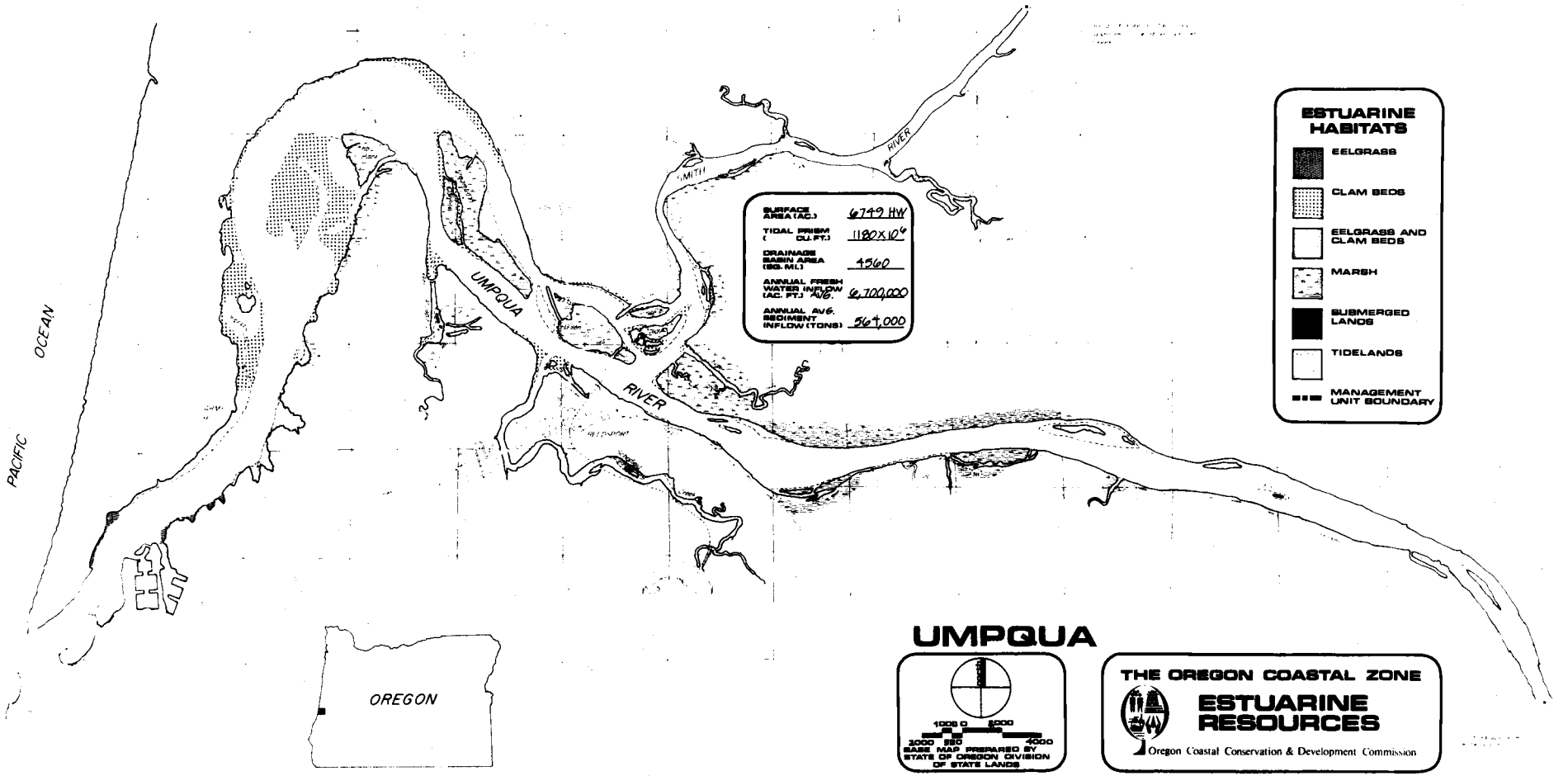
In the Siuslaw River there are 40.75 acres of landfill located on submerged and submersible lands. Most of the fill originated as dredge spoils and has been utilized to construct boat launches and other marine related facilities.

SIUSLAW RIVER ESTUARY - TYPE XII



SOUTH SLOUGH - TYPE VII




PACIFIC OCEAN
UMPQUA RIVER
SMITH RIVER
OREGON
SURFACE AREA (AC.) 6749 HW
TIDAL PRISM (CU. FT.) 1180X10⁶
DRAINAGE BASIN AREA (SQ. MI.) 4560
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG. 6,700,000
ANNUAL AVG. SEDIMENT INFLOW (TONS) 564,000
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
UMPQUA
1000 0 2000
3000 500 4000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

UMPQUA RIVER

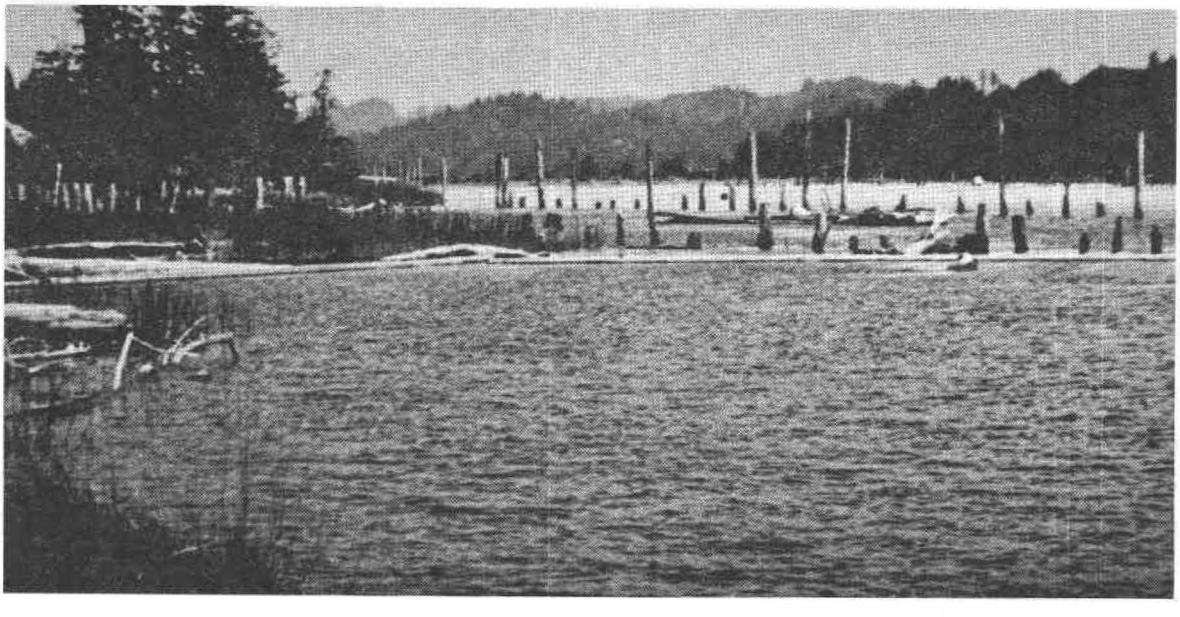
BIOPHYSICAL ELEMENTS

The entire Umpqua River estuary has been classified as a Type XII Estuary.

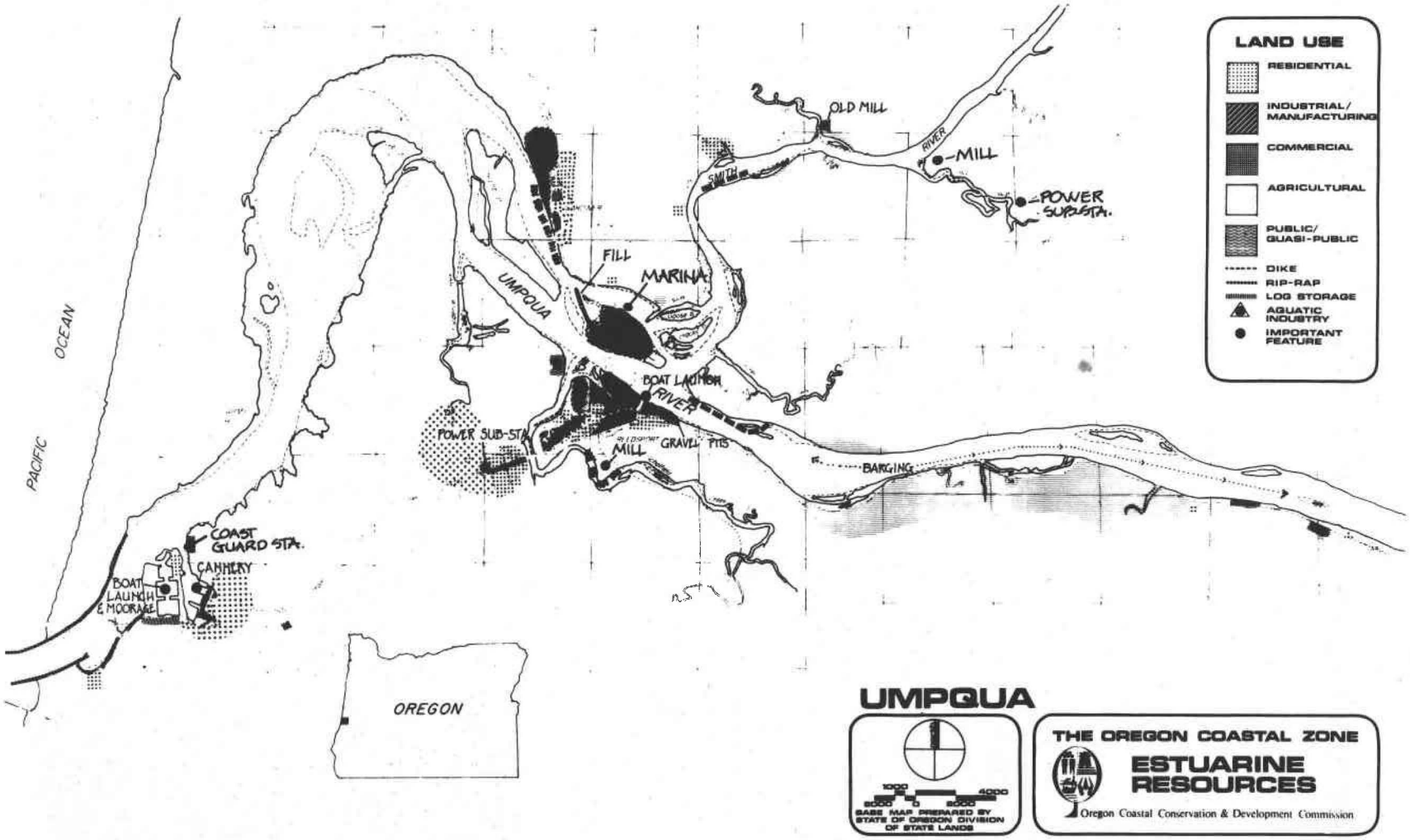
The Umpqua River has an approximate surface area of 6,430 acres. Its watershed covers 4,560 square miles and extends into the Cascades. The average stream discharge (measured at a station which represents only 80% of the total basin) is approximately 7,500 c.f.s.

The North Spit and adjacent open sand area is part of the National Dunes Recreation Area. Dune sand in the estuary is poorly vegetated in many locations near the mouth. Stream sediments transported into the estuary are estimated at 564,000 tons annually. Longshore drift also moves sediment around the north jetty and into the estuary.

Shad, herring, striped bass and bay clams are important harvested resources in the Umpqua esturay. Steelhead trout are the most widely distributed species of anadromous fish although salmon also occur. The only known herring spawning ground within the Umpqua estuary occurs in Winchester Bay. High densities of large softshell clams are also located in Winchester Bay. Some waterfowl winter in the estuary and large populations of big game, including white-tailed deer, winter along the shorelands.



ABANDONED LOG PILINGS IN UMPQUA RIVER


LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
OLD MILL
MILL
POWER SUB-STA.
SMITH
RIVER
FILL
MARINA
UMPQUA
BOAT LAUNCH
RIVER
POWER SUB-STA
MILL
GRAVEL PITS
BARGING
PACIFIC
OCEAN
COAST GUARD STA.
CANNERY
BOAT LAUNCH & MOORAGE
OREGON
UMPQUA
1000
4000
8000
0
8000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	-2 large lumber processing plants near Gardiner -Large fish processing plant in Winchester Bay -Regional, state and international markets for lumber and fish -Extensive sand and gravel mining -1 large lumber mill on Scholfield Creek	-Strip commercial in Reedsport meeting regional population needs, mixed with tourist commercial -Intense tourist commercial in Winchester Bay -Local commercial facilities in Winchester Bay and Gardiner			-Major center for sports fishing in the region. Many charter facilities, launches, moorages, etc. -Intensive tourist commercial at Winchester Bay -County park and state park located on the estuary			
4			-Channel to Reedsport dredged to 22 feet. Channels maintained to Winchester Bay, Gardiner, Scholfield Creek and Smith River -Major east-west highway -Major north-south highway -Large commercial and pleasure craft marina in Winchester Bay -Rail through Gardiner and Reedsport	-Major cluster of urban/suburban housing in Reedsport -Clustered neighborhoods in Gardiner and Winchester Bay -Scattered rural residential along Scholfield Creek and Smith River		-Moderately widespread grazing and pastureland along south shore of Umpqua River -Scattered small farms along Scholfield Creek and Smith River		
3								
2								
1								

UMPQUA RIVER ESTUARY

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4		-Strip commercial along Highway 101 serving local market -Intensive tourist commercial along waterfront, including motels, restaurants, charters and shops	-100 foot wide channel dredged to 12 feet -Mooring and turning basin -Highway 101, north-south -Large marina for commercial and pleasure craft -No rail transport -Good access to all portions		-Major center for sports fishing -Intensive tourist commercial -Large marina and moorage facilities' -County park			
3	-Large fish processing plant serving regional and interstate market			-Cluster urban/suburban housing near bay -Vacation home community on bluff above bay				
2								
1						-No farming due to intensity of development and topography		

WINCHESTER BAY
UMPQUA RIVER

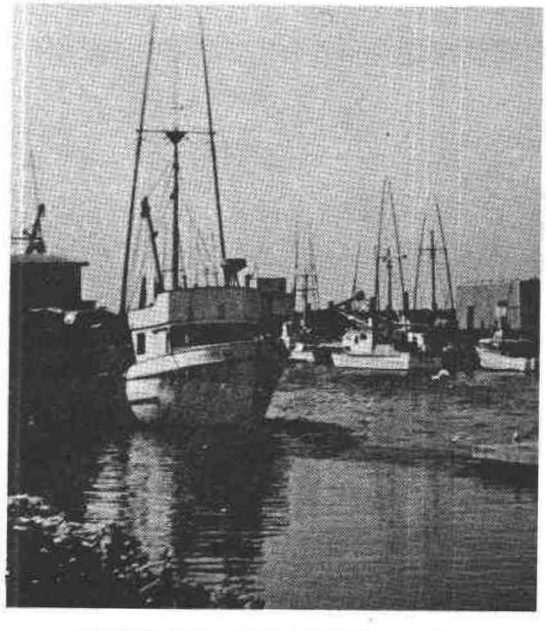
HUMAN USE ELEMENTS

The economy of the Umpqua depends primarily on fish and timber resources, although large amounts of sand and gravel are taken from the river. The Smith and Umpqua River Valleys support some farming and ranching, and tourism is important along the waterfront. Expansion of manufacturing output and employment in recent years has been due to continued development of Bolon Island and increased efficiency in general manufacturing processes. Prospects are for continuation of this trend because local facilities are largely in equilibrium with the long-term supply of local raw materials. Fishing activities are located mainly in Winchester Bay, due to the convenience of the large marina and fish processing plants within two miles of the river entrance. The offshore fisheries are not expected to be capable of significant increases in yeild in future years. Accordingly, changes in fish products output and employment are more likely to be the result of changes in accessibility of harbors to the sea, the availability of fish buying and processing facilities, and the size and location of seafood markets.

The human use charts on the preceding pages describe the existing intensity of human activities within the Umpqua estuary. Due to the difference in activities at Winchester Bay, it will be treated in a separate use chart.

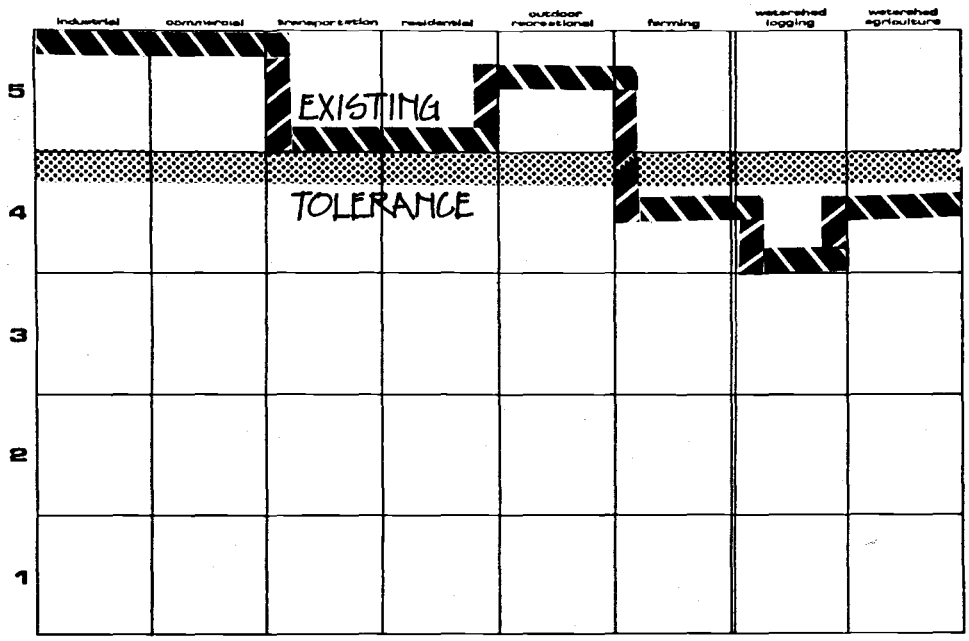
The Umpqua estuary has been extensively altered by human activity. Major alterations include three jetties, a main channel to Reedsport maintained to 22 feet in depth, and a turning basin in Reedsport. Channels are also maintained to Winchester Bay (12 feet), to Gardiner (12 feet) and to the Smith River (6 feet). Expansion of the entrance and river channels have been discussed.

The Inventory of Filled Lands prepared by the State of Oregon in June, 1972, lists 106 acres of landfill area in the Umpqua estuary. The major portion, almost 80 acres, was used to construct the marina and harbor at Winchester Bay. The remainder of the total landfill are marine oriented with heavy emphasis on deep water navigation and industry.

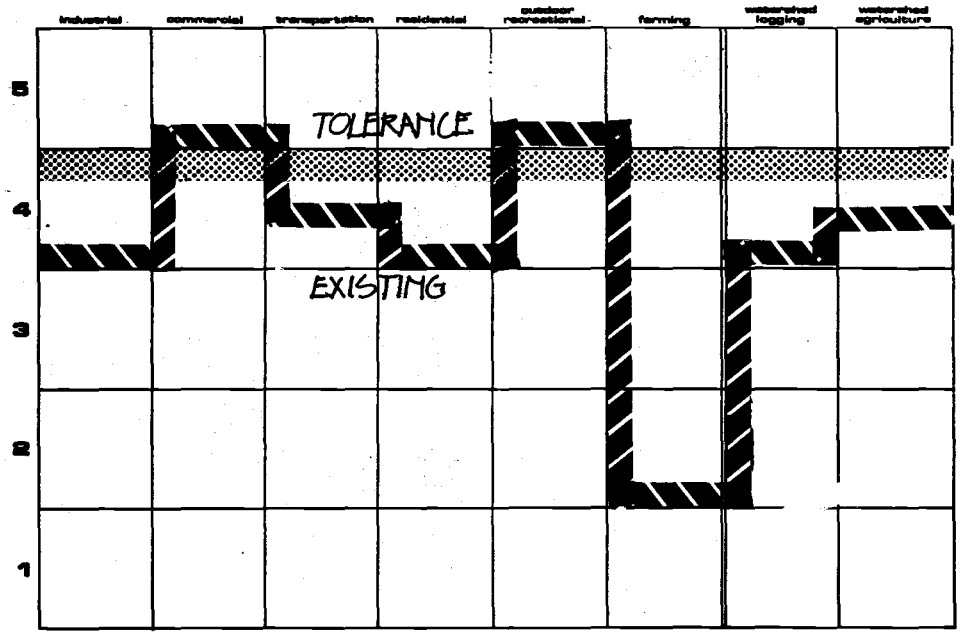


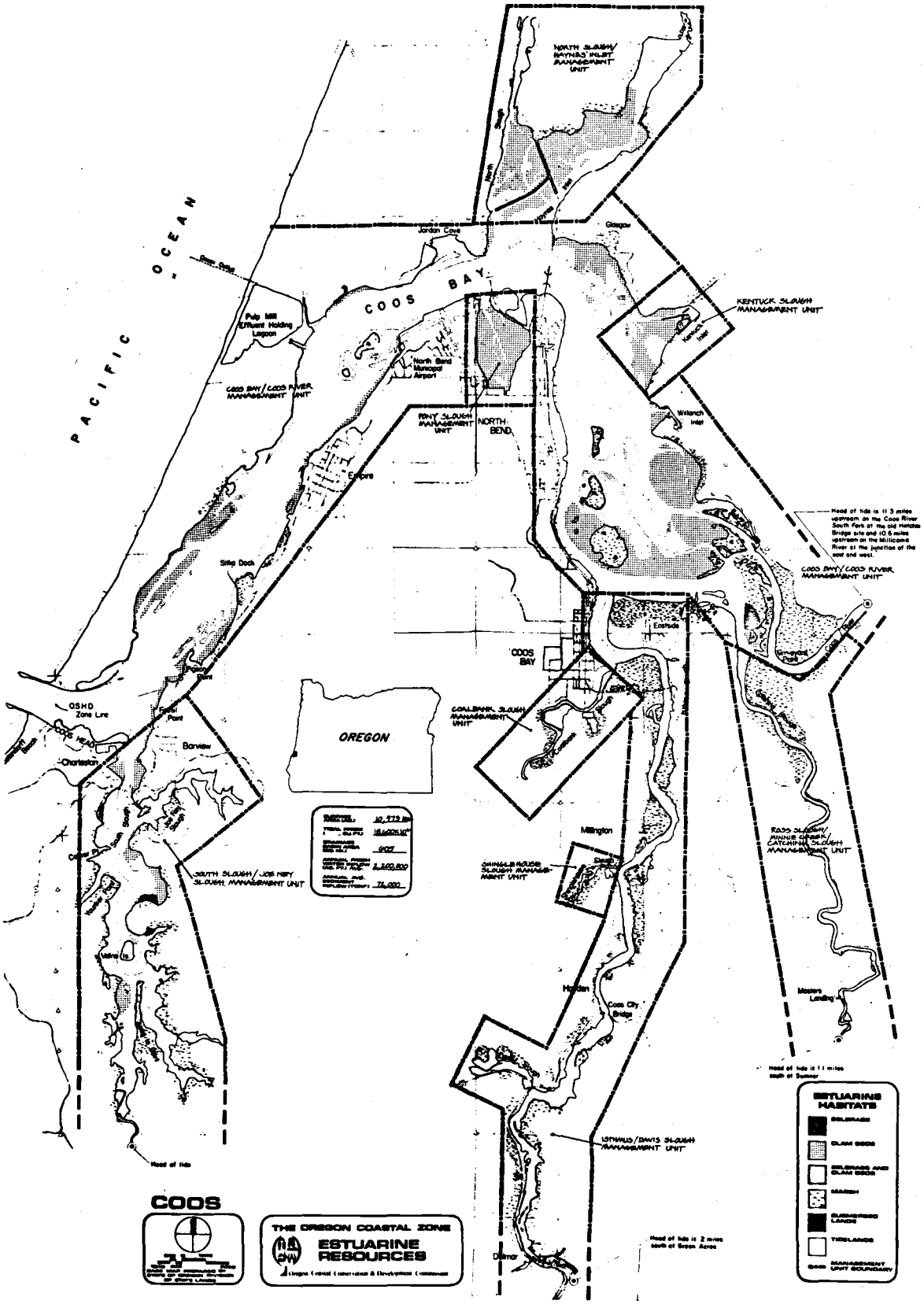
WINCHESTER BAY FISHING FLEET

UMPQUA RIVER - TYPE XII



WINCHESTER BAY - TYPE XII




PACIFIC OCEAN
COOS BAY
NORTH SLOUGH/ HAYNES' INLET MANAGEMENT UNIT
Jordan Cove
Glasgow
KENTUCK SLOUGH MANAGEMENT UNIT
Pulp Mill Effluent Holding Lagoon
North Bend Municipal Airport
COOS BAY/COOS RIVER MANAGEMENT UNIT
RINY SLOUGH MANAGEMENT UNIT
NORTH BEND
Empire
Wilanch Inlet
Head of tide is 11.3 miles upstream on the Coos River South Fork at the old Hetrick Bridge site and 10.6 miles upstream on the Millicoma River at the junction of the east and west.
COOS BAY/COOS RIVER MANAGEMENT UNIT
Silta Dock
Eastside
COOS BAY
OSHD Zone Line
Coos Head
Charleston
Barview
OREGON
COALBANK SLOUGH MANAGEMENT UNIT
Millington
SHINGLEHOUSE SLOUGH MANAGEMENT UNIT
ROSS SLOUGH/ MINNIE CREEK/ CATCHING SLOUGH MANAGEMENT UNIT
SOUTH SLOUGH/ JOE HEPY SLOUGH MANAGEMENT UNIT
Haynes
Coos City Bridge
Mosten Landing
Head of tide is 11 miles south of Sumner
ISTHMUS/DAVIS SLOUGH MANAGEMENT UNIT
Head of tide
Head of tide is 2 miles south of Green Acres
Dellrose
ESTUARINE HABITATS
MANAGEMENT UNIT BOUNDARY
COOS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES

BIOPHYSICAL ELEMENTS

The Coos Bay estuary has been separated into the following four management units due to varied biophysical characteristics:

Isthmus, Davis, Shinglehouse, Coalbank, Pony and Kentuck Sloughs	Estuary Type IV
Coos Bay/Coos River	Estuary Type V
Catching Slough	Estuary Type VI
North, Haynes, South and Joe Ney Sloughs	Estuary Type VII

Isthmus, Davis, Coalbank, Pony, Shinglehouse and Kentuck Sloughs are grouped together because they have only minor freshwater inflow and have experienced extensive human use. Isthmus Slough is long and narrow (approximately 12 miles long from its mouth to the head of tide) and has the much shorter Shinglehouse, Davis and Coalbank Sloughs as tributaries. Kentuck Slough is a tributary to the main portion of Coos Bay. It has been channelized between roadfill and a dike.

Along Isthmus Slough logging extends down to the waterline and together with construction activities these two uses represent a significant sediment contribution to the slough. Actual erosion rates were not available in the literature surveyed.

Shinglehouse Slough has had refuse dumped on surrounding marshes as well as engineered fill.

Pony Slough differs from the others in that it is short and wide. A narrow band of marsh area extends around much of its perimeter.

Coos Bay covers an area of approximately 10,000 acres and is the largest estuary on the Oregon coast. The drainage basin for Coos Bay is approximately 605 square miles. Coos River is the largest of 30 tributary streams and flows range from 5,500 c.f.s. to 90 c.f.s. The mean flow is approximately 2,200 c.f.s. Sedimentation occurs at a rate of 72,000 tons annually.

Much of the sand comprising the spit that extends down from the north and the dunes south of Pony Slough is highly mobile. Only local areas have been stabilized by vegetation.

The coast between Bandon and Florence has been categorized as a zone of potentially moderate earthquake damage. The damage associated with an earthquake is highly variable and is in part dependent upon the substrate. Impact from quakes can be very great in areas such as estuaries where there are thick

sections of saturated, unconsolidated ground. Coos Bay has a very large area of filled lands (1,260 acres) which rests on materials of low seismic stability. Although there are filled areas in other estuaries in this zone of expected moderate earthquake damage, none are as extensive as at Coos Bay.

Catching Slough is a long, narrow, meandering slough with a length of 10 miles from its mouth in Coos Bay to the head of tide. Topographically it does not differ from the Coos Bay Sloughs in Estuary Type IV, but was separated from them on the basis of biologic and human use information.

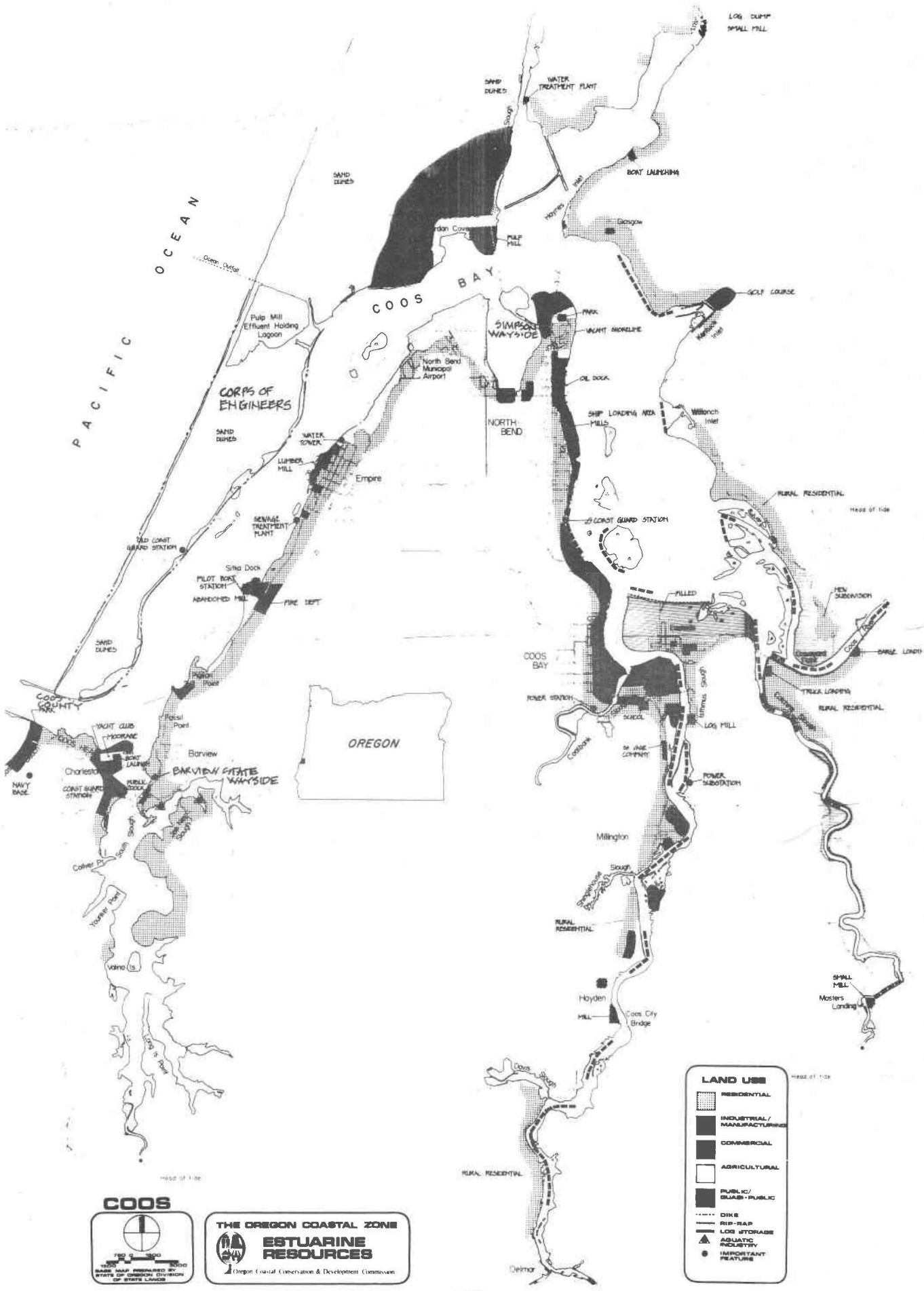
The North Slough of Coos Bay is very narrow near its head and broadens where it joins Haynes Inlet. Haynes Inlet is quite wide and consists mainly of mud-flats at low tide. Much of the perimeter of this inlet is subject to erosion, especially where vegetation has been removed. South Slough is approximately 5 miles long and has a digitate shoreline pattern formed by numerous small tributaries and inlets, including Joe Ney Slough. Locally the shoreline cliffs are very steep and erosion is a severe problem. Dune sand, where present, has been stabilized by forest vegetation.

Information on the benthic fauna and anadromous fish populations is lacking on Isthmus, Davis, Shinglehouse, Coalbank, Pony and Kentuck Sloughs. In general these sloughs are not valuable as wildlife or botanical areas, with the exception of Pony Slough which is an important waterfowl nesting and feeding area. Up to 100,000 wintering waterfowl may utilize Pony Slough at one time.

Coos Bay contains excellent populations of softshells, gaper and cockle clams and historically high numbers of native oysters appear throughout the estuary system. Coos Bay is the largest log exporting port in the United States, hence potential oyster production locations are affected by deleterious pollutants. Although the Coos Bay and River have been greatly affected by human activity, they are important wildlife areas, supporting at least 580,000 waterfowl use days annually. Sea otter are found at the estuary mouth and portions of the shorelands that are not developed are somewhat valuable for big game winter range.

Information is lacking on benthic fauna and most anadromous fish runs for North Slough and Haynes Inlet. These sloughs are notable as important waterfowl areas, however. A large great blue heron rookery is located on the North Spit.

South Slough and Joe Ney Slough are quite pristine and have experienced limited human interference with the natural setting. Extensive eelgrass and clam beds are noted throughout these systems. Pacific oyster production is successful, but native oysters which were once common, no longer exist. The potential for greatly increasing the production is available. These Sloughs are reknown for their waterfowl populations, with well over 100,000 waterfowl use days recorded annually. South Slough also supports an important great blue heron rookery. It has been approved as a natural estuarine sanctuary and further action awaits appropriation of the necessary state matching funds.


LOG DUMP
SMALL MILL
SAND DUNES
WATER TREATMENT PLANT
Slough
BOAT LAUNCHING
Hayes Inlet
Glasgow
Jordan Cove
PULP MILL
PACIFIC OCEAN
Ocean Outfall
COOS BAY
GOLF COURSE
Pulp Mill Effluent Holding Lagoon
PARK
SIMPSON WAYSIDE
YACHT SHORELINE
North Bend Municipal Airport
OIL DOCK
CORPS OF ENGINEERS
NORTH BEND
SHIP LOADING AREA
MILLS
Willanch Inlet
SAND DUNES
WATER TOWER
LUMBER MILL
Empire
RURAL RESIDENTIAL
Head of tide
SEWAGE TREATMENT PLANT
COAST GUARD STATION
OLD COAST GUARD STATION
Sitka Dock
PILOT BOAT STATION
ABANDONED MILL
FIRE DEPT
FILLED
NEW SUBDIVISION
SAND DUNES
BARGE LANDING
COOS COUNTY PARK
COOS BAY
POWER STATION
TRUCK LOADING
RURAL RESIDENTIAL
YACHT CLUB MOORAGE
Fossil Point
SCHOOL
LOG MILL
OREGON
Barview
BOAT LAUNCH
Charleston
BARVIEW STATE WAYSIDE
PUBLIC DOCK
COAST GUARD STATION
NAVY BASE
SW LINE COMPANY
POWER SUBSTATION
South Slough
Millington
Colver Pt.
Younger Point
RURAL RESIDENTIAL
Valino Is.
SMALL MILL
Masters Landing
Hayden
MILL
Coos City Bridge
Long Is. Point
Davis Slough
Head of tide
RURAL RESIDENTIAL
Delmar
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
COOS
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	-Pony Slough adjacent to North Bend airport -Extensive mill operations and deep water port along mouth of Isthmus Slough adjacent to City of Coos Bay. International market -Scattered mills on Coalbank and Shinglehouse Sloughs -No industrial activity on Kentuck or Davis Sloughs		-30 foot deep channel extends into Isthmus Slough -Large port and harbor facility adjacent to City of Coos Bay -Good road access to Isthmus Slough -Access to all but upper reaches of other sloughs	-Urban residential along Pony Slough, Isthmus Slough -Scattered suburban residential on Coalbank Slough -Scattered rural residential on Davis, Shinglehouse and Kentuck Sloughs				
4		-Strip commercial along portions of Pony and Isthmus Sloughs serving regional population needs. Not necessarily tourist oriented -Scattered strips of commercial along length of Isthmus Slough and portions of Coalbank Slough						
3								
2					-Golf course along Kentuck Inlet -Scattered boat launches and ramps	-Scattered agricultural use along Kentuck and Shinglehouse Sloughs confined to grazing -Agricultural activity excluded from other sloughs due to topography and intensity of development		
1								

ISTHMUS, DAVIS, COALBANK, SHINGLEHOUSE, PONY AND KENTUCK SLOUGHS
COOS BAY

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5	-Largest exporter of lumber and wood products -Intense industrial activity at Charleston (fish processing), North Bend (wood processing), Empire (mixed uses) -Moderate industrial activity on shorelines between industrial centers -Fish and wood processors draw resources from regional base and market internationally		-Jetties, 30 foot deep channel from mouth to Isthmus Slough -Numerous turning and anchorage basins -Water borne transport of major importance to regional economy -Road access to most of shoreline -Extensive marinas in Charleston -Highway, rail and air transport	-Scattered residential along Coos Bay between North Bend and ocean mouth -Urban/suburban residential in Empire, Barview and Charleston -Suburban residential, including new subdivisions, in proximity to Coos River				
4		-Scattered strip commercial along reaches of Coos Bay oriented toward regional population -No commercial activity on Coos River						
3					-Numerous charter services, marinas, moorages and launches in Charleston, serving recreational fishermen. -Limited launch facilities along bay and river shorelines	-Scattered agricultural use (grazing) along segments of Coos River -Active farming along bay limited to portions of northshore -Farming precluded due to topography and intensity of development		
2								
1								

COOS BAY AND RIVER ESTUARY

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4						-Active dairy farming and grazing along all reaches of Catching Slough -Widespread use of dikes to reclaim and protect agricultural areas.		
3				-Urban/suburban residential close to mouth of Catching Slough -Scattered rural residential the length of the slough				
2	-Small mill at Masters Landing -Log storage and empty log cribs scattered throughout -Truck loading area at mouth of slough		-Road along east shore of slough, portions constructed on dike -Limited road access to west shore					
1		-No commercial activity on Catching Slough			-Small boat landing on upper reaches of slough -Very limited recreational use			

CATCHING SLOUGH
COOS BAY

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5							HAYNES INLET NORTH SLOUGHS	
4								
3					-Boat ramps, moorages, etc. on north end of South Slough -Dunes areas on North Slough -Motel, restaurant at mouth of Haynes Inlet. Boat launch			
2	-No industrial activity on Joe Ney Slough -No industrial on North Slough -Small mill and log dump on upper reaches of Haynes Inlet -No industrial on South Slough (south of Charleston)	-Scattered restaurants and light commercial on South Slough, just south of Charleston -Motel, restaurant and tavern near mouth of Haynes Inlet -No commercial activity on North Slough or Joe Ney Slough	-North Slough and Haynes Inlet crossed by bridges -Road access to most portions of the sloughs -No dredging	-Scattered rural and sub-urban residential on segments of each slough		-Pastureland agricultural use on upper reaches of Haynes Inlet -Precluded on North and South Sloughs due to topography and sand soils	JOE NEY SLOUGH SOUTH SLOUGHS	
1								

NORTH SLOUGH, HAYNES INLET, SOUTH SLOUGH, JOE NEY SLOUGH
COOS BAY

HUMAN USE ELEMENTS

In addition to forest products manufacturing, the Port of Coos Bay has become one of the largest lumber and wood products exporters in the world. The economic profile has been, and will continue to be centered around the forest products industry. Secondary elements of the economy include tourism, recreation, fishing and diversified manufacturing.

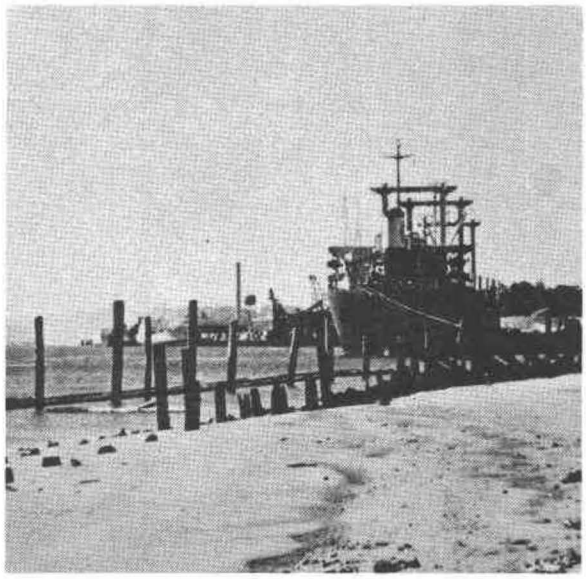
In the last four years seafood processing in the Coos Bay area has doubled. As one-quarter of all its employment involves the wood products industry, Coos Bay is highly susceptible to adverse social and economic impacts in times of recession related to adverse national and international wood product market conditions. The major wood product corporations can withstand fluctuations of product demands and price levels without undue corporate financial strain by adjusting production or employment levels. Construction of a new pulp mill offers the only major new employment prospect in this industry.

The Port of Coos Bay has indicated that port docking facilities are adequate to handle anticipated increases in water borne commerce in the future. The difficulties attending navigation in the bay channel and the limited accessibility of inland areas to the Port are, however, two problems that presently limit growth of water borne commerce.

The preceding human use charts describe the level of human activity within each of the four Coos Bay management units.

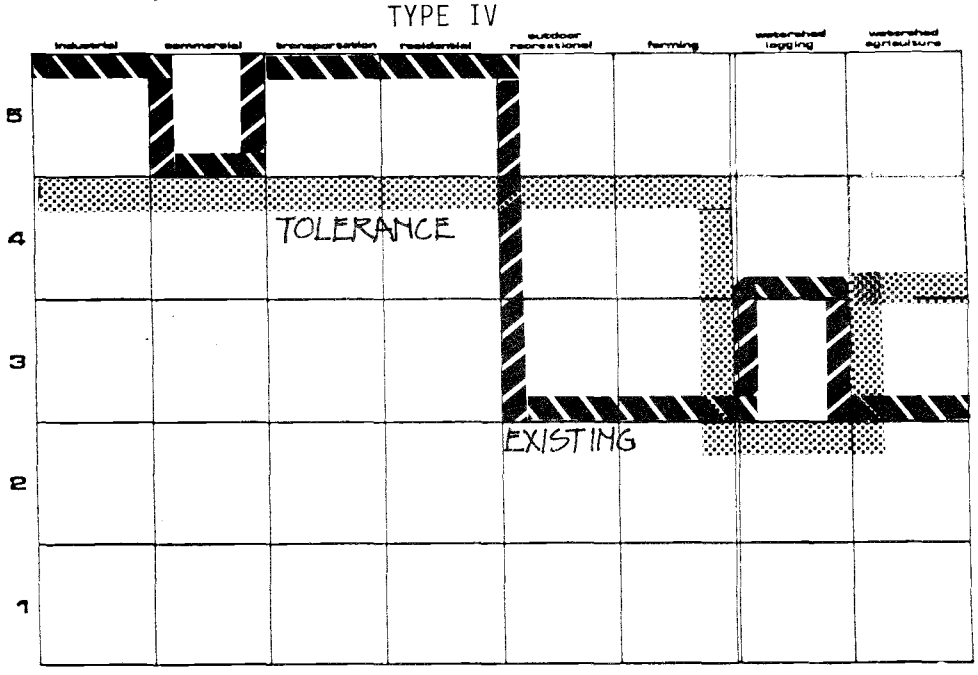
Extensive physical alterations have taken place within the Coos Bay estuary including construction of jetties, turning and anchorage basins, and a widespread system of channels. The entrance channel is maintained at 40 feet and the river channel to the mouth of Isthmus Slough to 30 feet. Channels to Millington on Isthmus Slough (18 miles from estuary mouth) and to the mooring basin at Charleston are also maintained. A mooring basin, breakwater and bulkhead have been built in Charleston.

The Inventory of Filled Lands prepared by the State of Oregon reports that 1,260 acres of landfill on submerged and submersible lands occur in Coos Bay. The major portion of these landfills are the result of dredged materials and are oriented towards industrial and residential development, with no particular emphasis on navigation.

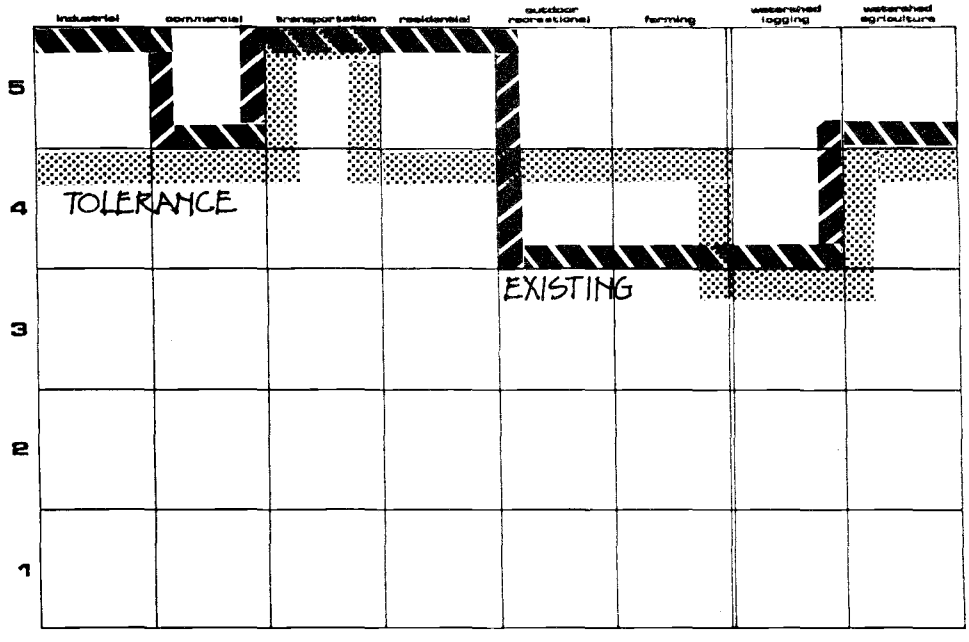


SHIP LOADING FACILITY ALONG COOS BAY

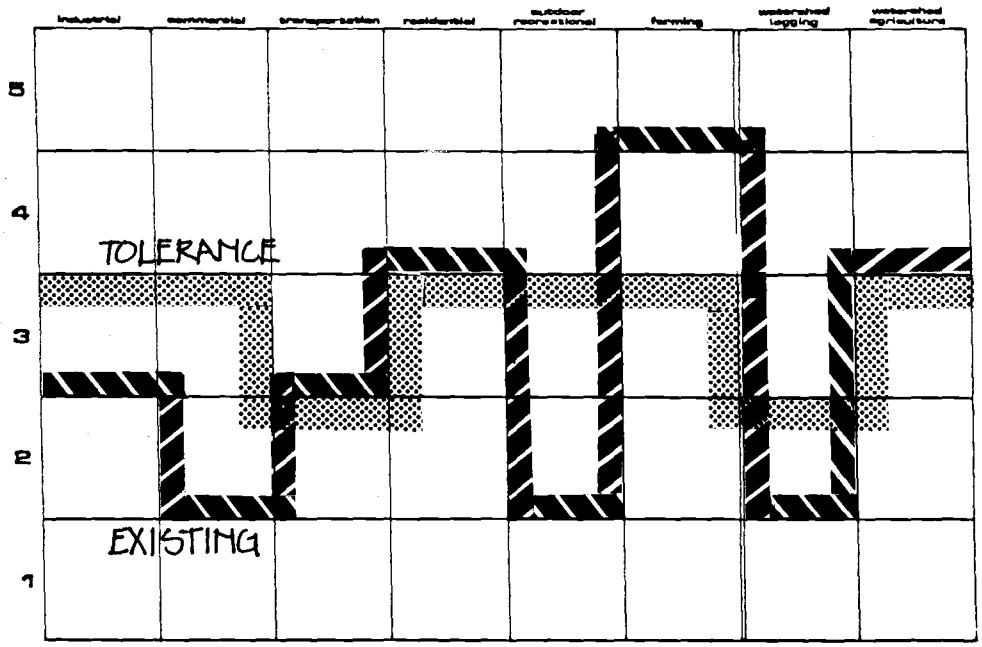
ISTHMUS, DAVIS, SHINGLEHOUSE, COALBANK, PONY & KENTUCK
TYPE IV



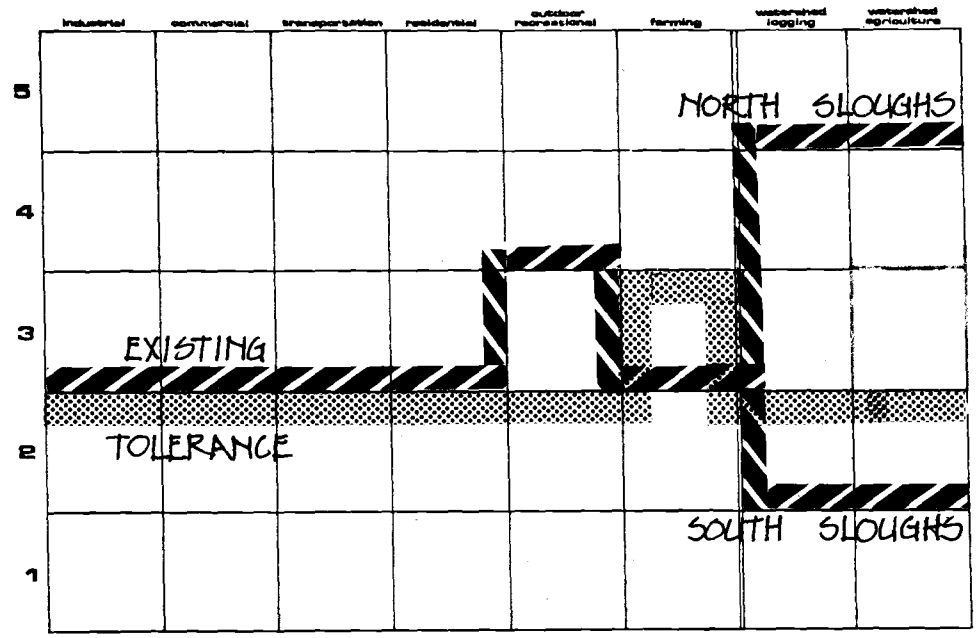
COOS BAY - TYPE V

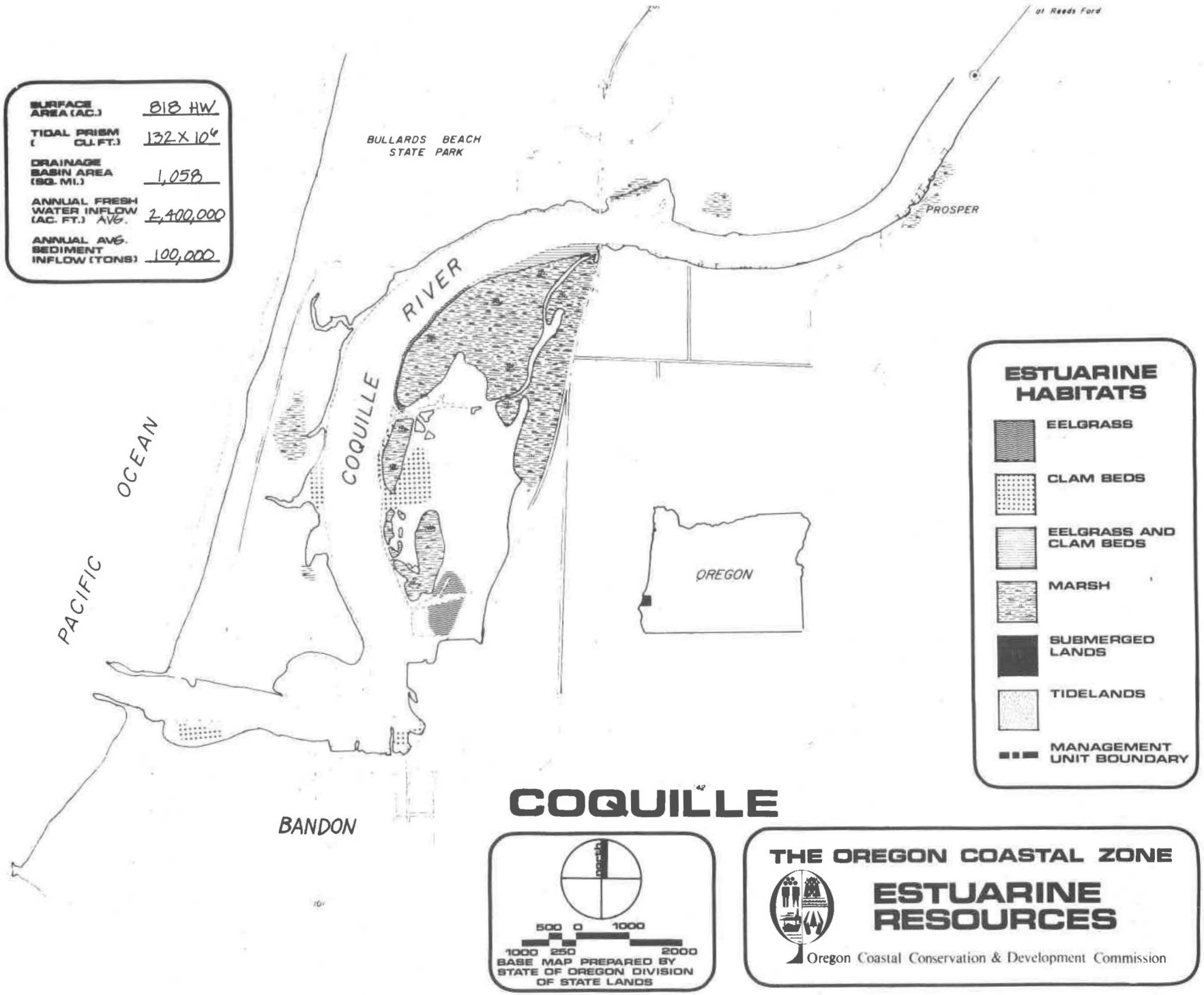


CATCHING SLOUGH - TYPE VI



SOUTH SLOUGH, NORTH SLOUGH, HAYNES INLET - TYPE VII




SURFACE AREA (AC.) 818 HW
TIDAL PRISM (CU. FT.) 132 X 10^6
DRAINAGE BASIN AREA (SQ. MI.) 1,058
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG. 2,400,000
ANNUAL AVG. SEDIMENT INFLOW (TONS) 100,000
BULLARDS BEACH STATE PARK
at Reeds Ford
PROSPER
COQUILLE RIVER
PACIFIC OCEAN
OREGON
BANDON
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
COQUILLE
north
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

COQUILLE RIVER

BIOPHYSICAL ELEMENTS

The Coquille estuary falls within Estuary Type X.

The Coquille estuary covers an area of approximately 760 acres and it drains a watershed of 1,058 square miles. The average discharge at the mouth is 3,300 c.f.s. Sedimentation is high with approximately 100,000 tons transported into the estuary each year. Large areas have been silted over since 1895.

On the north side of the estuary fairly well stabilized dune sand is present. To the south an old uplifted beach terrace which is locally subject to sliding extends down the coast line. North of Bandon and east of the estuary periodically flooded marshes border the estuary.

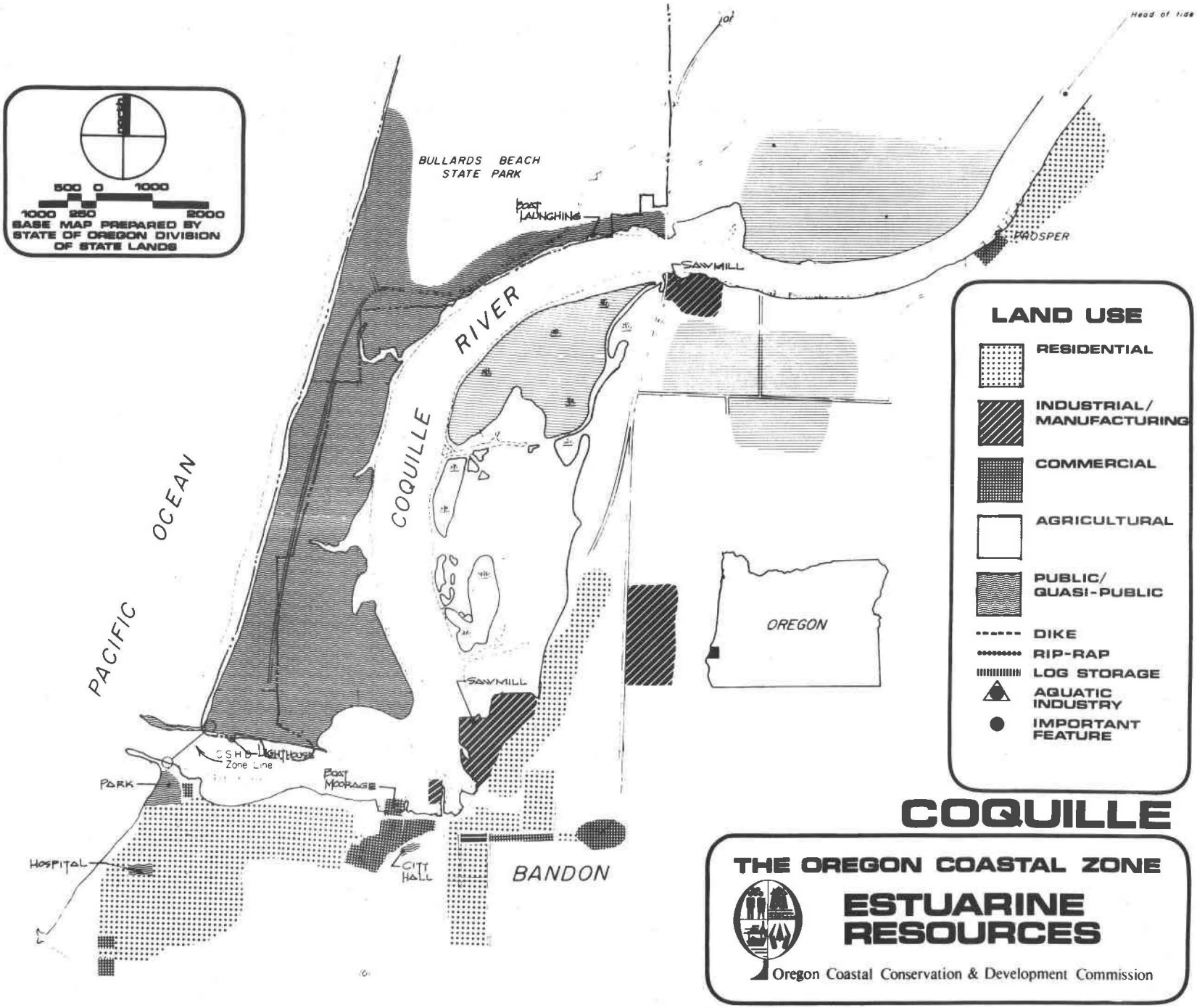
The Coquille River estuary provides valuable shad and salmon rearing grounds and supports large populations of shad, striped bass and perch. The bay is an important waterfowl wintering area, supporting about 40,000 waterfowl use days annually. It's shorelands provide valuable big game winter range.

HUMAN USE ELEMENTS

The economy of the Coquille River estuary is closely tied to lumber processing and transporting, although Bandon's small mills and port facilities have no competitive advantages over nearby Coos Bay. It is expected that the volume of lumber manufacturing will decrease due to the economies of scale available at plants in Coos Bay. River conditions often prevent efficient barge operations and local residents are fearful that due to these conditions, the mills will relocate in other ports. Poor bar conditions exist during the summer months, severely limiting the ability of commercial fishing vessels to gain access to the port.

A description of the intensity of existing human activities along the Coquille River estuary is provided in the use chart on the following page.

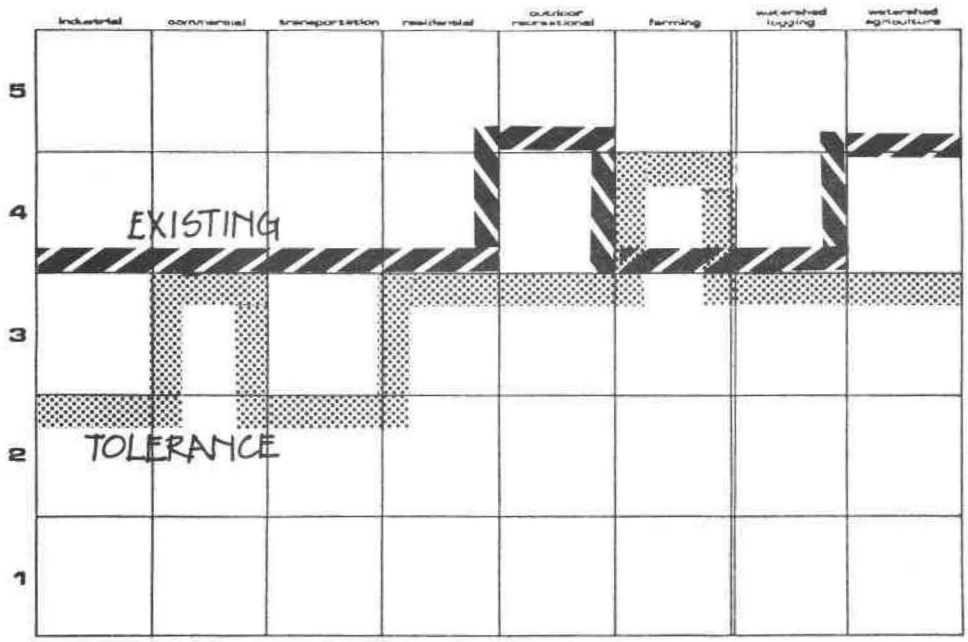
Two jetties and an entrance channel have been constructed within the Coquille River estuary and dredging averages 62,000 cubic yards annually. The entrance channel is maintained to a depth of 13 feet. There are approximately 55 acres of landfill on the estuary as reported by the State Division of Lands. These filled areas are currently being used for industrial and commercially oriented businesses and uses include dock facilities, residential areas, and a major mill site.


500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
BULLARDS BEACH STATE PARK
BOAT LAUNCHING
SAWMILL
PROSPER
Head of tide
COQUILLE RIVER
PACIFIC OCEAN
OREGON
SAWMILL
C.S.H.B. Lighthouse
Zone Line
PARK
BOAT MOORAGE
HOSPITAL
CITY HALL
BANDON
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
COQUILLE
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

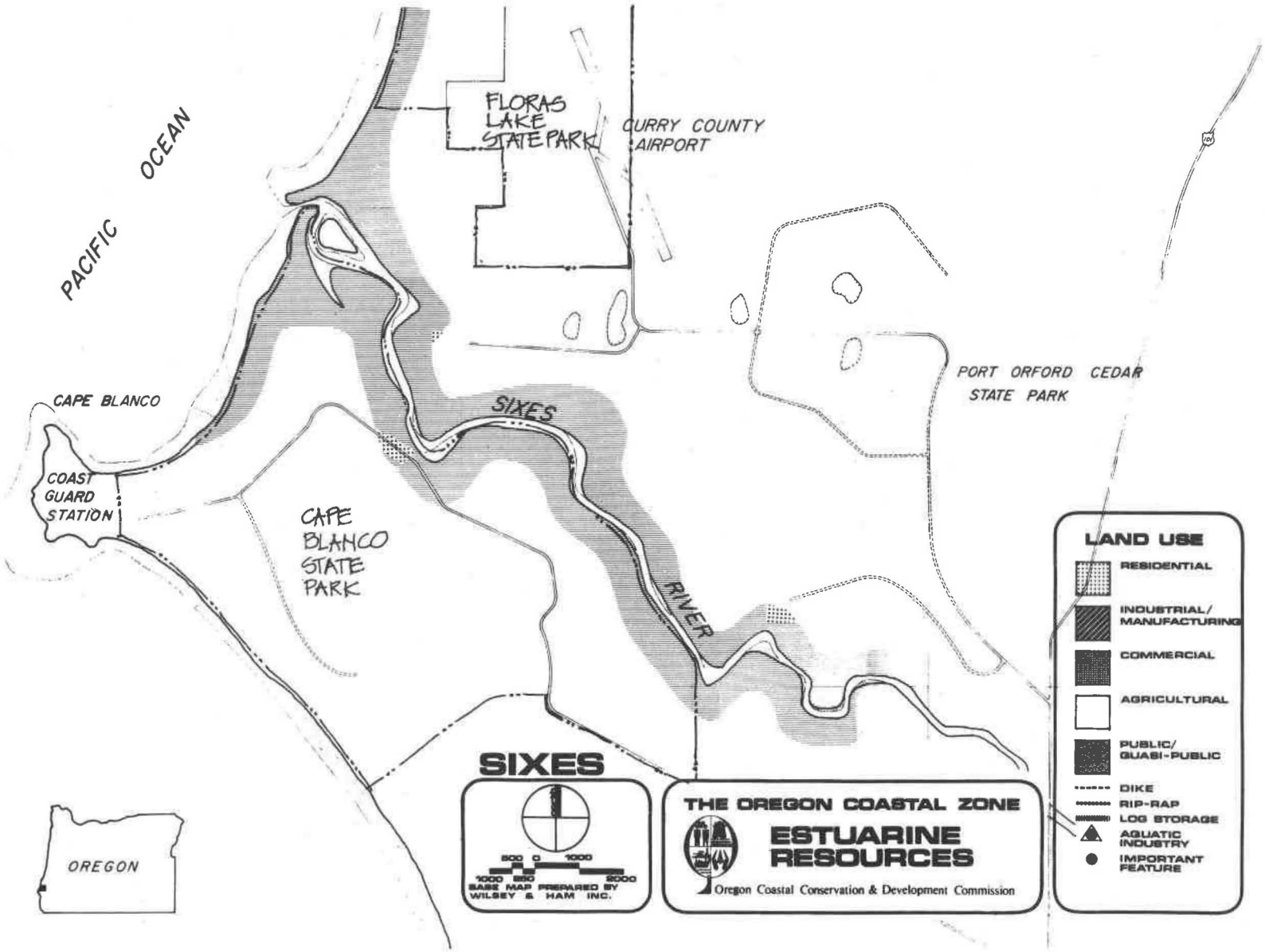
	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4					-Heavy sports fishing for salmon and trout -3 boat ramps and small boat basin located close to town -Clamming and crabbing popular -Bullards State Park fronts on estuary			
3	-2 medium lumber processing mills with coast-wide market -40% channel tonnage is processed wood products, 60% is log rafts -Small cheese processing plant with state-wide market -Fish processing plant ices catches for final processing elsewhere.	-Bandon commercial area located on Highway 101, serves as trade center for surrounding area. -Major or specialized items purchased in Coos Bay -Scattered tourist commercial along waterfront	-River channel through Bandon dredged to 13 feet. Jetties. Shallowdraft barges accommodated -Port facilities include wharf for loading lumber barges and small boat basin -Poor summer bar and river channel conditions -No east-west highway or rail transport	-2 major urban/suburban residential neighborhoods -Scattered residential along Coquille River west of Highway 101 -Scattered rural residential and occasional small neighborhoods upstream		-Flood plains, upstream of Bandon, heavy agricultural use -Livestock production and sales important to areas agricultural economy -Over 600 acres of cranberry bogs in area, national market		
2								
1								

COQUILLE RIVER ESTUARY

COQUILLE ESTUARY - TYPE X



EXPOSED INTERTIDAL ZONE ALONG SHIPPING CANAL IN COQUILLE ESTUARY


PACIFIC OCEAN
FLORAS LAKE STATE PARK
CURRY COUNTY AIRPORT
PORT ORFORD CEDAR STATE PARK
CAPE BLANCO
COAST GUARD STATION
CAPE BLANCO STATE PARK
SIXES RIVER
OREGON
SIXES
500 0 1000
1000 500 2000
BASE MAP PREPARED BY WILSEY & HAM INC.
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE

SIXES RIVER

BIOPHYSICAL ELEMENTS

The Sixes River is a Type I Estuary.

The estuary of the Sixes River is relatively small having an area of approximately 330 acres and a drainage basin of 129 square miles. Average stream flow taken at river mile 5.3 is 646 c.f.s. and much of the summer flow is subsurface due to the coarse nature of the sediments in the streambed. The Sixes River has a better developed floodplain than most of the other units in Estuary Type 1. Sedimentation in response to watershed uses such as logging presents greater problems here than in other Type I estuaries.

As in most other estuaries of this type, low summer flows are the limiting factor for fish production. The Sixes River, however, is considered to be one of the most important fall chinook streams on the Oregon coast. No data was available describing the terrestrial biology of this estuary.

HUMAN USE ELEMENTS

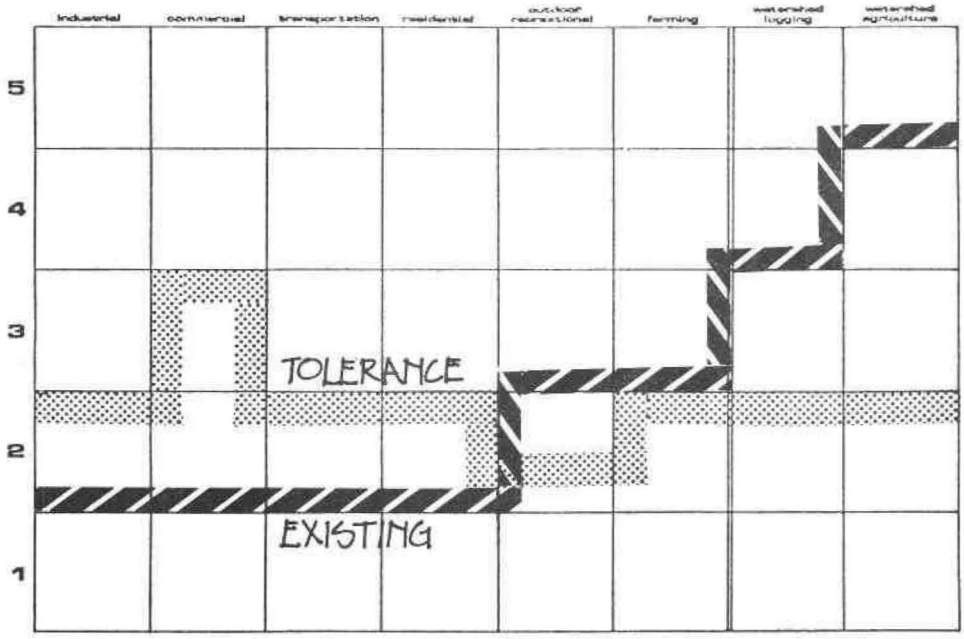
Irrigation, mining and gravel removal are the only known industrial uses on the Sixes River. Data on these activities is not available. The use chart on the following page illustrates the intensity of human activity within the estuary region.

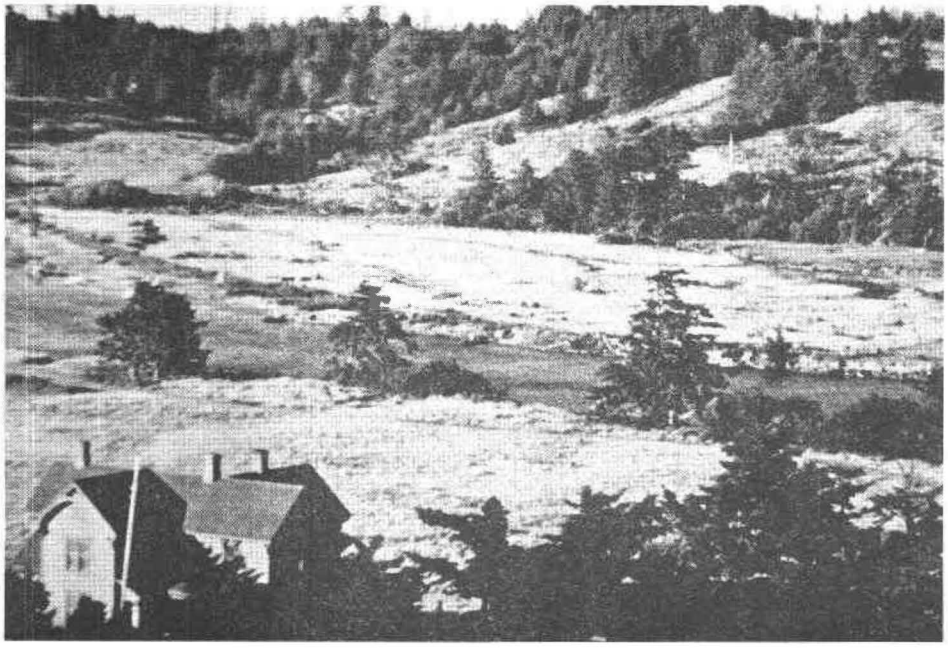
The Oregon Coast Highway Bridge (U. S. 101) is the only existing physical alteration near the estuary.

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3								
2					-Limited sports fishing -State parks in proximity	-Irrigation of pasture land -Scattered grazing		
1	-Gravel removal	-No commercial activity	-No water borne transport on Sixes River -Limited road access to shoreline	-Widely scattered rural residential				

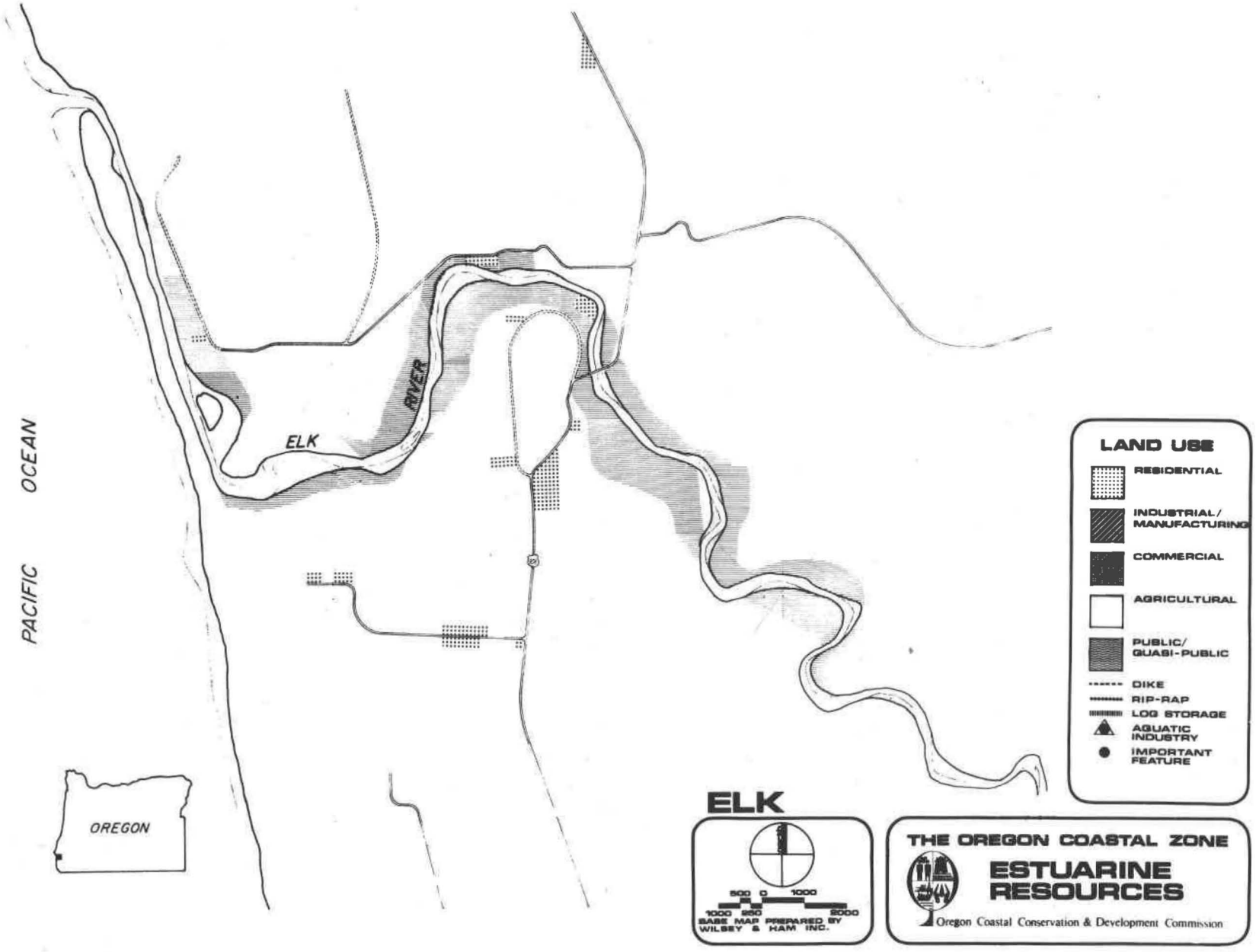
SIXES RIVER ESTUARY

SIXES RIVER ESTUARY - TYPE I





LIVESTOCK GRAZING ALONG SIXES RIVER


PACIFIC OCEAN
ELK
RIVER
OREGON
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
ELK
500 0 1000
1000 250 2000
BASE MAP PREPARED BY WILSEY & HAM INC.
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

ELK RIVER

BIOPHYSICAL ELEMENTS

Elk River is a Type I Estuary.

The mouth of the Elk River is constantly changing as sand is moved back and forth across the beach face. In the summer sand blocks off the estuary from the influence of saline water except during periods of very high tide. Approximate area of the estuary is 290 acres. Drainage basin size is 94 square miles.

Large cobbles and small boulders are being transported to the estuary by the Elk River at times of high flow. However, according to the Oregon State Game Commission, there is a shortage of spawning gravel. Average flow rate for the Elk at river mile 3.2 was 610 c.f.s. for the period October 1967 - June 1970.

Extensive logging in the watershed probably causes an accumulation of fine sediments in the stream channel and estuary during periods of low and moderate streamflow, although much of this material may be expelled during periods of high flow. Mud flats are not present in this estuary.

The Elk River is important as a juvenile rearing ground for chinook salmon during the summer months. Limited information is available concerning wildlife habitats and populations, although it is known for an occasional siting of sea otter at its mouth.

HUMAN USE ELEMENTS

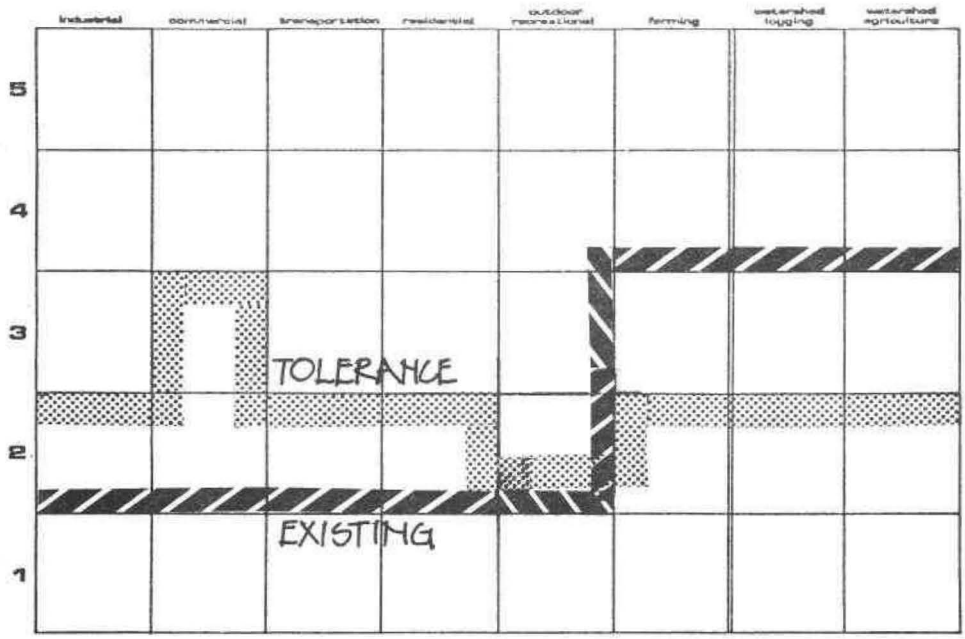
The Elk River estuary is characterized by low intensity residential and agricultural uses. The human activities occurring on the estuary are described in the following human use chart.

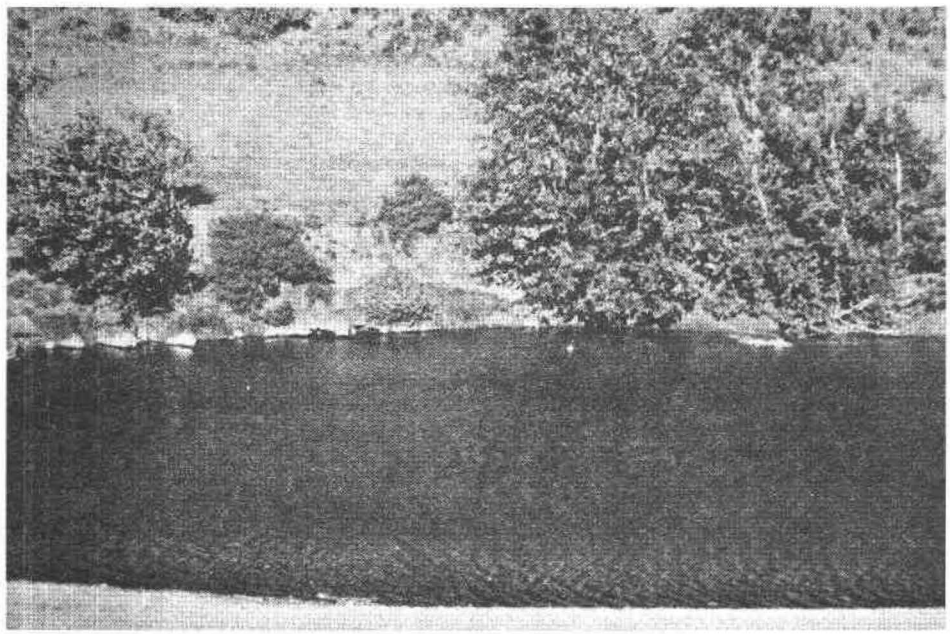
The Oregon Coast Highway (U.S. 101) Bridge, a plywood mill and a fish hatchery are the only physical alterations near the estuary.

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3						Agricultural activity primarily grazing Small, scattered farming units		
2								
1	-No industrial activity exists along the Elk River	-No commercial activity exists along the Elk River	-No access to estuary mouth or most of shoreline areas -Highway 101 crosses Elk River upstream -Unimproved roads lead to few residences located along estuary	-Scattered rural residential	-Sports fishing is popular among local residents -Recreation limited since only minor access to estuary			

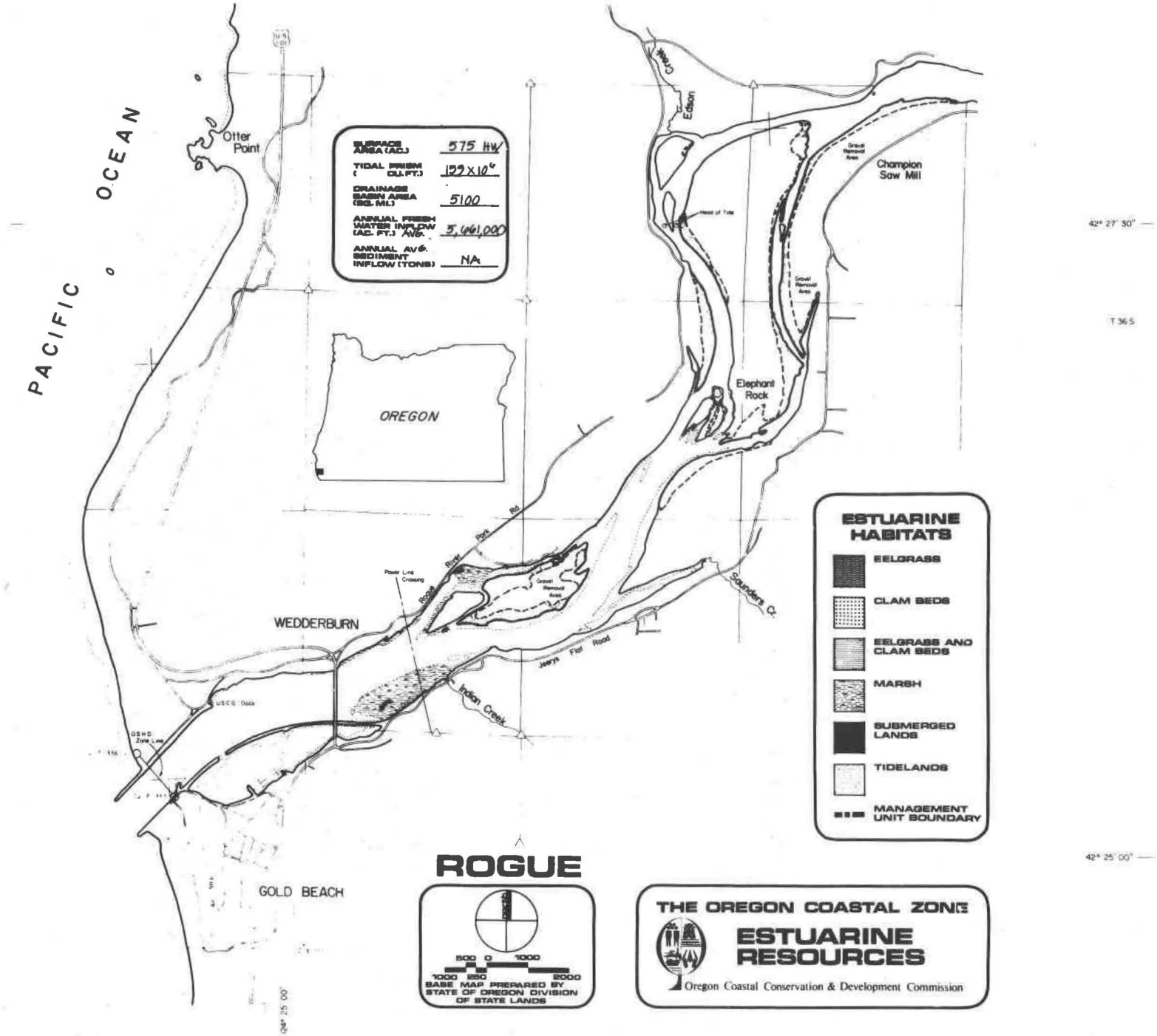
ELK RIVER ESTUARY

ELK RIVER - TYPE I





NARROW STREAM CHANNEL CHARACTERISTIC OF ELK RIVER


PACIFIC OCEAN
Otter Point
SURFACE AREA (AC.) 575 HW
TIDAL PRISM (CU. FT.) 129 X 10^6
DRAINAGE BASIN AREA (SQ. MI.) 5100
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG. 5,661,000
ANNUAL AVG. SEDIMENT INFLOW (TONS) NA
OREGON
Edson Creek
Champion Saw Mill
Elephant Rock
Port Rd
Rogue
Power Line Crossing
WEDDERBURN
Jerry's Flat Road
Indian Creek
Saunders Cr.
USCG Dock
OSHD Zone Line
GOLD BEACH
124° 25' 00"
42° 27' 30"
T 36 S
42° 25' 00"
ESTUARINE HABITATS
EELGRASS
CLAM BEDS
EELGRASS AND CLAM BEDS
MARSH
SUBMERGED LANDS
TIDELANDS
MANAGEMENT UNIT BOUNDARY
ROGUE
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

ROGUE RIVER

BIOPHYSICAL ELEMENTS

The Rogue River is a Type XI Estuary.

The Rogue River differs significantly from the other Type XI Estuaries in that it has a much larger drainage basin (5,100 square miles), a higher fresh-water inflow (mean discharge 7,800 c.f.s.) and does not have an associated bay. The lack of a bay, the relatively steep stream gradient, and the east-west orientation of the mouth, allow the tidal energy and the stream energy to be effective at flushing sediments out of the estuary especially during periods of high river flow. During times of lower river flow sediment may accumulate between the jetties. Flood waters are very important in flushing the channel of sediment.

Extensive siltation has occurred in the marina due to the presence of quieter water where suspended sediment can be deposited. The mouth of the marina appears to trap substantial amounts of sediment.

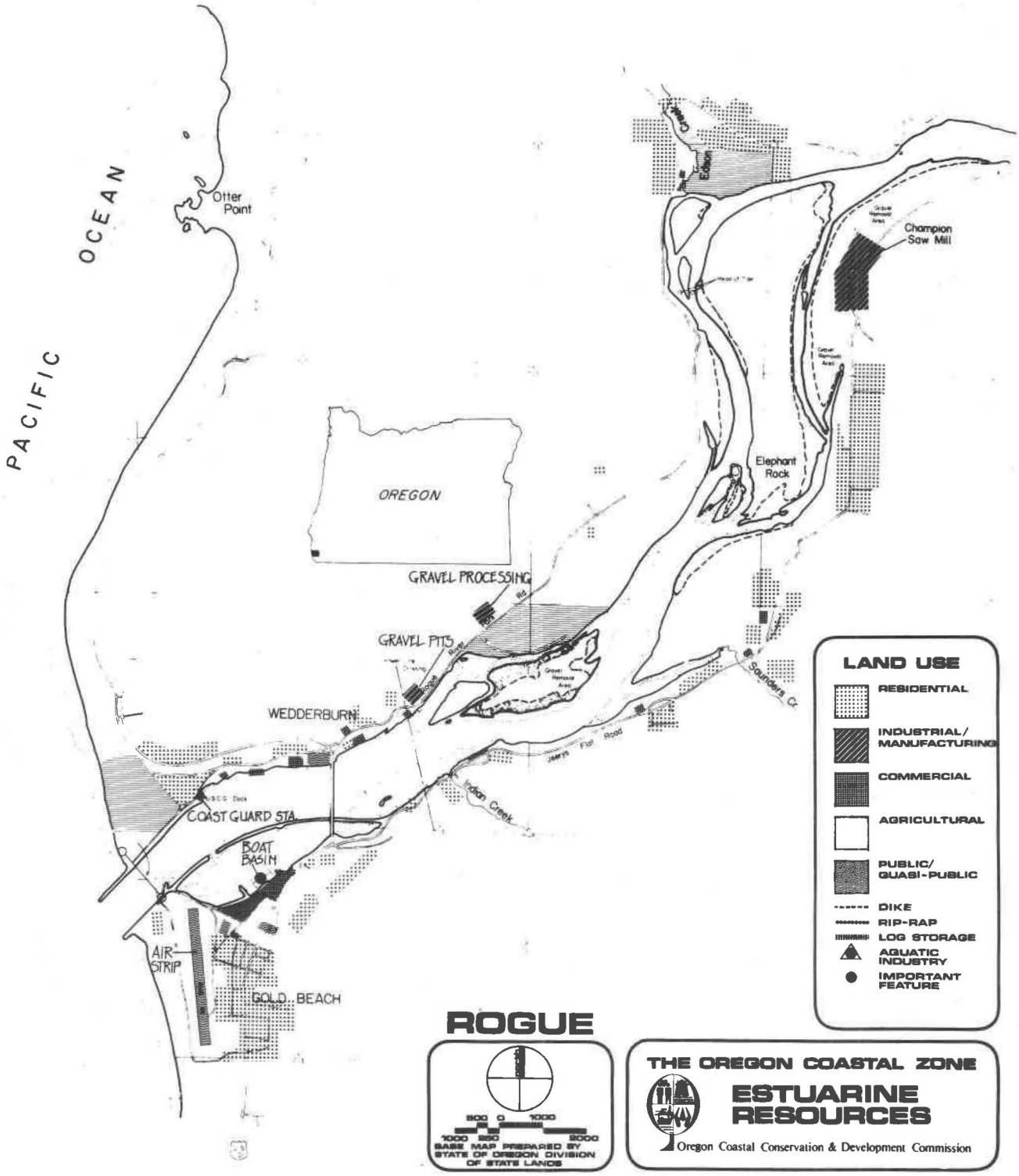
The Rogue River is an extremely important spawning ground for anadromous fish and supports the highest number of fall chinook and winter and summer steelhead in Oregon's estuaries. The most significant terrestrial biological feature of the Rogue River estuary is it's population of brown pelicans which are attracted to the estuary in the summer.

HUMAN USE ELEMENTS

Timber, offshore commercial fishing and recreation are the important economic components of the Rogue River estuary. Wood processing at Gold Beach is, however, facing the same dilemma as that of Brookings and Bandon as timber harvests from private lands decrease. The human use chart on the following page illustrates the level of human activities along the estuary.

Physical alterations constructed in the Rogue River estuary include two jetties, a turning basin and a channel from the entrance to the turning basin. The channel and the turning basin are maintained to a depth of 13 feet. Information on the level of dredging within the estuary is not available

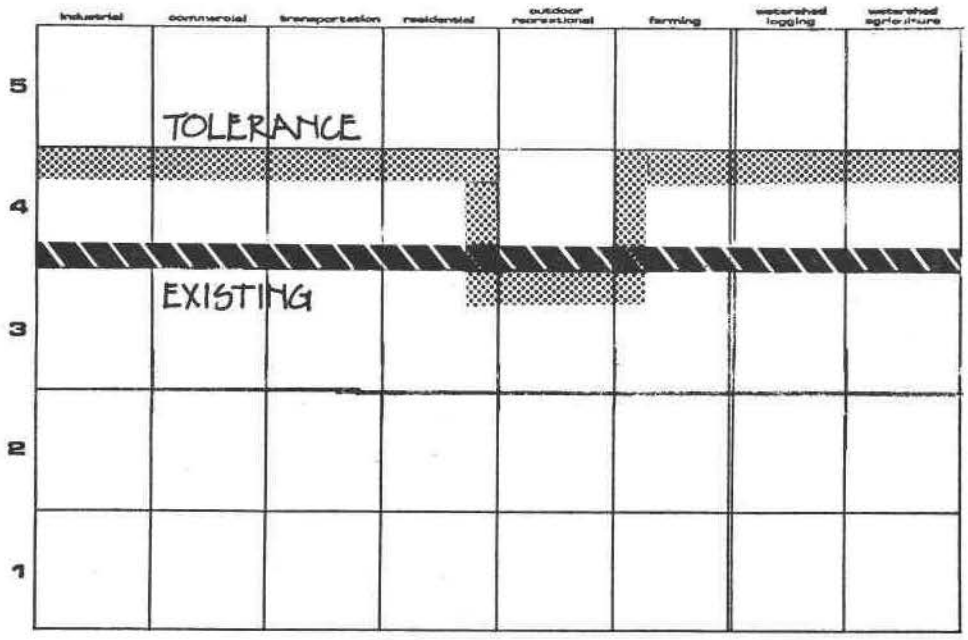
Landfill on submerged and submersible lands within the Rogue River estuary totals 27 acres. Major use of the fill has been for the construction of dock facilities, marinas and a breakwater.

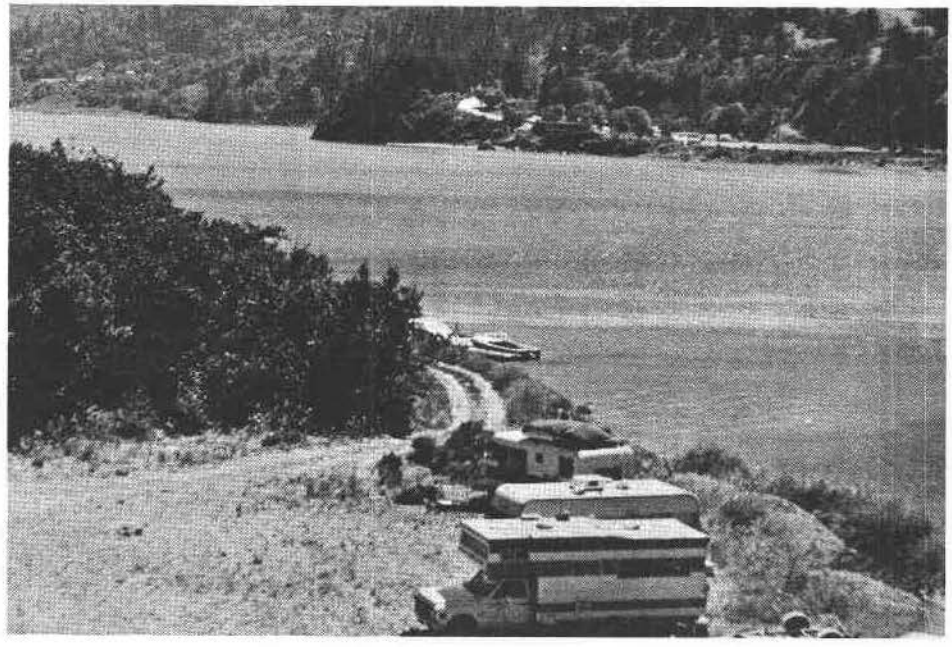

PACIFIC OCEAN
Otter Point
OREGON
GRAVEL PROCESSING
GRAVEL PITS
WEDDERBURN
COAST GUARD STA.
BOAT BASIN
AIR STRIP
GOLD BEACH
Indian Creek
Jerry's Flat Road
Elephant Rock
Champion Saw Mill
Saunders Cr.
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
ROGUE
500 0 1000
1000 2000 3000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3	-Large plywood mill up-river -Scattered small logging camps and contractors -Commercial fishing supports one cannery -Heavy sand and gravel mining	-Gold Beach commercial center for area -Scattered tourist-commercial at Gold Beach and Wedderburn	-13 foot deep channel, 300 feet wide with jetties and turning basin -90 % of 106,000 tons of waterborne goods are lumber -Small boat basin and break-water at Gold Beach -Airport at Gold Beach -Highway 101 through Gold Beach	-Neighborhood clusters in Gold Beach -Scattered residential Wedderburn -Scattered rural residential up-river	-Popular steelhead salmon fishing. Some hunting -Small boat basin in Gold Beach -Boat launching and moorage in Wedderburn -Charters available at Gold Beach	-Limited farming, most agriculture oriented to-wards pasture -Beef and dairy cattle -Scattered grazing along up-river area		
2								
1								

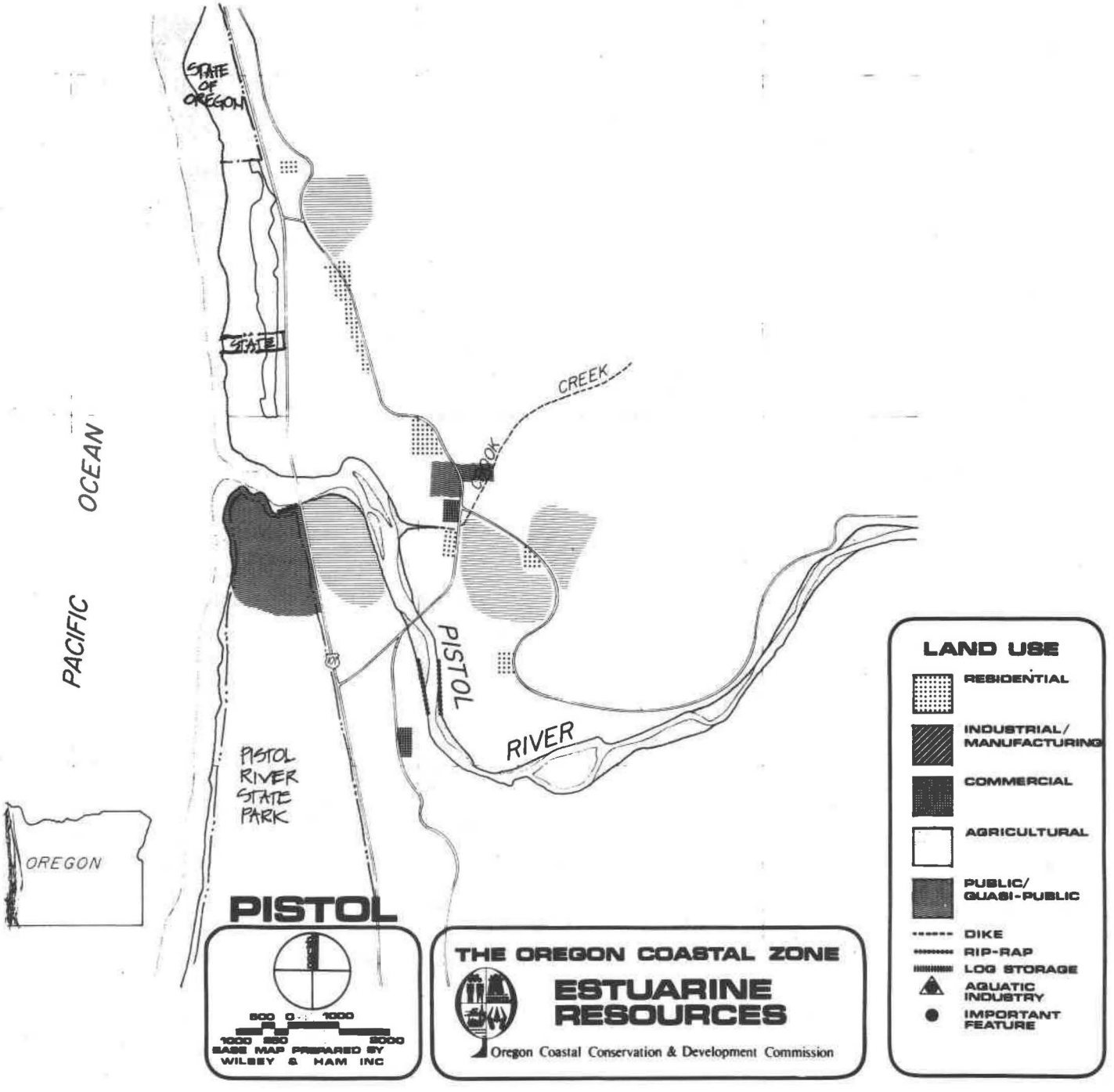
ROGUE RIVER ESTUARY

ROGUE RIVER - TYPE XI





BOAT LAUNCH ON ROGUE RIVER


STATE OF OREGON
STATE
CREEK
CROOK
PACIFIC OCEAN
PISTOL
RIVER
PISTOL RIVER STATE PARK
OREGON
PISTOL
500 0 1000
1000 500 2000
BASE MAP PREPARED BY WILSEY & HAM INC
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE

PISTOL RIVER

BIOPHYSICAL ELEMENTS

The Pistol River is a Type I Estuary.

The Pistol River is closed to the ocean during a portion of the summer except at very high tide. Gravels are delivered to the estuary by the river, and much of the summer flow may be beneath the surface of the stream bed due to the coarse nature of the sediments. The estuary bottom near the mouth is 80% sand/20% gravel, while farther upstream the bottom is principally gravel with some logs and other debris.

The Pistol River provides important rearing grounds for chinook salmon. No data was available regarding terrestrial biology.

HUMAN USE ELEMENTS

The Pistol River basin is characterized by low intensity residential, commercial and agricultural activity. The level of human activity is described in the use chart on the following page.

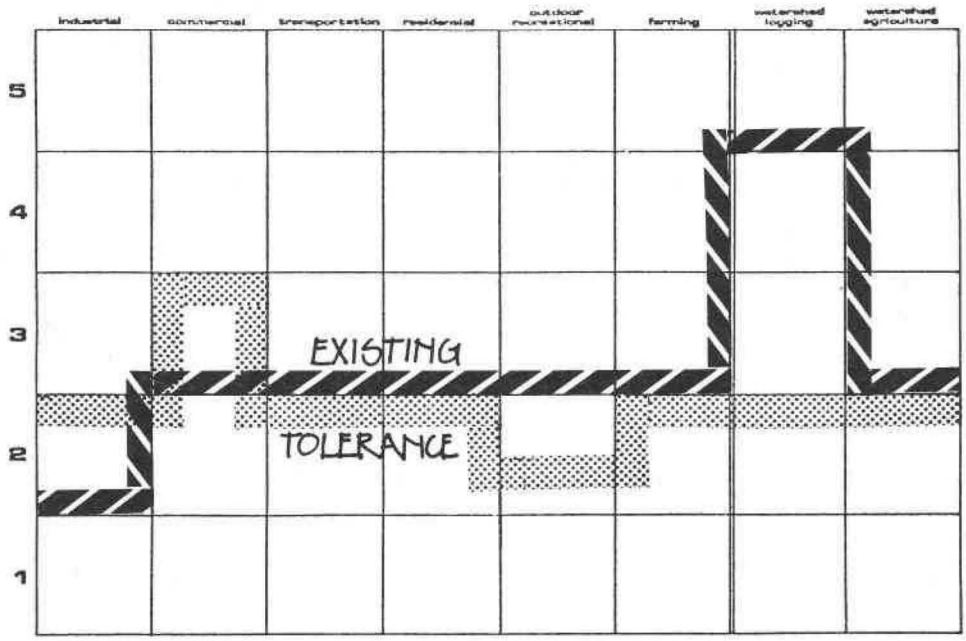
The only physical alteration near the estuary is the Oregon Coast Highway Bridge (U. S. 101).

HIGHWAY 101 CROSSING PISTOL RIVER

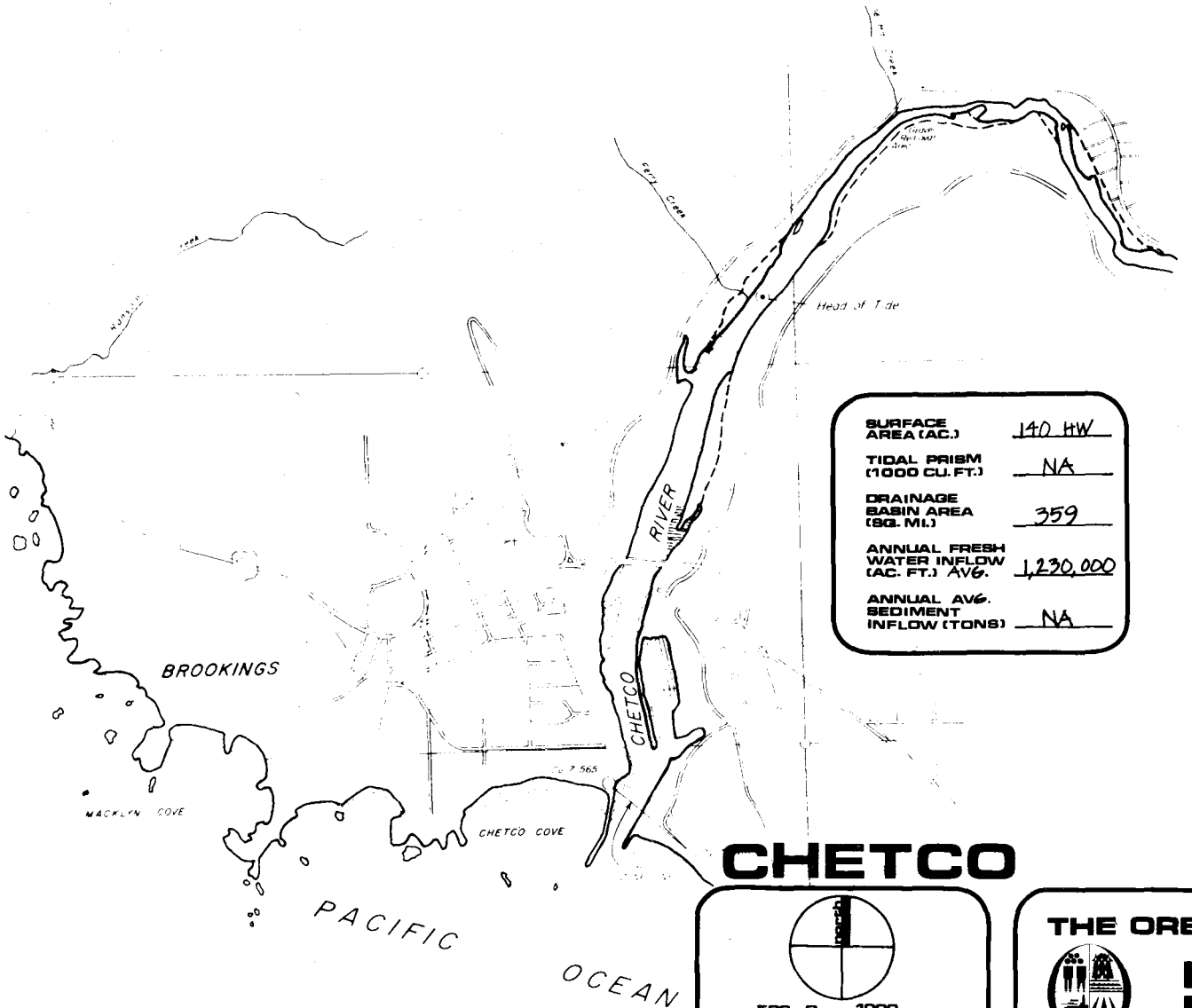
	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3								
2		-Small commercial center	-No water borne transportation -Highway 101 crosses estuary near its mouth	-Scattered rural residential -Mixed suburban residential	-Sports fishing limited due to low river flows -Highway 101 provides good access for beach activities -Small state park adjacent to estuary mouth	-Irrigation of pasture land -Scattered grazing		
1	-Limited gravel mining							

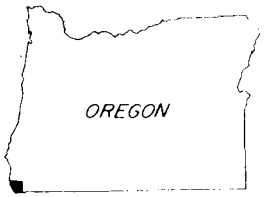
PISTOL RIVER ESTUARY

PISTOL RIVER - TYPE I



RESIDENTIAL AND GRAZING USES ALONG PISTOL RIVER





SURFACE AREA (AC.)	140 HW
TIDAL PRISM (1000 CU. FT.)	NA
DRAINAGE BASIN AREA (SQ. MI.)	359
ANNUAL FRESH WATER INFLOW (AC. FT.) AVG.	1,230,000
ANNUAL AVG. SEDIMENT INFLOW (TONS)	NA

ESTUARINE HABITATS

- EELGRASS
- CLAM BEDS
- EELGRASS AND CLAM BEDS
- MARSH
- SUBMERGED LANDS
- TIDELANDS
- MANAGEMENT UNIT BOUNDARY

CHETCO

500 0 1000
1000 250 2000

BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS

THE OREGON COASTAL ZONE

ESTUARINE RESOURCES

Oregon Coastal Conservation & Development Commission

CHETCO RIVER

BIOPHYSICAL ELEMENTS

The Chetco River estuary has physical characteristics that are similar to Type I Estuaries. It was included within Estuary Type VIII on the basis of biologic and mixing information. The estuary is small (approximately 140 acres) and is confined to the vicinity of the channel. The drainage basin extends over 359 square miles and the stream gradient is the highest of any of the rivers under discussion. A substantial number of sand and gravel operators are located upstream from the estuary mouth.

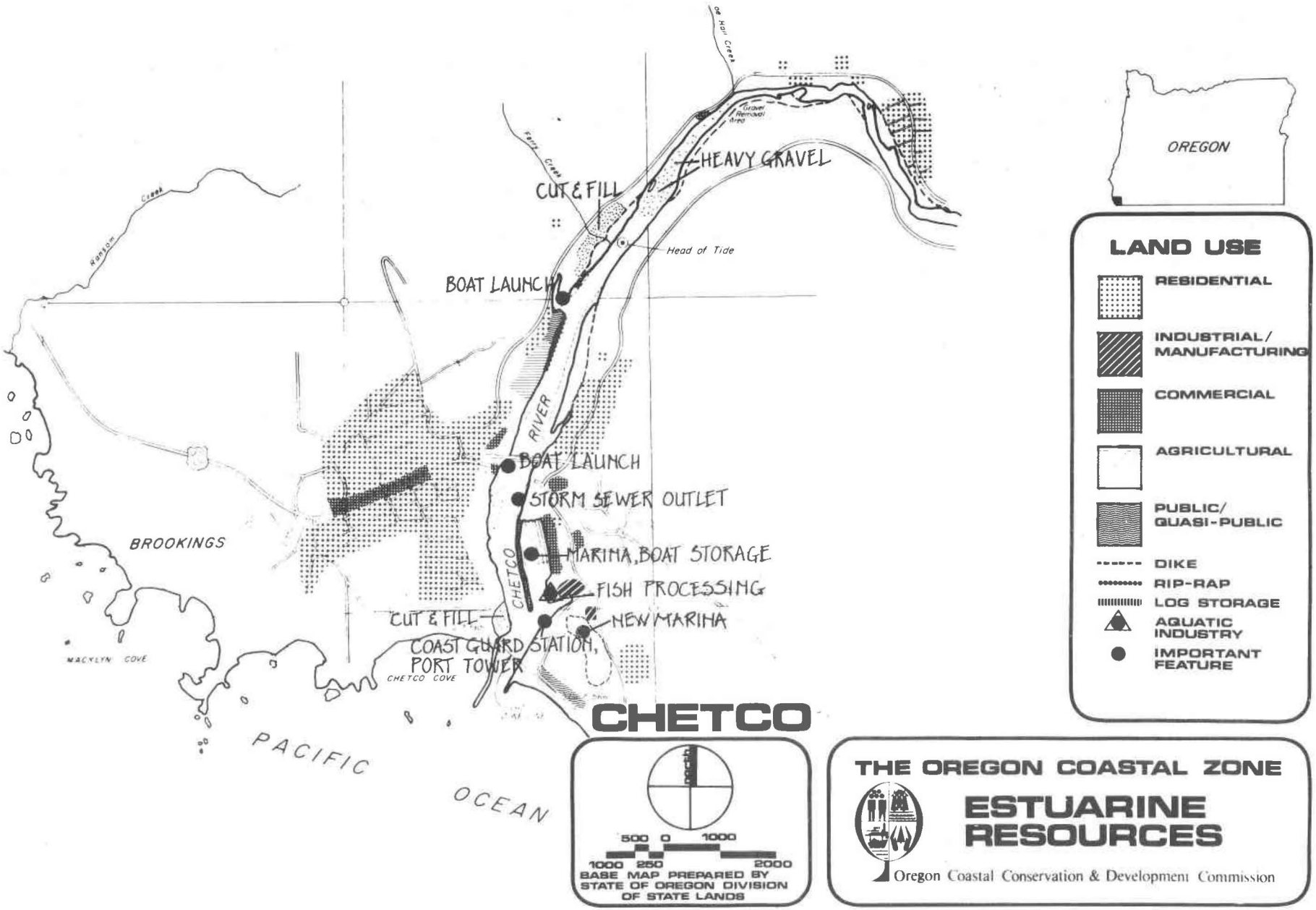
The Chetco River estuary provides important rearing grounds for chinook salmon, and northern anchovies are also an important segment of the fish population. Waterfowl and wildlife use of the estuary is light. Brown pelicans are drawn to the estuary due to the anchovies found here.

HUMAN USE ELEMENTS

The economy of the region surrounding the Chetco River is primarily dependent upon forest products and their processing, although tourism is the fastest growing sector of the local economy. Timber harvests from private lands have been decreasing steadily, while cuts from public lands have increased in compensation. Due to the existing transportation limitations of the Chetco River region, the local forest industries will not be in a favorable competitive position to keep logs from being processed in other ports such as Coos Bay and Reedsport. As log supplies decrease, competition between regional mills can be expected to increase greatly.

The use chart on the following page depicts the existing level of human activity on the Chetco River estuary.

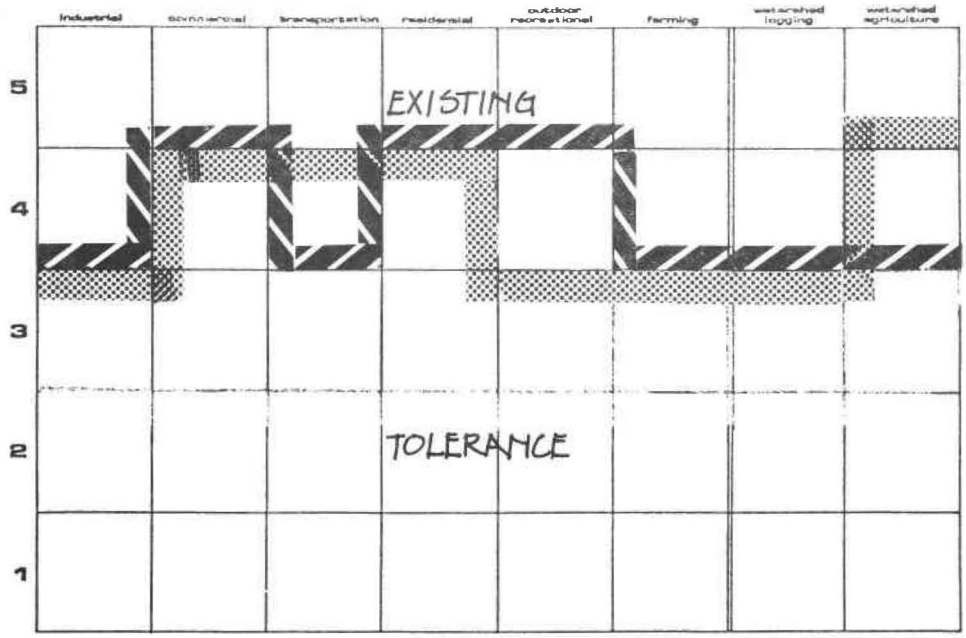
Physical alterations to Chetco Bay consist of construction of jetties, an entrance channel maintained to 14 feet in depth, a small boat basin and protective dikes. There are a little over 5 acres of landfill on submerged and submersible lands which have been used for creation of docking facilities for recreational and commercial boats.

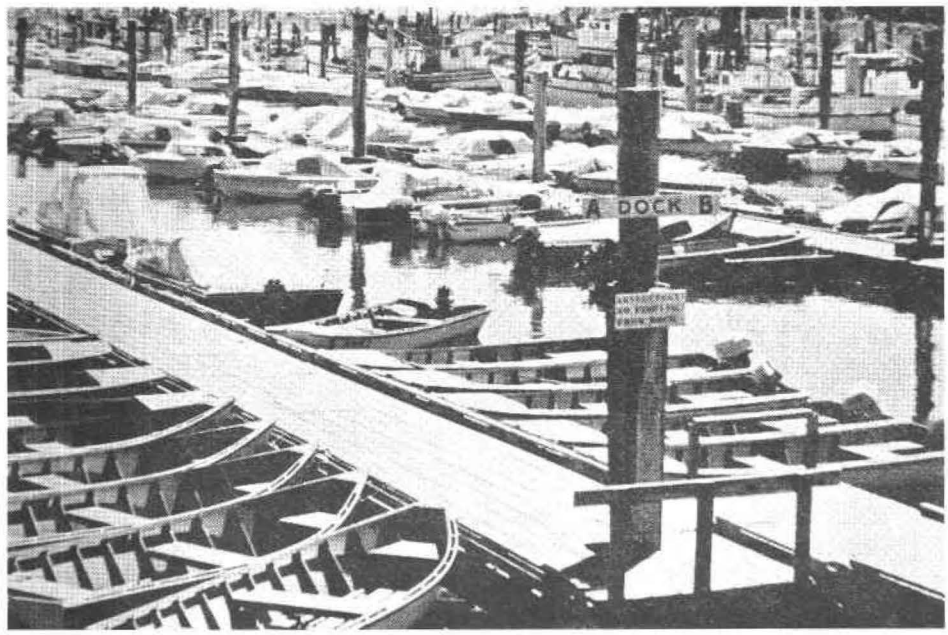

CHETCO
OREGON
LAND USE
RESIDENTIAL
INDUSTRIAL/ MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/ QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC INDUSTRY
IMPORTANT FEATURE
HEAVY GRAVEL
CUT & FILL
Head of Tide
BOAT LAUNCH
RIVER
BOAT LAUNCH
STORM SEWER OUTLET
MARINA, BOAT STORAGE
FISH PROCESSING
NEW MARINA
CUT & FILL
COAST GUARD STATION, PORT TOWER
CHETCO COVE
MACKLYN COVE
BROOKINGS
PACIFIC OCEAN
500 0 1000
1000 250 2000
BASE MAP PREPARED BY STATE OF OREGON DIVISION OF STATE LANDS
THE OREGON COASTAL ZONE
ESTUARINE RESOURCES
Oregon Coastal Conservation & Development Commission

	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4		-Downtown Brookings commercial area serves as regional trade center. Harbor shopping center draws 30% of volume from California residents -Increasing tourist services located on Highway 101 or along waterfront. Art gallery, restaurants and charter service existing major tourist commercial		-Brookings-Harbor population of 3,600 housed in urban-suburban neighborhoods -Scattered residential development characterizes upstream river banks	-Recreation is 2nd largest and fastest growing industry in Curry County -Excellent steelhead and salmon runs -Port owns one small boat basin, second under construction -Private moorage and launching facilities along estuary -Charter services			
3	-1 major, 2 medium lumber processing mills on estuary in Brookings. Products barged or trucked to intrastate and southern California markets -3 small seafood plants processing local catches with Oregon and northern California markets		-120 foot wide channel dredged to 14 feet. North and south jetties -Moderate barge traffic (100,000 tons annually) -Barge turning basin -Small boat basin -Highway 101 runs through Brookings and Harbor -No rail transport or east-west highway			-Primarily dairy use on agricultural lands -Livestock sales rapidly growing with primary market outside Coos-Curry Counties -Lily bulbs economically important specialty crop -Artichoke crop increasingly important		
2								
1								

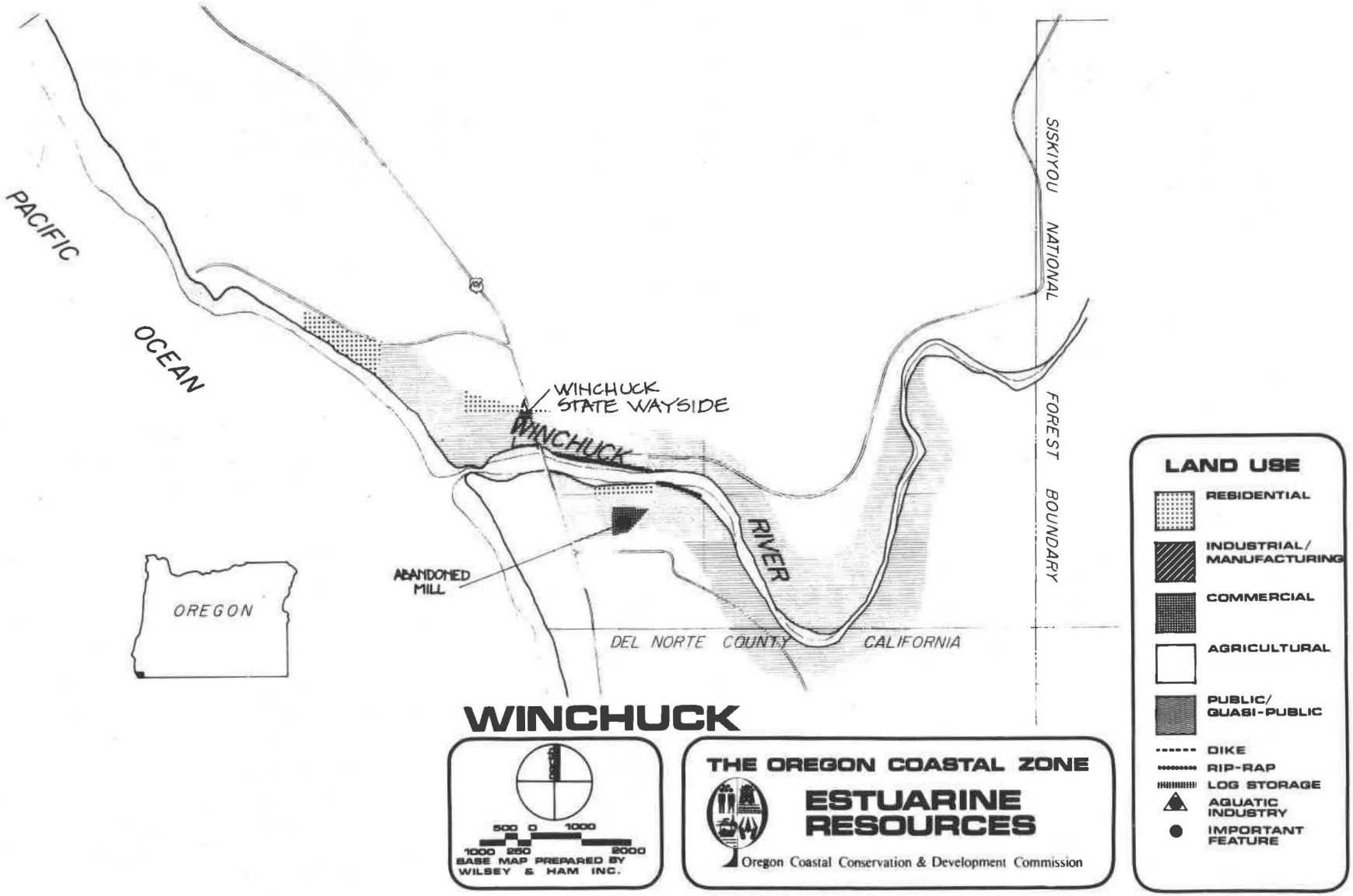
CHETCO RIVER ESTUARY

CHETCO RIVER ESTUARY - TYPE VIII





MARINA FACILITIES WITHIN THE CHETCO ESTUARY


PACIFIC
OCEAN
OREGON
WINCHUCK
STATE WAYSIDE
WINCHUCK
RIVER
ABANDONED
MILL
DEL NORTE COUNTY
CALIFORNIA
SISKIYOU NATIONAL FOREST BOUNDARY
LAND USE
RESIDENTIAL
INDUSTRIAL/
MANUFACTURING
COMMERCIAL
AGRICULTURAL
PUBLIC/
QUASI-PUBLIC
DIKE
RIP-RAP
LOG STORAGE
AQUATIC
INDUSTRY
IMPORTANT
FEATURE
500 0 1000
1000 250 2000
BASE MAP PREPARED BY
WILSEY & HAM INC.
THE OREGON COASTAL ZONE
ESTUARINE
RESOURCES
Oregon Coastal Conservation & Development Commission

WINCHUCK

WINCHUCK RIVER

BIOPHYSICAL ELEMENTS

The Winchuck is a Type I Estuary.

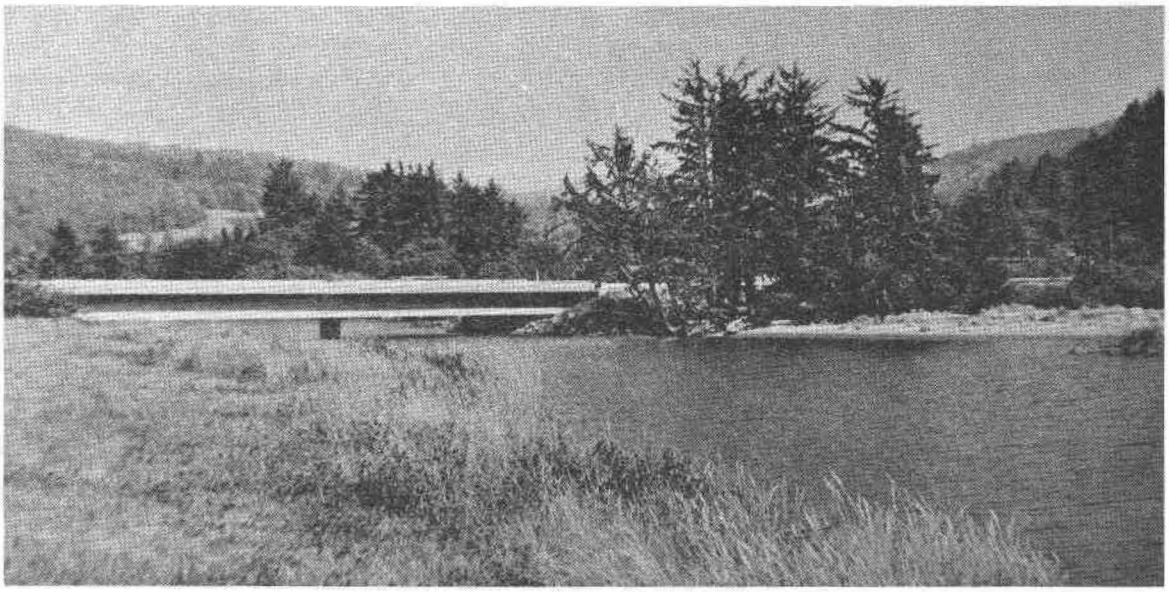
The estuary of the Winchuck River is small, having a surface area of 130 acres and a drainage basin size of 70 square miles. The mouth of the estuary is closed during the summer and much of the summer flow is subsurface due to the coarse nature of the bottom sediment.

The streams within the Winchuck basin are noted for their excellent spawning gravel and are heavily used by adult anadromous salmonids. Detailed information is not available concerning terrestrial wildlife populations.

HUMAN USE ELEMENTS

Suburban residential housing appears to be the major use of the area surrounding the Winchuck River. Little data was available on the region and the existing level of human activity is described in the use chart on the following page.

The only physical alteration near the estuary is the Oregon Coast Highway Bridge (U.S. 101).

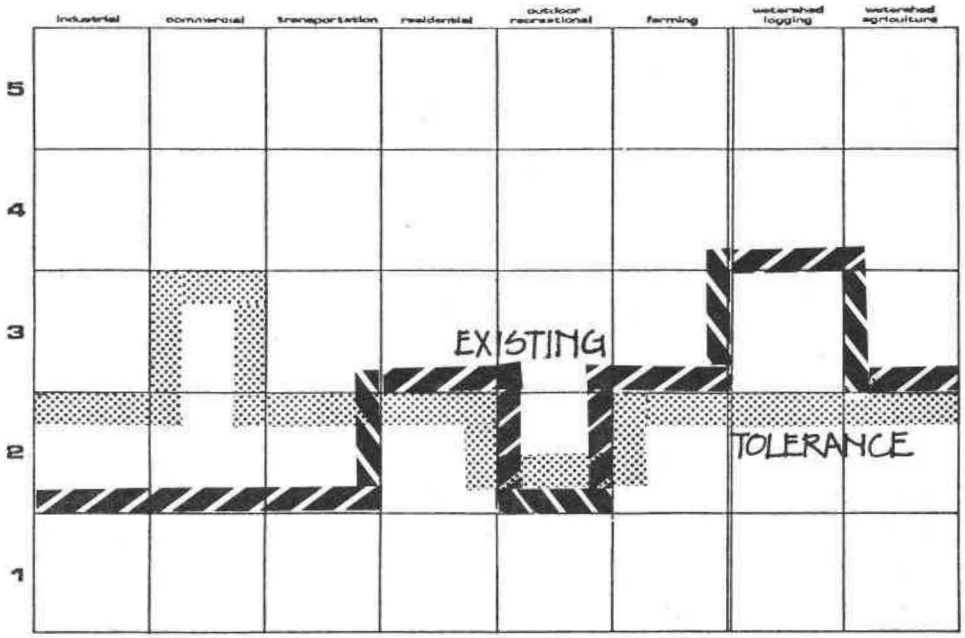


HIGHWAY 101 CROSSING WINCHUCK RIVER

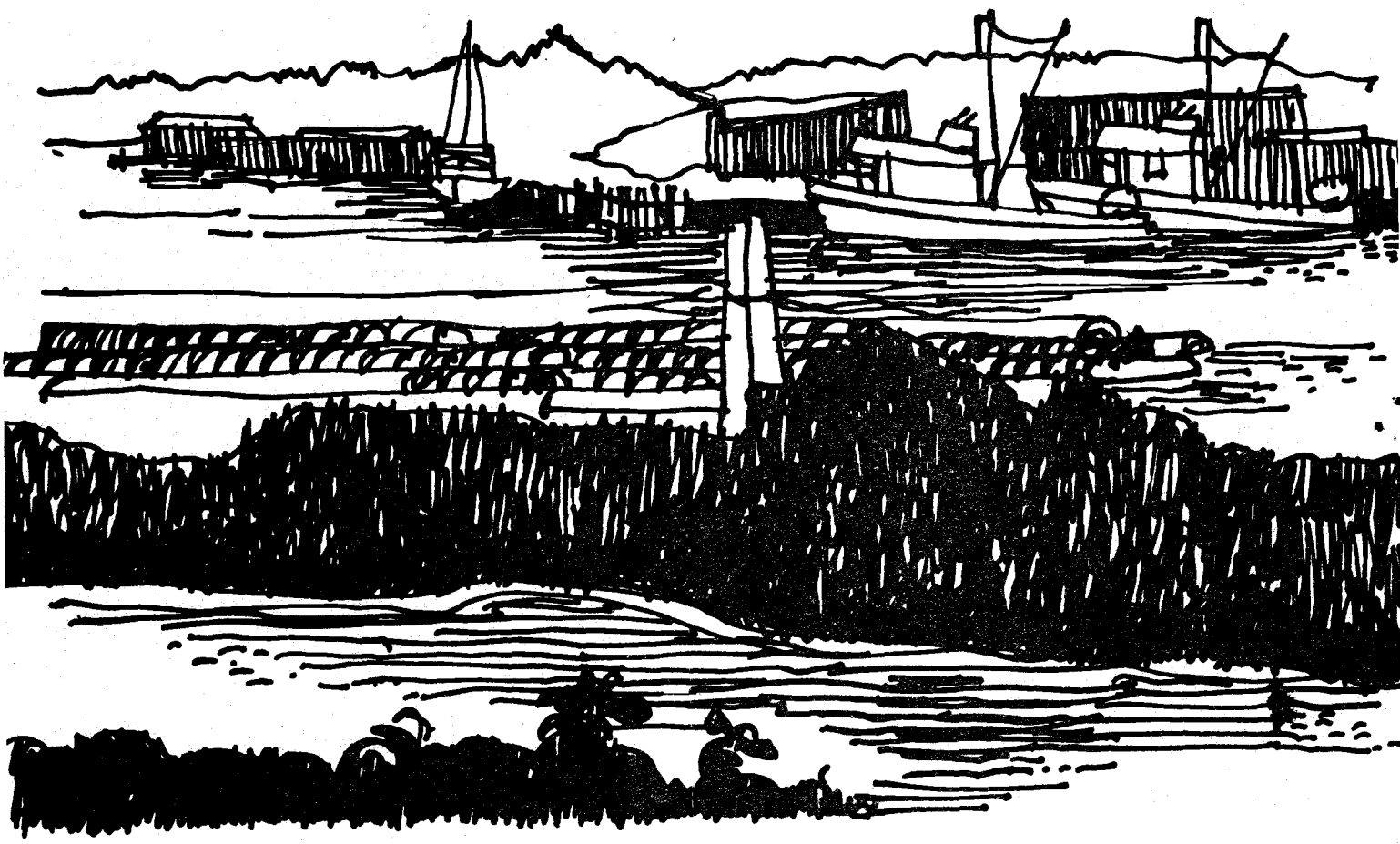
	industrial	commercial	transportation	residential	outdoor recreational	farming	watershed logging	watershed agriculture
5								
4								
3								
2				-Suburban residential housing clusters		-Irrigation of some pasture land -Scattered grazing		
1	-No industrial activity	-No commercial activity	-Highway 101 traverses river -Limited road access to estuary shorelines -No water borne transportation		-Sports fishing for anadramous salmonids			

WINCHUCK ESTUARY

WINCHUCK RIVER - TYPE I



UPSTREAM REACHES OF WINCHUCK RIVER



MANAGEMENT CONCEPTS

INTRODUCTION

To be a viable and productive biological system, an estuary must retain its basic integrity. The elements of a healthy, functioning system that insure this integrity have been extensively discussed in previous sections of the report. These include: physical form; the mixture of salt water and fresh water; tidelands and eelgrass beds; and marine and terrestrial wildlife habitats. These elements are also the resources which have stimulated human use of the estuaries. In fact, because of the resource value of estuaries, many have become critical focal points of the coastal economy, including transportation, industry and recreation. Yet the very amenities which make the estuaries important are being threatened by our use and over-use of them. All human activity has varying degrees of impact on the different estuaries in Oregon. Regardless of this, it is clear that our use of the estuaries must continue. How this use may continue to occur and, in selected situations even expand, without disrupting estuary integrity is a management problem.

This report presents a methodology to assist in the management of Oregon estuaries which is based on the classification of Oregon estuaries according to their bio-physical characteristics, it is also based on the evaluation of the intensity of the human uses of each estuary. This chapter shows how the analysis provided in this document can be tied to an identification of management needs and subsequently, what management "tools" are available to meet these needs.

I. THE TOLERANCE OF OREGON'S ESTUARIES TO HUMAN USE

The classification of Oregon's estuaries and their management units was achieved by establishing twelve hypothetical estuary types based on the previously described bio-physical characteristics. Then each of the 21 estuaries of Oregon and their respective management units were placed in one of the twelve hypothetical estuary types by matching the physical parameters of the units (type of physical form, mixing characteristics, extent of mudflats and eelgrass beds, and the character of the terrestrial and aquatic biology) as closely as possible to the physical parameters of the twelve hypothetical estuary types.

After fitting each estuary and its respective management units into the twelve estuary types, the intensity of human uses presently occurring at each estuary was compared to the established threshold of tolerance level for the corresponding estuary type. The result was a chart for each estuary and its subunits which illustrates the relationship of the estuary's existing human uses to its threshold of tolerance level. These charts readily point out the areas of human activity which fall above or below an estuary's threshold for tolerance and in so doing provide some valuable information for determining management guidelines. It must be noted however, that these charts are only adequate as indicators of relative estuary development and that development of specific management decisions will require careful analysis in each situation.

The threshold of tolerance charts define three distinct cases which may require individual management decisions: 1) those activities which have exceeded the threshold of the estuary and threaten to alter the estuary's

character, 2) those activities which appear to be in balance with the estuary and 3) those activities which occur at a level of intensity below the possible threshold of the estuary. If, for example, an estuary exhibits an equilibrium between residential use and the estuary's threshold of tolerance for such use, policy makers may consider either prohibiting future housing development along the shoreline, or may require construction of storm and sanitary sewers in any new development, in order to preserve that balance. In a second case, if the level of residential activity exceeds the threshold of the estuary for such uses, policy makers could consider construction of storm and sanitary sewer systems for the existing residences in order to lessen the impact of that activity upon the estuary.

The process by which the hypothetical thresholds of tolerance to human use were derived and the purposes for which they could be used are shown diagramatically on page 208.

II. MANAGEMENT ALTERNATIVES

Introduction

The above discussion summarizes how the methodology developed in this report leads to an identification of the threshold of tolerance for human use of Oregon's estuaries and management units. Once the threshold is compared to actual useage, then management decisions must be made by those who live and work in Oregon, as citizens, as policy makers and as public officials. This concluding section presents a brief discussion of the interests which must be balanced in order to establish what the objectives of management are to be. Then a variety of "tools" (i.e. permit systems, zoning, etc.) are compared in order to show their relative effectiveness, and how well such "tools" have worked in other situations.

Special Interests to be Balanced

In order to accomplish the management of Oregon's estuaries, a variety of special interests must be balanced. No management program will be successful unless it can appeal to interests at the individual, the local, and the regional and state levels. This discussion will briefly explore the interests to be balanced on each of these levels.

Individual Interests

Historically in this country, land use has been accomplished on an individual basis and the concept of private property rights has evolved. The concept of private property rights basically holds that people should have the right to do as they please on their own land. (Traditionally, the freedom, dignity and worth of the individual has been realized through the development of private property, entrepreneurship and decentralized decision making.) It should be noted that the concept of private property rights evolved at a time when the methods for land development were limited. Land was usually developed for personal use on a relatively small scale, versus the scale of some of the more ambitious land development projects being carried out today on the corporate level. Consequently, this has led some to question whether or not the concept of private property rights is still valid given that land can now be exploited on a much larger scale with potential effects on the environment being much greater than in previous times.

BIOPHYSICAL CONSIDERATIONS

Physical Form
Mixing
Eelgrass Beds & Mudflats
Terrestrial & Aquatic

HUMAN USE CONSIDERATIONS

Industrial
Commercial
Transportation
Residential
Outdoor Recreation
Farming
Watershed Logging
Watershed Agriculture

Twelve hypothetical estuary types based on combinations of the above parameters

Evaluation of the intensity of each use on a scale of one to five

Evaluation of the threshold of tolerance of each of the twelve estuary types for development

Analysis of Oregon's estuaries and management units by:

1) Categorization into estuary types
2) Evaluation of intensity of human use
3) Comparison of use to threshold of tolerance

MANAGEMENT NEEDS

If threshold for tolerance for use exceeds the existing intensity of use then more development could possibly be supported by the estuary.

If threshold of tolerance is lower than the existing intensity of use then the uses could be decreased in order to maintain the existing nature of the estuary.

If threshold for tolerance and the existing use coincides, then development could be maintained at its present level.

One primary problem with devising an estuary land use management program centers on the question of allowing individual land owners to exercise their notions of private property rights when it is possible that such individuals may have too limited a perspective regarding the effects of their activities. For example, a recent survey of residents of Siletz Bay revealed very few local property owners value the estuary as a resource of natural importance. Rather, they conceive the estuary as a means to accomplish personal economic goals. Those wanting development expressed the belief that the estuary was not being used to its optimum.

Local Interests

Beyond the individual estuary land use interests are the local use interests. Local interests are most frequently expressed through comprehensive plans and implemented with zoning laws. Zoning is a means of specifying limitations on the type and character of land uses allowable within a given jurisdiction. Increasingly there is concern that zoning has severe limitations.

Zoning is sometimes susceptible to special interest pressures and lack of a clear understanding of critical land use issues on the part of those administering zoning laws. Mechanisms which have been written into zoning ordinances to provide flexibility (variances, conditional uses and amendments) are sometimes manipulated in order to redirect previously formulated land use policies which the zoning was originally intended to implement.

Local interests sometimes conflict with regional interests. In an example in the State of Washington, local interests wanted to transform the Nisqually delta, an area of scientific and ecological value, into a deep water port. State economic studies confirmed the basic conclusion, already reached by environmental interests, that a deep water port was not justifiable. Local interests were only concerned with revenues to be generated and jobs to be created. This imbalance of interests precipitated the realization in Washington State that very few channels existed for inputing statewide and regional considerations into local planning processes.

Regional and State Interests

In Oregon, there are two additional interest levels involved with land use and resource management concepts. Regional interests are usually dealt with through agencies or organizations that have a special planning or advisory capacity, but seldom a strong administrative role. Councils of governments (COG's) and special entities created at the state level directed toward regional concerns, such as the OCC & DC, are examples of these. Both are similar in their advantages and disadvantages.

Land use and resource management issues at the regional or state levels are intended to be dealt with from a perspective which relates to broader based interests of people in Oregon. Land use management at the regional or state level is not necessarily a panacea, however. The basic problem is one of achieving sufficient communication of individual needs from all people who exist within the region in question, such that policies formulated truly address a balance of these needs. Many people question the effectiveness of the communication that is feasible at the regional or state level and some fear the possibility that special interest influence could occur unchecked because of the inaccessibility of the policy making body. When there is an inadequate communication of individual interests as input to broad regional land use policies, those charged with implementing such

policies may lose sight of a true balance of needs. In addition, land use management at the state or regional level, in many cases has resulted in an unwieldy procedural process. The multiplicity of permits, restrictions, plans and environmental considerations have created confusion.

Objectives of Estuary Management

Ideally, estuary land use and resource management is progressive and is an attempt to balance conflicting interests, needs and ecological limitations. These conflicts are almost always complex in nature. Due to the variety of interests involved, estuary management cannot be reduced to issues stated in simple terms such as the environment versus the economy.

There are many examples in law which affirm this last statement. Often in recent years, individuals or groups who are proponents of "environmental values" have succeeded in preventing proposed construction projects in locations that they perceive to be sensitive to environmental damage. Preventing development on a case by case basis simply shuffles development pressures to other locations which may be equally sensitive in environmental impact. Although a specific development may have been halted, the problem of how a viable living and working environment is going to eventually be provided for people with present needs has not been solved. In a sense, the necessity to use estuarine and other resources was created a long time ago.

The objectives of estuary management have been the subject of much discussion in Oregon in the last several years. One approach for accomplishing progressive estuary land use and resource management has been termed the diversity approach. Planning for diversity calls for the uneven distribution of human uses throughout Oregon's estuaries. Development efforts are clustered within a number of selected estuaries or estuary management units, while specific steps are taken to prevent or reduce development in others. A high value is placed on environmental variety, including a wide range of essentially untouched ecosystems. Under a diversity approach, decisions to preserve ecosystems are as binding as decisions to develop others.

Diversity planning suggests at least three categories of use in Oregon estuaries and their geographical subdivisions. The first would be termed a "productive" category. Estuaries designated for this level of use would support the principal industrial and residential centers. Facilities for power, waste disposal, transportation, etc. would be provided in a manner which encourages the best use of the available resources. The second land use category would be termed "mixed" and would support limited business, industrial and residential uses. A wide variety of ecological habitats would be preserved in estuaries given this designation. The third level of use would be termed "protection" and would include a variety of estuarine environments. Existing human use would be reduced and future development would be curtailed.

The diversity approach to estuary land use management is a contrast to a planning approach which would allow for some uses of all types to occur in every estuary. One of the advantages of the diversity approach is that it preserves options for future use decisions and thus allows greater opportunity to make adjustments in land use techniques based on increased knowledge of environmental impact.

While diversity planning has certain commendable advantages, including progressive and preserving environmental options, it is not clear that it accomplishes an acceptable balance of interests any more so than other types of planning. For example, some people will want recreational amenities preserved. In other cases, owners of land adjacent to an estuary will probably resist any plan calling for total preservation because it would conflict with their intent to realize an economic return on their land.

Types of Tools to Accomplish Oregon Estuary Land Use Management

Definition

Prior to the implementation of an estuary land use management program, it is necessary to decide specifically which lands are to be managed by such a program. Some of the problems in defining shorelands have been explored in a previous section of this report (pages 39-40). It was noted that different definitions may satisfy different needs, but that no one definition is likely to be universally acceptable.

Along this same vein it can be noted that definitions of shorelands have also varied depending on the purposes of various policies and laws. For example, the common law definitions of shorelands were generally expressed in terms of points of tidal influence and such a definition was adequate for its primary purpose, namely, to determine ownership rights. Once a state has determined that it is necessary to actively manage its shorelands, because of environmental concerns, it becomes necessary to develop an expanded definition of shorelines. Land use and resource management, in a present day context, requires a different sort of definition. The actual definitions for management purposes by the different states have varied, according to the particular needs of the states. The following examples illustrate a few possible variations in approach:

1) California

The San Francisco Bay Conservation and Development Commission has jurisdiction over lowlands one hundred (100) feet inland from the line of mean high tide. Cal. Gov't. Code Section 66610 (West supp. 1972).

The California Coastal Zone Conservation Act of 1972 grants the commission interim permit power over that portion of the coastal zone lying between the seaward limits of the jurisdiction of the state and 1000 yards landward from the mean high tide line (excluding otherwise regulated parts of San Francisco Bay).
Cal. Gov't. Code Section 8800-8827 supp. 1972.

For planning purposes under the same act, the coastal zone is defined as that land and water area of the State of California ... extending seaward to the outer limits of state jurisdiction, including all islands within state jurisdiction and extending inland to the highest elevation of the coastal range (except in certain counties, it only extends 5 miles inward if that is the shorter distance).

2) Maine

The regulated zone is any swamp, marsh, bog, beach, flat or other contiguous lowland above extreme low water which is subject to tidal action or normal storm drainage at any time excepting portions of maximum storm activity.
M. E. Rev. Stat. Ann. Title 12 Section 4701 (supp. 1972.)

3) New Hampshire

Regulates the area submerged or flowed upon by mean high tide.
N. H. Rev. Stat. Ann. Section 438-A: 1-a(1) (supp. 1971).

4) Texas

Requires permits for any land located within 15000 feet of any public beach.
Tex. Rev. Civ. Stat. Ann. Art. 54 15g Section 2 (supp. 1971).

5) Washington

Shoreline Management Act applies to land within 200 feet landward of the ordinary high water mark.
Wash. Rev. Code Ann. Section 90.58.030 (2)(c)-(e) (supp. 1971)

6) Oregon

The Oregon legislature has claimed state ownership of the Oregon ocean shore, except for portions disposed of prior to 1947 and has declared the ocean shore to be a recreational area.

Also, state has claimed ownership of all submersible and submerged lands of all navigable streams and lakes in the state. Submersible lands are: lands lying between the line of ordinary high water and the line of ordinary low water of all navigable waters and all islands, shorelands or other such lands ... within the boundaries of the state ... whether such waters or lands are tidal or non-tidal. Ors. 274.085 (8) (1969) Submerged lands are those lying below the line of ordinary low water whether such waters are tidal or non-tidal. Ors. 274.005 (7) (1969).

Possible Management Approaches

Once it has been decided how to best balance the variety of interests in estuarine land use management, what the broad objectives of management are (such as planning for diversity, or whatever), and what land area is to be affected by management, it is necessary to consider the specific tools to be used to implement estuarine land use management. Most states with coastal and estuarine areas use one or combinations of several of the following management tools: permit systems; zoning and land planning systems; strict committment of an area to one use; pollution laws; and, land acquisition programs. A discussion of the advantages and disadvantages inherent in each of these management tools for Oregon estuary land use management follows.

1. Permit Systems

A common form of state regulation is to require an individual or industry carrying on certain activities to apply for a permit or license. The regulated activities tend to be those which impair the ability of the coastal or estuarine areas to support wildlife, marine life, commercial fishing and recreation. Activities commonly requiring permits include: dredging and filling, draining, discharging sewage, construction improvements, mining of mineral deposits and removal of sand dunes. The agency from which an applicant may seek approval or permits is often a local governmental board whose approval is subject to some agency of state government. The imposition of a permit system usually does not affect existing operations which, if initiated in the future, would have required permits.

An example of the permit system operating to achieve estuary land use management is the Army Corps of Engineers filling and construction permits which regulate fills and structures on navigable waters below the high tide mark. Previously, these permits were granted in due course if the project had no impact on navigable waters. After the passage of the National Environmental Policy Act of 1969 (NEPA), the Corps of Engineers stated that it will consider environmental considerations in addition to navigational considerations. To back up this new perspective, the Corps of Engineers re-emphasized the Fish and Wildlife Coordination Act of 1958, which originally expressed the intent to reconcile the objectives of both the Corps of Engineers and the Federal Fish and Wildlife Bureau. Subsequent to the passage of the Fish and Wildlife Coordination Act there have been a number of situations where a Corp of Engineers permit was used to regulate construction on non-navigable water because the non-navigable water was directly or indirectly connected with a navigable body of water. The Corp of Engineers permit could be increasingly used in the future to protect marshy areas adjacent to estuaries. Some states already have permit requirements to achieve the protection of non-navigable types of wetlands.

2. Zoning Systems and Land Planning Systems

Zoning is distinguished from permits in that it affirmatively allows a particular activity in specific areas while proscribing that activity in other areas. Zoning as an implementation of comprehensive laws represents a partial means of resolving land use conflicts in that notice is given to potential users to locate only in certain areas, if at all. Zoning requires that some agency inventory the subject areas and establish a list of priority of uses.

Zoning, as a management tool, is an improvement over permit systems, in that it is not an ad hoc, or situation by situation, approach; thus it is not so subject to the discretion of the administering official. However, zoning for environmental considerations may involve a considerable time lag before implementation due to the time required for the supporting studies. The California Coastal Zone Conservation Act requires a plan and supporting study by 1976. In the interim, the subject zone is being managed by a permit system. Basically it uses the findings of facts required by NEPA and the state equivalent, California Environmental Quality Act (CEQA), to determine whether a permit to construct should be granted. Other states which have undertaken similar planning studies include: Florida, Maryland, Massachusetts, New Jersey, North Carolina and Oregon.

3. Strict Committment of Land to One Use

The strict committment of a specified area to one use, or the strict prohibitions of some uses is one of the simplest means of accomplishing land use management. Such an approach involves no administrative discretion in the form of permits, master plans, priority lists, etc. Simple examples include programs instituted by Hawaii and Florida, which have established setbacks and have prohibited construction seaward of this line. Also, Oregon has declared ownership of the ocean shore (except portions disposed of prior to 1947) and declared it to be a recreational area.

Sometimes strict prohibitions of some uses is used as a stop gap measure in the absence of other means to resolve land use conflicts. For example, in Oregon the Department of Environmental Quality has enforced a blanket building ban for a ten mile strip between Gearhart and Warrenton on what is termed the Clatsop Plains, until such time as a sewage disposal system is constructed. Likewise, new construction is prohibited from Cannon Beach to Cape Arch until such time as sewage disposal is provided.

In at least one instance, blanket restrictions are being used to implement long range coastal land management. The State of Delaware has recently passed their Coastal Zone Act which excludes heavy industrial uses from the coastal zone (all of the land between the territorial limit of Delaware, in the Delaware River and Bay and Atlantic Ocean). Heavy industry is defined in terms of specific uses frequently associated with the worst industrial pollutors and in some cases the minimum amount of space needed (20 acres) to support such a use. Any expansion of existing non-conforming uses requires the issuance of a permit. Such a system has some notable advantages. It does not require extensive administration and is not dependent on extensive planning studies. Secondly, it is thought that at least in Delaware, economic stagnation will not result. Existing uses will continue, light industrial uses will be allowed as well as businesses oriented towards vacationers and tourists. Thirdly, because of the inland waterway system, heavy industry may be located upstream of the ecologically sensitive estuaries.

In the State of Florida, a different approach was taken. A state wide system of 25 aquatic preserves was evolved on the premise that some coastal areas are of special value to the state in their natural condition and should be dedicated to biological, aesthetic, or scientific uses. No more submerged lands would be sold and no dredge-fill permits to create waterfront real estate would be issued. Traditional uses such as swimming, sport and commercial fishing, bona fide navigation channels and docks would be allowed or continued. The aquatic preserve concept assumes the boundaries of the regulated zone should be established on the basis of technical factors rather than on the basis of political expediency.

4. Pollution Laws

All states have pollution laws of some form. These are the least effective as a land use management tool because of the problems of enforcement. Agencies must constantly be on the alert and develop processes for quantifying and qualifying individual industries wastes on a regular basis. Extensive and constant interaction between the regulators and the regulated creates sympathy and leniency by the regulators and tends to undermine the effectiveness of the system.

5. Land Acquisition Programs

Regardless of how a state approaches the question of management of coastlines, whether with permits or by planning or by strict limitations on use the question of "taking" will eventually arise. The "taking question" is: "could the property be considered 'taken' without just compensation" if there were no substantial possible use of the land (alone or perhaps in conjunction with other land) while subject to the restriction, i.e., filling or whatever, which would yield the owner a fair return on his investment or the fair market value of the land free of the restriction. Simply the problem is the fear that a management program will be found to be an unconstitutional taking and therefore, void. The solution to this problem used in Massachusetts is to have the state acquire land if a court determines that application of the regulation amounts to a "taking".

Other states have gone beyond dealing with "taking question" brushfires on a case by case basis and are aggressively pursuing programs to acquire and preserve that coastal or estuarine land which is important to them. Sometimes this is done in conjunction with park programs. Some form of management program (permits, zoning, etc.) is still required unless the entire coastal or estuarine area is purchased; total acquisition is not likely.

Prominent examples include the New Jersey Green Acres bond issue which is expected to result in the acquisition of about 90% of the high value coastal marshes at a cost of $60 million. New York is acquiring wetlands through out the state at a cost of $150,000 annually. In the last two years Connecticut spent $70,000 for this purpose and North Carolina spent $500,000; both states have plans for further acquisitions. California, Maine, Rhode Island have also initiated or plan to initiate acquisition programs.

III. CONCLUSION

The Oregon Coastal Conservation and Development Commission was created by the 1971 session of the Oregon Legislature to prepare and recommend coordinated plans and their methods of implementation for the wise management of the natural resources in the coastal zone. Pursuant to the above charge the OCC & DC has launched an aggressive work program involving a broad range of local, state and federal governments and agencies, and the people of the State of Oregon, in developing a plan for the coastal zone which will provide a balance between the conservation and development of coastal resources.

On January 17, 1975, the Commission will submit a final report for legislative action to the 58th Legislative Assembly, in the form of a series of management policies and standards against which proposed uses of the natural resources of the coastal zone may be evaluated. The program will also establish a basis for determining preferences between conflicting uses of natural resources.

In support of the final report of the commission, a variety of studies have been prepared covering such areas of environmental concern as wetlands, beaches and dunes, the continental shelf, wildlife and fish habitats, and

historic and archaeological sites, to name a few. This report is also one of the studies prepared to support the final report of the OCC & DC.

After the completion of this report, as well as all the other reports, the OCC & DC will undertake the task of formulating management policies and standards against which proposed uses of natural resources of the coastal zone may be evaluated, and will establish a basis for determining preferences between conflicting uses of natural resources.

The intent of this report has been to provide a basis for management of Oregon's estuaries, to identify management needs and to briefly explore some of the means to accomplish management objectives. It has not been the purpose of this document to establish management objectives or select the means to accomplish them. Such a function can only be performed by the citizens, policy makers and elected officials of Oregon. This document, hopefully, will be a useful input to those decisions.

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