PHYSICAL PROCESSES AND GEOLOGIC HAZARDS ON THE OREGON COAST

by

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The Beaches and Dunes Handbook for the Oregon Coast represents a compendium of a number of documents which together comprehensively address management and implementation techniques for Oregon's coastal beaches and dunes. As such, each document is prepared as an individual work for subsequent independent distribution. The various documents which together comprise the Beaches and Dunes Handbook fall into five general categories and are listed as follows:

BACKGROUND ON BEACH AND DUNE PLANNING:

AN INTRODUCTION TO BEACH AND DUNE PHYSICAL AND BIOLOGICAL PROCESSES
Christianna Crook, OCZMA Beaches & Dunes Study Team Research Associate

BEACH AND DUNE PLANNING AND MANAGEMENT ON THE OREGON COAST: A SUMMARY OF THE STATE-OF-THE-ARTS
Carl Lindberg, OCZMA Beaches & Dunes Study Team Project Director

BEACH AND DUNE IDENTIFICATION:

A SYSTEM OF CLASSIFYING AND IDENTIFYING OREGON'S COASTAL BEACHES AND DUNES
Christianna Crook, OCZMA Beaches & Dunes Study Team Research Associate

PHYSICAL AND BIOLOGICAL CONSIDERATIONS:

PHYSICAL PROCESSES AND GEOLOGIC HAZARDS ON THE OREGON COAST
Dr. Paul D. Komar, Dept. of Oceanography, Oregon State Univ.

CRITICAL SPECIES AND HABITATS OF OREGON'S COASTAL BEACHES AND DUNES
Bill Burley, Project Biologist, The Oregon Natural Heritage Program of The Nature Conservancy

MANAGEMENT CONSIDERATIONS:

DUNE GROUNDWATER PLANNING AND MANAGEMENT CONSIDERATIONS FOR THE OREGON COAST
Christianna Crook, OCZMA Beaches & Dunes Study Team Research Associate

MANAGEMENT CONSIDERATIONS, CONT.

IMPLEMENTATION TECHNIQUES:

ANNOTATED BIBLIOGRAPHY:

In addition to the various documents noted above, the Beaches and Dunes Study resulted in a slide show, "Managing Oregon's Beaches and Dunes" which is available through each of Oregon's seven coastal county planning departments. The brochure, "Planning and Managing Oregon's Coastal Beaches and Dunes" was prepared as a supplement to the slide show.

* Model Ordinances prepared under separate contract between the Oregon Department of Land Conservation & Development and the Bureau of Governmental Research, Eugene, for inclusion in the <u>Beaches and Dunes Handbook</u>.

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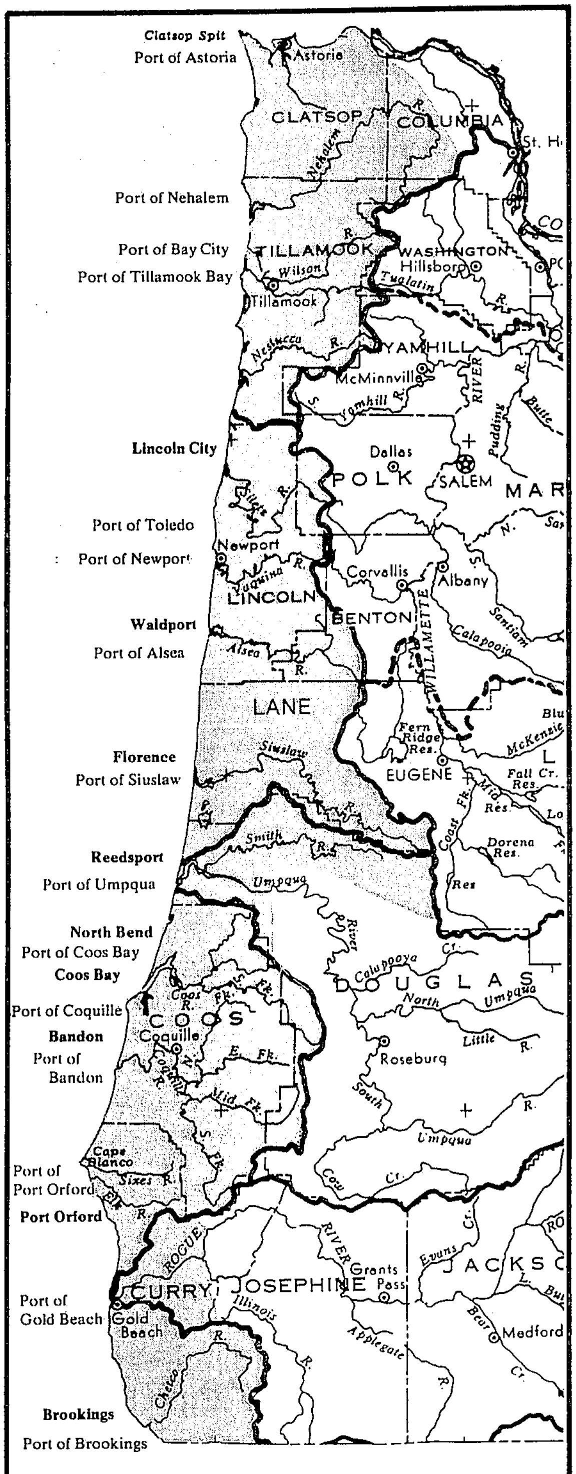
BACKGROUND OF THE STUDY

The basic objective of beach and dune planning and management is the balancing of multiple demands in order to improve the economy and liveability of the coastal area while protecting important environmental and social elements. Striving for such a balance necessitates that decision-makers evaluate both the immediate and long range impacts of proposals to ensure that sufficient choices and resources remain for future generations.

When planning for beach and dune areas, consideration should be given to their role as an integral part of the total resource of the coastal region. This view will ensure that all factors and resources, including their interactions and interdependencies, are considered in the decision-making process.

The Beaches and Dunes Handbook herein, addresses the importance of beaches and dunes from an aesthetic and recreational aspect. It focuses on the dynamic geologic and biologic nature of Oregon's living dunes. Attention is given to the limited sources of beach sand found along the Oregon coast, and the resultant potential impact of sand removal and/or beachfront protective measures. The crucial importance of foredunes for shorefront protection is repeatedly emphasized; the conclusion being drawn that all foredunes are subject to ocean undercutting and/or wave overtopping and thus are "active". Repeated attention is given to the importance of stabilizing vegetation in dune areas where development exists or is approved. Additionally, the potential impact(s) of development on groundwater, and conversely, the impact(s) of high water tables on development are examined. Finally, the study details implementation techniques to assist decision-makers and citizens in ensuring a balanced use of these unique resources while ensuring public health and safety and the protection or enhancement of natural resources.

Following approval of Oregon's Coastal Management Program and the four coastal goals in December of 1976, members of the Oregon Coastal Zone Management Association, Inc. identified the Oregon Beaches and Dunes Goal as warranting



Oregon's Coastal Zone

Figure 1. Oregon's Coastal Zone which contains the seven counties of (north to south) Clatsop, Tillamook, Lincoln, Lane, Douglas, Coos and Curry.

special attention if elected officials were to indeed comply with its requirements. A proposal for a comprehensive evaluation of beach and dune management considerations and implementation techniques was submitted to the Oregon Land Conservation and Development Commission in June of 1977, and in May of 1978, the proposal was approved. The area addressed by the study extends along the Oregon coastline from the State of Washington to the State of California, and includes Oregon's seven coastal counties and a number of coastal cities (Figure 1).

Because beaches and dunes are dynamic landforms, it was not the purpose of the project to identify specific locations for various beach and dune activities. Too, because Oregon's land use planning process requires extensive citizen's involvement, it was felt premature and inconsistent to make policy or specific implementation recommendations for beach and dune areas. Rather, the study focused on providing elected officials, planning commissions, planning staffs and citizens with the tools necessary to make knowledgeable land use decisions affecting beaches and dunes. The <u>Beaches and Dunes Handbook</u> is intended to provide basic physical, biological, and management information which will be applicable throughout the years, and which is easily understandable to the most novice in beach and dune planning.

While the Beaches and Dunes Study was intended to address the specific requirements of Oregon's Beaches and Dunes Goal, it is recognized that further technical study is needed in some instances to fulfill Goal requirements or to address issues not covered by the Goal.

Such research needs identified during the study include: the extent and impact of driftwood removal; potential for beach nourishment using dredge spoils and other techniques; specific building standards for dune areas; and specific information on groundwater quality and quantity in dune aquifers.

Lastly, it is recognized that in the future, coastal jurisdictions will, in all likelihood, require the assistance of personnel trained in the field of coastal resources to assist with site investigation report evaluations and other planning and implementation needs associated with Oregon's coastal beaches and dunes.

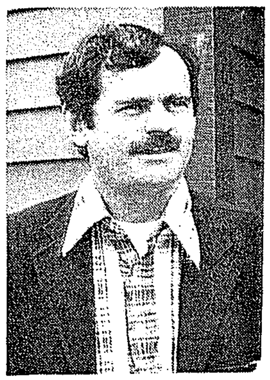
ABOUT THE CONTRIBUTORS

Kathy Bridges Fitzpatrick, Editor and Project Administrator, Oregon Coastal Zone Management Association, Inc.

The author of the Beaches and Dunes Study proposal, administrator of the project and editor of the products, Ms. Fitzpatrick also serves as Assistant Director of the Oregon Coastal Zone Management Association. A graduate of Utah State University, Logan, Ms. Fitzpatrick has finalized manuscripts for the International Biological Program.

Carl A. Lindberg, Project Leader, OCZMA Beaches and Dunes Study Team

Previously holding the position of planning director for the City of Lincoln City, Oregon, Mr. Lindberg has had extensive planning experience in Ohio, Missouri, and Iowa. Mr. Lindberg holds a Masters degree from the Center for Urban Affairs, Saint Louis University, Missouri.



Christianna Stachelrodt Crook, Research Associate, OCZMA Beaches and Dunes Study Team

With extensive experience in biophysical land classification and resource capability assessments, Ms. Crook contributed to the technical aspects of the project. Ms. Crook has held various positions at the University of Victoria and received her Masters from the University of Victoria specializing in resource management and environmental law.

Timms Fowler, WICHE Intern,
OCZMA Beaches and Dunes Study

As an intern with the Western Interstate Commission for Higher Education, Timms Fowler worked with the team concentrating his efforts on the off-road vehicle element of the project. A graduate in Environmental, Population and Organismic Biology from the University of Colorado, Mr. Fowler has had previous experience working with the Colorado Division of Wildlife.

Arlys Bernard, Project Secretary
OCZMA Beaches and Dunes Study

With a degree in elementary education and extensive background in public relations and clerical responsibilities, Ms. Bernard brought to the Study Team attributes of professionalism with attention to the finest of details.
(OCZMA also expresses appreciation to Ruby Edwards, Project Secretary during the first four months of the study.)

Wilbur E. Ternyik, Wave Beachgrass Nursery, Florence, Oregon

Having worked in the field of sand dune stabilization for over 30 years, Mr. Ternyik is a recognized authority for his work in stabilization techniques. As Chairman of the Oregon Coastal Conservation & Development Commission (1971-1975), as Executive Director of the Oregon Coastal Zone Management Association, and as a Siuslaw Port Commissioner and Florence City Councilman, Mr. Ternyik contributed invaluable practical expertise to the project.

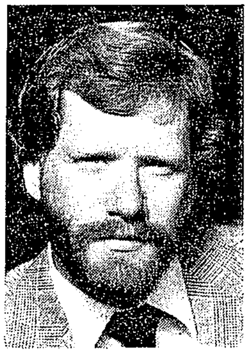
Dr. Paul D. Komar, Professor of Oceanography, Oregon State University, Corvallis

Author of the text, Beach Processes and Sedimentation and countless other publications. Dr. Komar is a recognized authority for his work concerning coastal shoreline erosion and sand transport processes. A graduate of Scrippts Institute of Oceanography, Dr. Komar's involvement in the project focused on coastal geologic hazards.

Bill Burley, Program Biologist, Oregon Natural Heritage Program, The Nature Conservancy

Utilizing its extensive data base, the Oregon Natural Heritage Program has conducted statewide inventories of unique habitats within Oregon. Through his involvement in the project, Mr. Burley identified critical beach and dune habitats and offered suggestions for management.

Doug Daggett, Clearwater Visuals, Eugene, Oregon

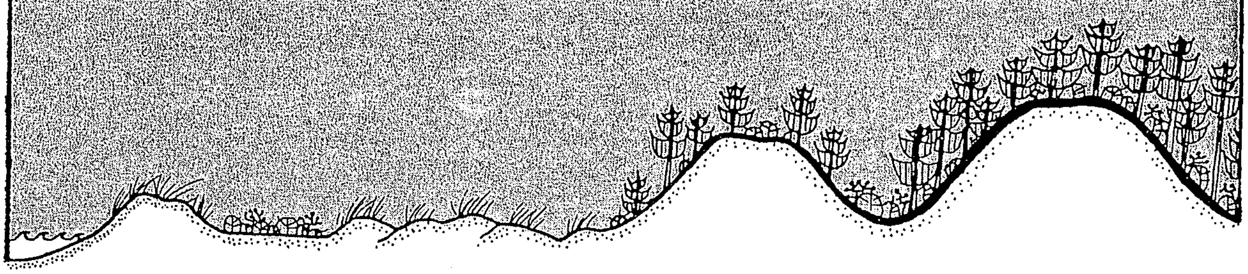


As owner of Clearwater Visuals audio-visual production firm, Mr. Daggett has had considerable experince in the field of public relations, business and industry advertising and production of educational programs. A graduate of the University of Oregon, Eugene, Mr. Daggett was responsible for preparation of the slide program and brochure which accompanied the study products.

Special appreciation is extended to Bob Cortright, Project Liaison and Coastal Specialist for the Oregon Department of Land Conservation and Development, Salem. Mr. Cortright was instrumental in serving as liaison between the state's interest and local concerns in beach and dune planning and management. A graduate of the University of Oregon, Eugene, Mr. Cortright holds a degree in Economics.

OCZMA is a voluntary intergovernmental association of coastal counties, cities, ports and soil and water conservation districts organized pursuant to Oregon statute for the purpose of remaining informed of and involved in the development and implementation of Oregon's Coastal Management Program.

An Introduction To Beach & Dune Physical & Biological Processes



Oregon Coastal Zone
Management Association, Inc.

This report was prepared as part of a larger document addressing various beach and dune planning and management considerations and techniques. Other segments of the document and additional materials are:

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*Beach and Dune Implementation Techniques: Model Ordinances**

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*Prepared under separate contract between Oregon Department of Land Conservation and Development and the Bureau of Governmental Research, Eugene.

Illustrations by Lorraine Morgan, Newport, Oregon.

AN INTRODUCTION TO BEACH AND DUNE PHYSICAL AND BIOLOGICAL PROCESSES

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AN INTRODUCTION TO BEACH AND DUNE PHYSICAL AND BIOLOGICAL PROCESSES

I. Setting the Stage

Areas of sand landforms which occupy nearly fifty percent of the Oregon coastline, have their beginnings thousands of years ago during the Pleistocene glacial period (1,000,000 to 15,000 years ago). For thousands of years, sea level rose and fell in response to the amount of water locked up in polar ice sheets. When sea level was stationary for a period of time, wave action cut terraces into the coastal range foothills (Figure 1). At the same time, ocean currents distributed and deposited large quantities of sediment on the wave-cut terraces and other gently sloping land areas (Figure 2). Origins of these sediments are uncertain, however some may be glacial sediments from as far away as the Canadian Rockies. These ancient deposits persist today and are critical to the beaches and dunes of the Oregon Coast.

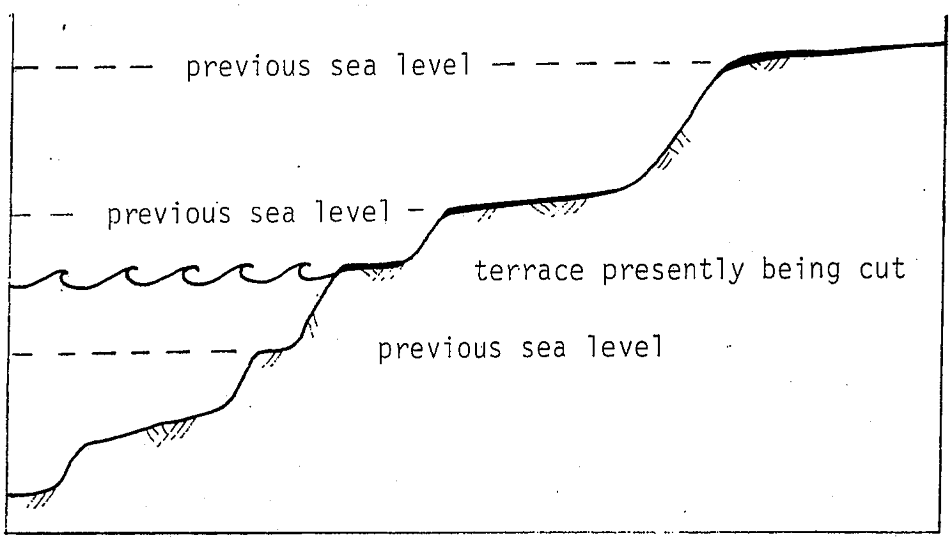


Figure 1. As a result of the Pleistocene glacial period, sea level rose and fell resulting in a series of terraces upon which sediments were deposited.

At some sites, sand deposits, particularly the surficial layers, have been repeatedly reactivated and thus are characterized by loose sands. Other, older deposits have been vegetated and stabilized for a sufficient length of time to allow the sands to become somewhat cemented or stabilized.

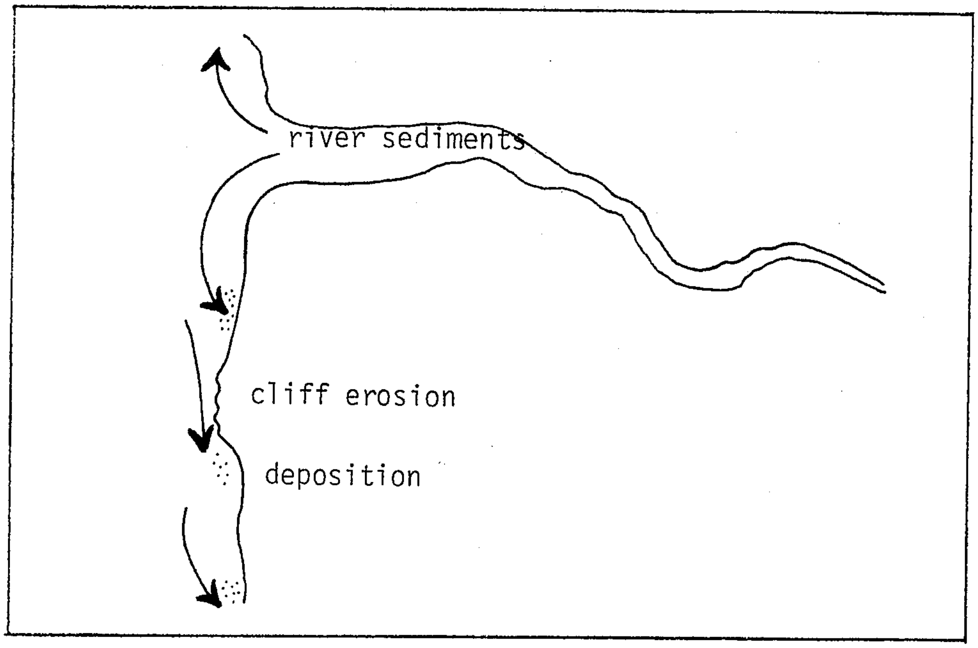


Figure 2. Sediments from rivers and coastal erosion were distributed and deposited along the wave-cut terraces, giving rise to the beach and dune materials we are familiar with today.

The coastal sand areas along Oregon are separated by numerous headlands made up of rocks more resistant to wave erosion. Even the headlands, however, experience continuous erosion as evidenced by the presence of small pocket beaches made up of black pebbles eroded from adjacent basaltic cliffs. These headlands appear to be sufficiently substantial to interrupt weak longshore currents which would otherwise distribute sands from one beach region to another. Thus, all new sand supplies to replace that lost to offshore areas and inland dunes must come from local sources.

Surprisingly, with the singular exception of the Columbia River, little coastal sand is derived from riverine sediments. This is primarily due to the existence of sizeable protected estuaries at river mouths which act as sand sinks, capturing the sediments before they reach the ocean. Only a few southern rivers, such as the Rogue and the Siuslaw, have sufficiently narrow estuaries to allow sediments to reach the beach area, but here deposits are insignificant. The major source of new sand available to the system for the maintenance of beaches and dunes comes from the erosion of ancient terrace deposits which persist today in a semi-cemented form. The loose beach and dune sands are also continuously eroded from one site and redeposited in another. Such deposits may be new to a site but are not new additions to the beach and dune system as a whole

II. Physical Processes

The interactions of a number of naturally occuring phenomenon create a range of sand dune landforms on the surface of the coastal sand deposits. The elements of concern here include wave action, wind, sand, moisture, and vegetation. The interaction of sand and wind comprise the most simplistic combination of elements in the formation of sand dunes. The specific results of this combination will vary somewhat depending on sand supply and nature of prevailing winds, but they are generally characterized by the repetition of uniform wave-like dune forms. For example, the transverse-ridge dune which develops in the open sand areas of the south-central Oregon coast during the dry summer months, is similar in form to the Saharan barcaan dune, characteristic of desert landscapes. In this instance, both dunes are characterized by a gently sloping windward side and a more steeply sloping lee side as an expression of the interaction between wind and open sand.

The addition of moisture as a third agent can result in significantly different landforms. Moisture, principally groundwater, acts as a sand binding agent, and because it exists in a relatively uniform pattern it tends to produce uniform landforms. The deflation plain, a low plain which develops inland from the foredune, is an example of a moisture controlled landform. In this situation, wind scours dry sand down to the water table where moisture binds sand particles together. A low uniform plain of deflation results.

The addition of vegetation as a controlling factor also produces characteristic forms but they commonly take a less uniform expression. Interior hummock dunes occur where beachgrass interrupts wind-blown sand, causing deposition. These dunes commonly exhibit relatively less uniform spacing and form than transverse-ridge dunes. Of course, wave action through the erosion and deposition of sedimentary materials is crucial to the very existence of beaches and dunes. Waves form beaches through the transport and deposition of sediments ranging from fine sands to pebbles and cobbles. Wave intensity contributes to the grain size deposited and the beach's angle of slope. Cusps or embayments in the beach are also created by waves and nearshore currents. Under certain conditions, these embayments can foster erosion of inland areas by allowing storm waves closer access.

III. Biological Processes

The landform types produced by the interaction of environmental factors in the beach and dune areas support a wide variety of biological habitats. The western snowy plover, considered rare in Oregon, nests in the upper beach adjacent to the drift log tangles. The deflation plain often supports a fresh water association, providing habitat for waterfowl including migratory species. Additionally, a number of wildlife species, including deer, racoon, fox and even bobcat, are found in the older forested dunes and often frequent the beach area.

IV. Dune Forms Characteristic of the Oregon Coast

Several regions along the Oregon coast have relatively broad sand borders ranging from one to four miles wide. This includes the Clatsop Plains, the Florence Dune Sheet and the Coos Bay Dune Sheet. Significant sand deposits also occur at Manzanita, Newport, Sand Lake, Bandon and Langlois. Numerous other deposits of local importance occur intermittently along the coast. The major and secondary sand areas in cross-section exhibit characteristic progressions of landforms from the beach landward. Because of varying environmental conditions, these landform progressions vary regionally along the coast. Areas of smaller sand deposits commonly display a somewhat limited selection of these sand landforms.

The Clatsop Plains probably exhibits the most uniform sand dune topography. It is comprised primarily of recently developed sand dune ridges which occur essentially parallel to the beach (Figure 3). Intervening deflation plains and swales are often occupied by streams and linear lakes and marshes. These ridges develop as foredunes adjacent to an accreting beach. The foredune is a ridge of sand which develops immediately above high tide line and parallel to the beach. It is created where the seaward-most beachgrasses, introduced by man, interrupt wind blown sand causing deposition and mound building. As the beach continues to advance seaward, new foredunes develop just landward of the new high tide line and seaward of the previous foredune. The foredune in Clatsop County exhibits a more gently sloping topography than its southern counterparts.

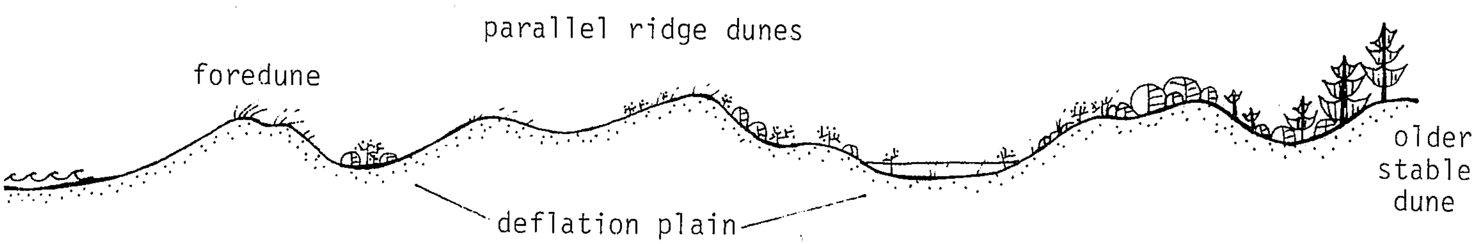


Figure 3. Dune cross-section of the Clatsop Plains dunes sheet illustrating parallel ridge dunes.

In all counties south of Clatsop, the well established foredunes often possess a steeper angle of slope (Figures 4 and 5). Just landward of the foredune, wind scouring occurs eroding sand down to the surface of the summer water table. This feature, known as the deflation plain, often exhibits standing water during the winter and may be occupied by marsh grass associations as well.

On the north-central Oregon coast, vegetated hummock dunes occur immediately inland from the deflation plain, or inland from the foredune when no deflation plain has developed (Figure 4). These dunes may be sparingly or thickly covered with beachgrass and a few other herbaceous and woody species. Like the foredune, hummock dunes are formed by the progressive deposition of sand where beachgrass interrupts wind-blown sand. While hummock dunes are generally found in Lincoln and Tillamook Counties, they occasionally occur in Curry County also.

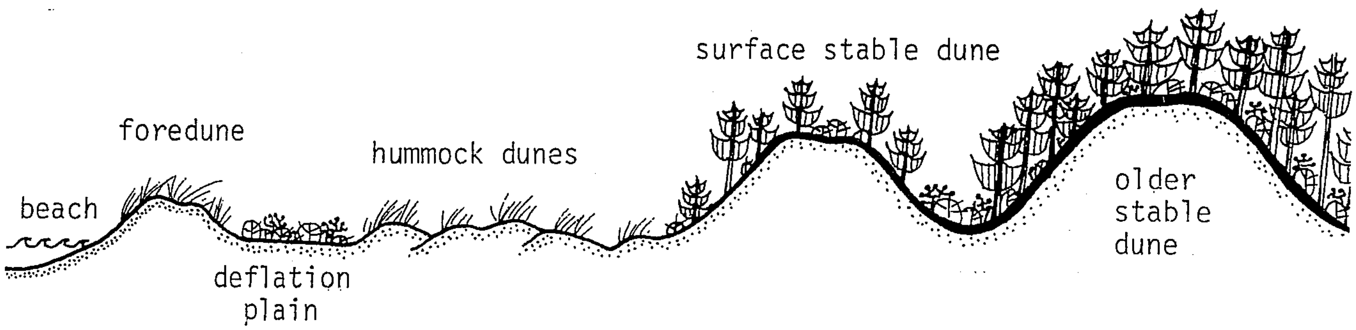


Figure 4. Dune cross-section, north-central coast, illustrating deflation plain and interior dunes.

At the same site in the south-central Oregon coast, transverse-ridge dunes occur in vast open sand sheets (Figure 5). Further inland, the transverse-ridge dunes commonly ride-up over the flanks of the massive oblique-ridge dunes (Figure 5). This dune form, which may reach nearly 200 feet in height, occurs only in the open sand areas common to Lane, Douglas and Coos Counties.

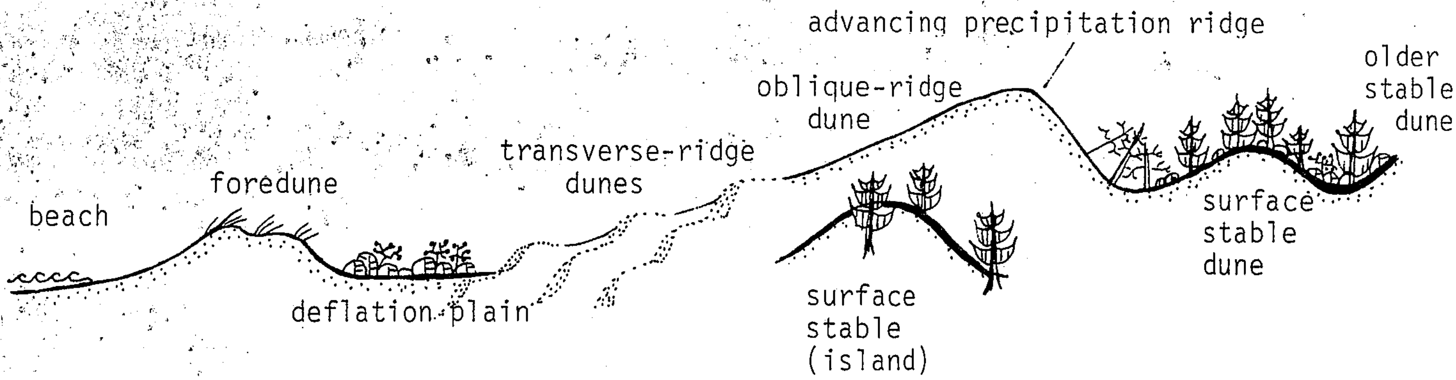


Figure 5. Dune cross-section, south-central coast, illustrating deflation plain, transverse-ridge and oblique-ridge dunes.

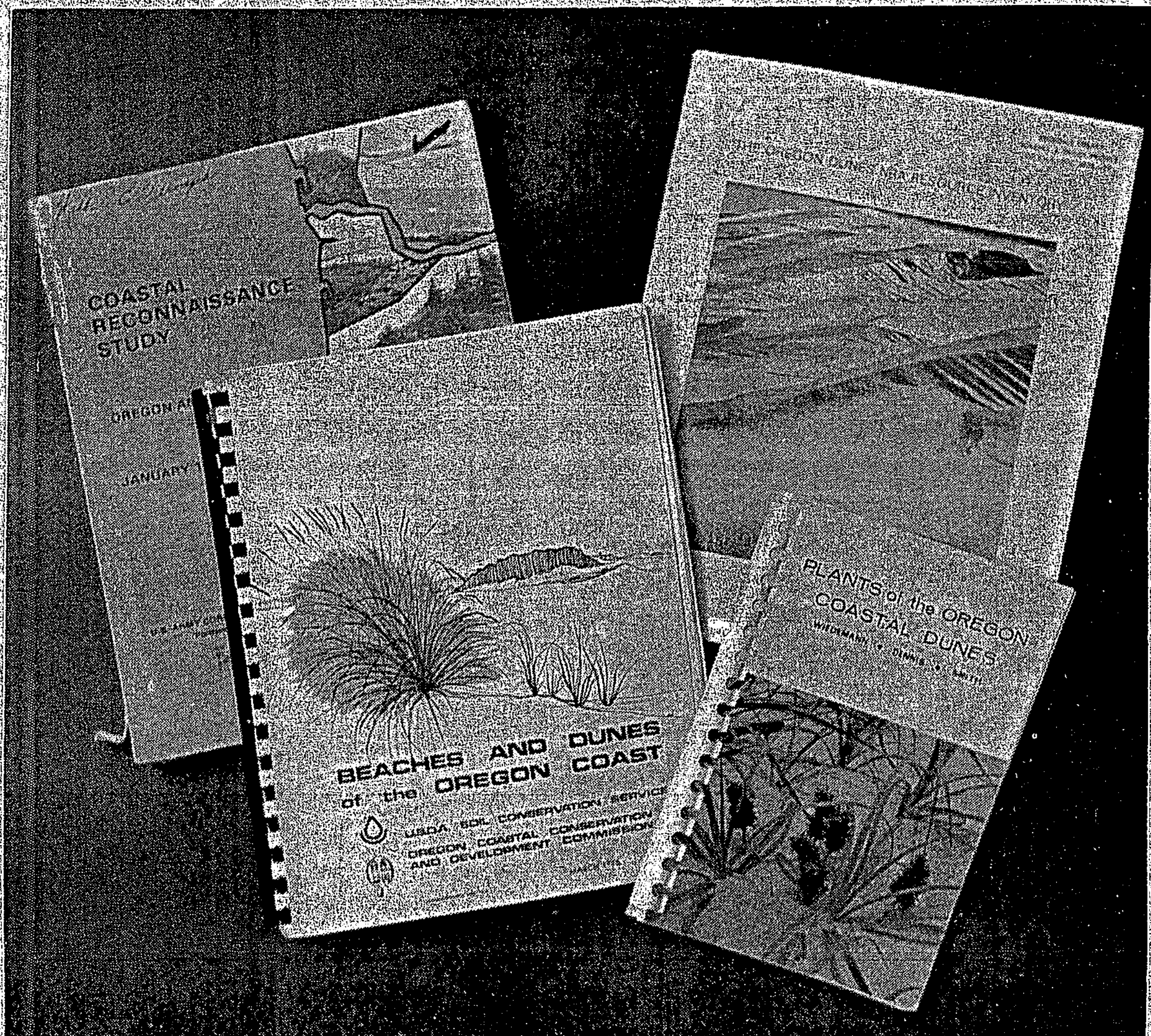
Landward of the hummock dunes of the north-central coast, and interspersed within the oblique-ridge dunes of the south-central coast, occur two varieties of forested soil-covered dunes (Figures 4 and 5). The first is the younger, surface stable dune which is underlain by loose sands and which can be easily activated when vegetation or soil cover are disturbed. The second variety, the older stable dune, exhibits semi-cemented underlying sands which will not commonly be reactivated except where they contain lenses of loose sand. The older stable dune will form a cliff where it is excavated but slumping is common. More resistant iron bands and older buried soils may be found within either of the soil covered dunes but most commonly in the older stable dune.

V. Beaches and Dunes: An Overview

The beaches and dunes of the Oregon Coast are unique and important geologic features which support a wide variety of biological habitats. These forms have evolved through geologic time from the interaction of natural coastal processes including wind, waves, vegetation, moisture and sand supply. Some sand dune landforms have been modified in recent years by man--an example is the introduction of European beachgrass in the foredune area. Management techniques which will allow man to utilize these unique sand dune landforms must take into consideration the dynamic forces at play in the beach and dune area.

Beach & Dune Planning & Management On The Oregon Coast:

A Summary Of The State-Of-The-Arts



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*Prepared under separate contract between Oregon Department of Land Conservation and Development and the Bureau of Governmental Research, Eugene.

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BEACH AND DUNE PLANNING AND MANAGEMENT ON THE OREGON COAST:

A SUMMARY OF THE STATE-OF-THE-ARTS

by

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PREFACE

The following report presents an overview of the state-of-the-arts of planning and managing Oregon's coastal beaches and dunes. This study was conducted by Carl Lindberg, Project Leader, with assistance from other OCZMA Beaches and Dunes staff members composed of Christianna Crook, Project Associate, Arlys Bernard, Project Secretary, Wilbur Ternyik, Project Coordinator, and Kathy Fitzpatrick, Project Administrator. This report constitutes one element of an overall analysis of planning for and managing coastal beaches and dunes as required by Oregon's Beaches and Dunes Goal.

OCZMA expresses appreciation to the following individuals for their contributions during the preparation of this report: Marilyn Adkins, City of Florence Planning Department; Phil Bredesen, Lane County Planning Department; Dave Crow and Bob Higbie, Curry County Planning Department; Keith Cubic, Douglas County Planning Department; Steve Goeckritz, Tillamook County Planning Department; Craig Hall, Mutual Aid Planning Service; Bruce Maltman, City of Gearhart; Kathy Mecone, Coos-Curry Council of Governments; Mike Morgan, Clatsop-Tillamook Intergovernmental Council; Philip Quarterman, Coos County Planning Department; and Curt Schneider, Clatsop County Planning Department.

Additionally, OCZMA acknowledges the following participants on the Beaches and Dunes Steering Committee, who contributed considerable time and effort throughout the project:

R. A. Corthell, U.S. Soil Conservation Service
Steve Stevens, U.S. Army Corps of Engineers
Sam Allison, Oregon Department of Water Resources
Peter Bond and John Phillips, Oregon Department of Transportation Parks and Recreation Division
Bob Cortright, Oregon Department of Land Conservation and Development
Jim Lauman, Oregon Department of Fish and Wildlife
Jim Stembridge, Oregon Department of Soil and Water Conservation
Steve Felkins, Port of Coos Bay
Rainmar Bartl, Clatsop-Tillamook Intergovernmental Council
Gary Darnielle, Lane Council of Governments
Kathy Mecone, Coos-Curry Council of Governments
Marilyn Adkins, City of Florence Planning Department
Phil Bredesen, Lane County Planning Department
Steve Goeckritz, Tillamook County Planning Department
Oscar Granger, Lincoln County Planning Department
Curt Schneider, Clatsop County Planning Department

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I. SETTING THE STAGE

In 1973, the Oregon Coastal Conservation and Development Commission (OCCDC) identified beaches and dunes as one of nine resource categories to be studied as part of the Oregon coastal planning program. The initial identification of beaches and dunes as a topical area and the formulation of original planning management policies were a product of Commission action based on information gained from participants in sixteen coastal workshops and from the assistance of eleven technical resource specialists.

The OCCDC drafted a set of preliminary policy statements and recommended actions which later served as the basis for the Land Conservation and Development Commission's Beaches and Dunes Goal (Goal #18).

In order to visualize the transition that occurred during the development of Goal 18, and perhaps to retrieve useful policies lost during years of debate, original preliminary policies and recommended actions are presented (Ternyik, 1974):

"<u>Beaches and Dunes</u>[1]

"Preliminary Policies - Phase 1

"<u>Planning</u>

"1. Special management guidelines shall be applied to areas specifically identified because of their inherent values, such as deflation plains, freshwater lakes within or adjacent to dune areas, and hummock dunes. (RS)

"2. Certain areas of deflation plains shall not be modified in such a manner as to preclude or reduce availability for wildlife. (RS)

"3. Breaching of a foredune for any purpose shall be controlled. (RS)

"<u>Development</u>

"4. Any development on dune areas (as defined in the OCCDC inventory)

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[1](PI) - means the source is public input, primarily workshops
(RS) - means the source is resource specialist input.
(CON) - indicates consensus between public and resource specialist input.

shall be subject to a site investigation conducted by a qualified specialist in the field and his report submitted prior to the granting of approval for the proposed action.

"5. Any individual, agency or organization proposing construction or development on dune areas shall submit a plan to the appropriate local authority. The plan shall include specifications for: (RS)

(a) the type of development intended;
(b) control of the area through temporary stabilization during construction;
(c) a permanent stabilization program;
(d) an on-going maintenance program;
(e) protection of existing vegetation while construction is in progress;
(f) water distribution and sewerage collection facilities; (EP) and
(g) protection of the surrounding area. (CON - RS; PI)

"6. Those proposing a development in dune areas shall be required to post a performance bond sufficient to cover the cost of making repairs to on-site or off-site areas damaged as a result of the development activity. (RS)

"7. Industrial uses including sand mining and mill sites as well as commercial sites shall be controlled in sand areas, but not eliminated. (PI)

"8. Removal of driftwood from beaches and dunes shall be controlled. (PI)

"9. Some undeveloped open sand areas shall be preserved as open space to allow continuance of active dune processes and maintenance of the aesthetic values. (PI)

"10. The effects of stabilization on adjacent land must be considered. (PI)

"11. Controlled sand removal shall be permitted where necessary.

"<u>Access</u>

"12. (Existing Policy). NOTE--In this section, the authority for planning and management of the state-controlled section of the beach west of the zone line was described. This authority is vested in the State Parks and Recreation Branch by ORS 390.

"13. Sand areas designated as conditionally stable or as a dune complex (as identified in the OCCDC inventory) shall be managed on a limited access basis. (RS)

"Recreation

"14. Pedestrians and vehicles shall be separated in sand dune areas. (CON - RS; PI)

" Beaches and Dunes

"Preliminary Recommended Actions

"Planning

"1. Planning should identify those areas to be protected and those suitable for development and shall recommend use restrictions, limitations or reglations for sand areas . (PI)

"2. Special management guidelines should be developed for areas specifically identified because of their inherent values, such as deflation plains, freshwater lakes within or adjacent to dune areas, and hummock dunes. (RS)

"3. Because of the special characteristics of some areas of deflation plains they should be identified and maintained for wildlife habitat.

"4. An educational program explaining dune processes should be developed and taken to the general public and to schools. (PI)

"Development

"5. Specifications for construction activity (such as excavations) in sand areas should be developed to prevent: (RS)

(a) moisture loss and plant root damage;
(b) exposing older sand areas to erosion; and
(c) creating or causing slope instability.

"6. Cutting and removal of timber and understory vegetation or ground cover should be conducted in such a manner that no threat to moisture loss is posed to the survival of the adjacent and surrounding plant communities. (RS)

"7. Existing channels and jetties should be maintained. (PI)

"8. Some undeveloped open sand areas should be identified for preservation as open space. (PI)

"Access

"9. Access to sand areas should conform to the physical characteristics of the site. (PI)

"Recreation

"10. Specified sand dunes areas should be designated for vehicles, and vehicles restricted from all other areas. (CON - RS; PI)

"11. ORVs (off-road vehicles) should be regulated by a permit system or special licensing program which applies fees for control and maintenance of their use areas. (PI)

"12. The impact of motor vehicles, pedestrians, and livestock use of beaches and dunes should be studied."

During the time when the OCCDC merged with the then-newly created Land Conservation and Development Commission (LCDC) in 1975, two informational sources were being developed:

(1) A series of state and county environmental geology reports were being compiled by the Oregon Department of Geology and Mineral Industries (DOGAMI) which included information addressing beach and dune problems and management suggestions.

(2) The U.S. Department of Agriculture, Soil Conservation Service was busily preparing an inventory of coastal beaches and dunes under contract with the OCCDC. About ten pages of the final document were devoted to existing and potential management problems.

In December of 1976, the Oregon Land Conservation and Development Commission approved the Beaches and Dunes Goal--the eighteenth of nineteen planning goals for the State of Oregon. The goal was adopted in conjunction with the state's involvement in the federal Coastal Zone Management Act of 1972, and as such applies only to Oregon's coastal zone[1]. The goal sets forth beach and dune planning and management objectives for coastal counties and cities (see Appendix A).

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[1]Oregon's coastal zone extends from the Washington border on the north to California on the south, seaward to the extent of state jurisdiction as recognized in federal law, and inland to the crest of the coastal mountain range. Three exceptions exist on the eastern boundary. They are:

1. The Umpqua River Basin, where the coastal zone extends to Scottsburg;
2. The Rogue River Basin, where the coastal zone extends to Agness; and
3. The Columbia River Basin, where the coastal zone extends to the downstream end of Puget Island (LCDC, 1976).

II. COASTAL JURISDICTION EFFORTS

Since the demise of OCCDC in 1975, coastal jurisdictions have been busy preparing local comprehensive plans pursuant to LCDC's nineteen statewide goals and guidelines, A survey of coastal jurisdictions in late September, 1978 indicated that the DOGAMI and OCCDC publications were the main printed sources of information used by planning staffs in planning and development review under the Beaches and Dunes Goal (#18). In response to written questionaires and follow-up telephone conversations, the following is a synopsis of the state-of-the-arts of beach and dune planning throughout the Oregon coast.

A. Clatsop County

Clatsop County, from the mouth of the Columbia River to the north to Tillamook Head on the south, contains a series of parallel-ridge dunes that extend approximately one and one-half miles inland. "A sand stabilization project was established in the Clatsop Plains area in 1935 by the Soil Conservation Service. In this program, 3,000 acres of shifting sand were progressively stabilized by forming a series of foredunes" (U.S.D.A., Soil Conservation Service and OCCDC, 1975, p. 74).

Since the massive sand stabilization program of the 1930's, the Warrenton Dune Soil and Water Conservation District has maintained a management program to ensure continuing stability of the Clatsop Plains dune sheet. A copy of the regulations adopted by the District are included in Appendix B.

Several recent planning studies have been conducted which address the county's dune areas, one of which covers the subject of dune stability. Dr. Leonard Palmer, a consulting geologist from Portland State University, prepared a draft report on the stability of Clatsop coastal dunes which recommends:

> "that developers be required to provide site-specific studies done by qualified experts in areas of potential hazard. Primary concerns are to define: the beach and dune rates of change; storm-tsunami tide and wave height; preservation of groundwater supplies; and proper vegetation maintenance" (Palmer, 1978, p. 2).

A zoning ordinance pertaining to uses on active dune areas and an exception for the Surf Pines area has recently been adopted by Clatsop County and is reproduced in Appendix B.

B. Tillamook County

Tillamook County has 53 miles of shoreline that consists of sand beach and dune areas between rocky headlands. Along with the state environmental geology study for the county and the OCCDC inventory, the county planning department uses SCS soils maps (1979) and has generated specific inventory and policy recommendations for its beach and dune areas. These proposed policies have been the topic of discussion during the citizen's involvement process and have been fairly well received. The draft policies address the Beaches and Dunes Goal requirements in six major policy areas: Geology and Geologic Hazards, Flood Hazards, Groundwater and Water Quality, Wildlife Habitat, Development and Recreation. A copy of the current working paper on these policies is included in Appendix C along with a Tillamook County handout which addresses the effect of the Beaches and Dunes Goal on home and property owners. Additionally, Tillamook County has developed extensive findings pertaining to beaches and dunes, critieria for site investigations, exceptions to the Beaches and Dunes goal and is preparing an ordinance for regulating beach and dune activities.

C. Lincoln County

Lincoln County has a shoreline of approximately 54 miles that is characterized by sandy beaches interspersed with rocky headlands and inlets. The county reported use of the state environmental geology report for the county (Schlicker, et al., 1973), the OCCDC Beaches and Dunes Inventory and a recent coastal shorelands and hazards study conducted by RNKR Associates of Corvallis, Oregon (1978). The county uses these resources, along with the LCDC goal requirements, agency concerns and basic planning techniques to classify sand landforms and produce findings-of-fact on individual proposed actions. Under the current county zoning ordinance, the county may require a geotechnical study be conducted in known or suspected hazards areas. On-site inspection by staff may also be required prior to issuing development permits along beaches and shorelands. The OCZMA Beaches and Dunes Study draft addressing uses was included in its entirety in Lincoln County's recently released draft comprehensive plan (Lincoln County Planning Department, 1979).

D. Lane County

Lane County has approximately thirty miles of shoreline with major dune areas to the north and south of the Siuslaw River. The county utilizes the Environmental Geology of Coastal Lane County (1974), soil surveys, and on-site inspections when identifying the location and extent of sand landforms. The Wilsey and Ham consulting firm has completed a coastal resource inventory for the county (1978). This inventory has a forty-two page section dealing with beaches and dunes covering such topics as nature and stability of dunes, patterns of land use and land ownership, aesthetic and scenic values, and recreational opportunities.

The county planning department has prepared a seven-page draft document on beach and dune policies that will be expanded after analyzing the Wilsey and Ham inventory and the forthcoming OCZMA Beaches and Dunes Study (Bredesen, 1979). Additionally, the county is exploring the use of alternative land use controls for implementation of the local comprehensive plan in rural areas.

E. Douglas County

Douglas County has only seventeen miles of shoreline, and almost all of that lies within public ownership (mostly within the Oregon Dunes National Recreation Area). Thus the county's planning priorities have been directed toward the non-coastal statewide planning goals (#1-15). Two inventories were identified by the county staff as being utilized in determining the location and types of sand landforms (Cubic, 1978):

(a) "Final Environmental Impact Statement, Oregon Dunes National Recreation Area Management Plan," by the U. S. Forest Service (1977), and
(b) "An Environmental and Socio-Economic Description of Coastal Douglas County (Draft)," by the Umpqua Regional Council of Governments (1978).

F. Coos County

The 1975 OCCDC study identified over 12,000 acres of active and conditionally stable beach and dune areas within Coos County, with wet deflation plains comprising the most extensive dune landform of over 5,820 acres (U.S.D.A., Soil Conservation Service and OCCDC, 1975). Coos County makes use of the OCCDC study, as well as aerial photography from the SCS and the 1974 "Coastal Reconnaissance Study" by the U.S. Army Corps of Engineers. The sand information is used in classifying sand landforms and no procedures have been developed for the production of findings-of-fact or for site investigations. A natural resource zone (1NR) has been used in a number of beach and dune areas to protect natural resources.

In February of 1978, a fifty-seven page rough-draft policy and inventory document was released for public review and comment. The document contains four sections dealing with beach and dune planning: natural resources, uses and activities, impacts and natural hazards related to dune activities, and coordination with other agencies dealing with beaches and dunes (Quarterman, 1978). The county has developed general policies directed toward uses of beaches and dunes and has been working on development of a Coastal Shorelands/Dune Lands Combining Zone (CSD).

G. Curry County

While having the longest stretch of coastline of any other coastal county in Oregon, Curry County has the smallest area of dune activity. Currently the county utilizes the OCCDC inventory, SCS soil surveys, the environmental geology report on Western Curry County (1976) and aerial photographs provided by the Oregon Highway Division for lands west of the vegetation line.

The OCCDC classification system was identified as the source of information used to classify beach and dune types. Neither general findings-of-fact relating to the existence of hazards, nor criteria for site investigations have been developed. The county has not initiated the preparation of any specialized implementation ordinances directed toward the Beaches and Dunes Goal (Higbie, 1978).

H. Clatsop-Tillamook Intergovernmental Council (CTIC)

The Clatsop-Tillamook Intergovernmental Council provides planning assistance to various jurisdictions within Clatsop and Tillamook Counties. Specifically, the Cities of Manzanita, Rockaway and Cannon Beach are affected by the Beaches and Dunes Goal and receive assistance through CTIC. The supplementary provisions of Manzanita's zoning ordinance No. 78-6 (adopted September, 1978) specify dune construction requirements, as does Rockaway's ordinance No. 143 (adopted January 1978). Cannon Beach in its adopted land use plan (March, 1979) has delineated specific policies for areas identified as hazardous, which includes provisions for beach-front property and addresses sand dune construction policies and beach-front protective structure policies, (see Appendix D).

CTIC has relied heavily on the OCCDC inventory, on the PhD thesis prepared by Jim Stembridge (1975), and on work conducted by Leonard Palmer. Additionally, CTIC contracted with a registered engineering geologist who conducted studies of each community and provided basic information for use in the planning process (Morgan, 1979).

I. Mutual Aid Planning Service, Lincoln County

The Mutual Aid Planning Service located in Lincoln County, serves the planning needs of the county and all cities within the county with the exception of the City of Yachats.

Depending on the finalization of urban growth boundaries, the City of Waldport is likely to be the only city affected by the beaches and dunes goal. Policy statements and implementing procedures have not been developed pending finalization of the OCZMA Beaches and Dunes Study (Hall, 1979).

J. Coos-Curry Council of Governments (CCCOG)

The Coos-Curry Council of Governments provides planning assistance to many of the communities within the two county area, however, only one of its client cities contains active dunes within its jurisdiction. On-site inspections and the use of aerial photographs are used in determining the location and extent of existing beach and dune landforms. Field inspections are used in determing the classification of sand landforms. Information from DOGAMI's environmental geology reports (1973 and 1976) and data from the SCS are used in producing findings-of-fact. No specific criteria has been developed for site investigations, nor have specific implementing ordinances been developed (Mecone, 1978).

K. City of Gearhart

The City of Gearhart has initiated an inventory of beach and dune areas, and has retained a consultant (Morgan, Ryan and Associates, Inc.) to assist with final preparation of the plan and the development of implementing ordinances. While the City has prepared several draft alternatives for beach and dune management, the City has not yet adopted policies or ordinances to implement the beaches and dunes goal (Maltman, 1979).

L. City of Florence

As early as 1968, the City of Florence adopted an ordinance addressing development on, or removal of, sand landforms within the City's jurisdictions.

Since that time, the City has been planning pursuant to the statewide goals. The draft plan contains several references to beaches and dunes within the context of recreation, scenic values, and housing. Beaches and dunes are being addressed within the plan in terms of the physical environment and land use constraints. An extensive study conducted by Wilsey and Ham included the City of Florence, and the City is presently awaiting the release of OCZMA's Beaches and Dunes Study to finalize its implementation techniques (Adkins, 1979).

M. City of Gold Beach

The City of Gold Beach has finalized its comprehensive plan policies and zoning ordinances, and has submitted its plan for acknowledgement by LCDC (Krogh, 1979). The plan identified 650 acres of beaches and dunes and maps active and stabilized dunes using 1970 SCS surveys (City of Gold Beach, 1978). Within the City's zoning ordinance, most active dune areas are designated as "conservation" which allows for the following outright permitted uses: (City of Gold Beach, 1979)

(1) Wildlife and water life sanctuaries.
(2) Recreational uses.
(3) Fishing and similar activities.
(4) Aquaculture and accessory facilities.
(5) Disposal of dredge spoils on sites described in permits issued by Federal and/or State Governmental agencies.

III. THE LONG AND WINDING ROAD

Pursuant to Oregon's statewide planning program and coastal management program, coastal jurisdictions have until July of 1980 to bring local plans and implementing ordinances into compliance with the Oregon Land Conservation and Development Commission's nineteen goals. Planning for beach and dune areas proves particularly cumbersome due to the dynamic nature of the landforms, associated hazards, and the difficult resolution of open space designations and property right issues. The ultimate use of Oregon's coastal beaches and dunes will be the result of extensive citizen's input, coupled with specific data and information regarding housing needs, recreational demands, and other projected uses, within the context of the dynamic nature of these living landforms.

IV. REFERENCES CITED

Adkins, Marilyn. Personal Communication. 1979. Planner, City of Florence, Oregon.

Baldwin, Ewart M., John D. Beaulieu, Len Ramp, Jerry Gray, Vernon C. Newton, Jr. and Ralph S. Mason. 1973. Geology and Mineral Resources of Coos County, Oregon. Bulletin 80, Oregon Department of Geology and Mineral Industries, Portland, Oregon 82 pp. + maps.

Beaulieu, J. D. and P. W. Hughes. 1976. Land-use Geology of Western Curry County, Oregon. Bulletin 90, Oregon Department of Geology and Mineral Industries, Portland, Oregon. 148 pp.

Bredesen, Phil. Personal Communication. 1979. Senior planner, Lane County Planning Department, Eugene, Oregon.

Clatsop County Planning Department. 1979. "Clatsop County Zoning Ordinance." Ordinance #78-26, Section 4.160, Clatsop County Planning Department, Astoria, Oregon.

Cubic, Keith L. Personal Communication. 1978. Director, Douglas County Planning Department, Roseburg, Oregon.

Goeckritz, Steve. 1979. "Working Paper, Draft II, Beaches and Dunes Goal No. 18." Tillamook County Planning Department, Tillamook, Oregon. 54 pp. + maps.

Gold Beach, City of. 1978. "Gold Beach Comprehensive Land Use Plan - Draft." Gold Beach, Oregon. 137 pp.

Gold Beach, City of. 1979. "City of Gold Beach Zoning Ordinance, No. 327." Gold Beach, Oregon. 25 pp.

Hall, Craig. Personal Communication. 1979. Planner, Mutual Aid Planning Service, Newport, Oregon.

Higbie, Robert. Personal Communication. 1978. Director, Curry County Planning Department, Gold Beach, Oregon.

Krogh, Dave. Personal Communication. 1979. Planner, Curry County Planning Department, Gold Beach, Oregon.

Maltman, Bruce. Personal Communication. 1979. City Administrator, City of Gearhart, Oregon.

Martin, Michael. 1978. "An Environmental and Socio-Economic Description of Coastal Douglas County." Umpqua Regional Council of Governments, Roseburg, Oregon. 450 pp.

Mecone, Kathleen. Personal Communication. 1978. Planner, Coos-Curry Council of Governments, North Bend, Oregon.

APPENDIX A

The Beaches and Dunes Goal

18. BEACHES AND DUNES *

GOAL

OVERALL STATEMENT

To conserve, protect, where appropriate develop, and where appropriate restore the resources and benefits of coastal beach and dune areas; and

To reduce the hazard to human life and property from natural or man-induced actions associated with these areas.

Coastal comprehensive plans and implementing actions shall provide for diverse and appropriate use of beach and dune areas consistent with their ecological, recreational, aesthetic, water resource, and economic values, and consistent with the natural limitations of beaches, dunes and dune vegetation for development.

INVENTORY REQUIREMENTS

Inventories shall be conducted to provide information necessary for identifying and designating beach and dune uses and policies. Inventories shall describe the stability, movement, groundwater resource, hazards and values of the beach and dune areas in sufficient detail to establish a sound basis for planning and management. For beach and dune areas adjacent to coastal waters, inventories shall also address the inventory requirements of the Coastal Shorelands Goal.

COMPREHENSIVE PLAN REQUIREMENTS

Based upon the inventory, comprehensive plans for coastal areas *shall*:

(1) identify beach and dune areas; and
(2) establish policies and uses for these areas consistent with the provisions of this goal.

Identification

Coastal areas subject to this goal shall include beaches, active dune forms, recently stabilized dune forms, older stabilized dune forms and interdune forms.

Uses

Uses shall be based on the capabilities and limitations of beach and dune areas to sustain different levels of use or development, and the need to protect areas of critical environmental concern, areas having scenic, scientific, or biological importance, and significant wildlife habitat.

IMPLEMENTATION REQUIREMENTS

(1) Local governments and state and federal agencies shall base decisions on plans, ordinances and land use actions in beach and dune areas, other than older stabilized dunes, on specific findings that shall include at least:

(a) the type of use proposed and the adverse effects it might have on the site and adjacent areas;
(b) temporary and permanent stabilization programs and the planned maintenance of new and existing vegetation;
(c) methods for protecting the surrounding area from any adverse effects of the development; and
(d) hazards to life, public and private property, and the natural environment which may be caused by the proposed use.

(2) Local governments and state and federal agencies shall prohibit residential developments and commercial and industrial buildings on active foredunes, on other foredunes which are conditionally stable and that are subject to ocean undercutting or wave overtopping, and on interdune areas (deflation plains) that are subject to ocean flooding. Other development in these areas shall be permitted only if the findings required in (1) above are presented and it is demonstrated that the proposed development:

*From Oregon Land Conservation and Development Commission, 1977.

(a) is adequately protected from any geologic hazards, wind erosion, undercutting, ocean flooding and storm waves; or is of minimal value; and
(b) is designed to minimize adverse environmental effects.

(3) Local governments and state and federal agencies shall regulate actions in beach and dune areas to minimize the resulting erosion. Such actions include, but are not limited to the destruction of desirable vegetation (including inadvertent destruction by moisture loss or root damage), the exposure of stable and conditionally stable areas to erosion, and construction of shore structures which modify current or wave patterns leading to beach erosion.

(4) Local, state and federal plans, implementing actions and permit reviews shall protect the groundwater from drawdown which would lead to loss of stabilizing vegetation, loss of water quality, or intrusion of salt water into water supplies.

(5) Permits for beach front protective structures shall be issued under ORS 390.605 -- 390.770, only where development existed on January 1, 1977. The Oregon Department of Transportation, cooperating with local, state and federal agencies shall develop criteria to supplement the Oregon Beach Law (ORS 390.605 -- 390.770) for issuing permits for construction of beach front protective structures. The criteria shall provide that:

(a) visual impacts are minimized;
(b) necessary access to the beach is maintained;
(c) negative impacts on adjacent property are minimized; and
(d) long-term or recurring costs to the public are avoided.

(6) Foredunes shall be breached only to replenish sand supply in interdune areas, or on a temporary basis in an emergency (e.g., fire control, cleaning up oil spills, draining farm lands, and alleviating flood hazards), and only if the breaching and restoration after breaching is consistent with sound principles of conservation.

GUIDELINES

The requirements of the Beaches and Dunes Goal should be addressed with the same consideration as applied to previously adopted goals and guidelines. The planning process described in the Land Use Planning Goal (Goal 2), including the exceptions provisions described in Goal 2, applies to beaches and dune areas and implementation of the Beaches and Dunes Goal.

Beaches and dunes, especially interdune areas (deflation plains) provide many unique or exceptional resources which should be addressed in the inventories and planning requirements of other goals, especially the Goals for Open Spaces, Scenic and Historic Areas and Natural Resources; and Recreational Needs. Habitat provided by these areas for coastal and migratory species of of special importance.

A. Inventories

Local government should begin the beach and dune inventory with a review of **Beaches and Dunes of the Oregon Coast,** USDA Soil Conservation Service and OCCDC, March, 1975, and determine what additional information is necessary to identify and describe:

1. The geologic nature and stability of the beach and dune landforms;
2. patterns of erosion, accretion, and migration;
3. storm and ocean flood hazards;
4. existing and projected use, development and economic activity on the beach and dune landforms; and
5. areas of significant biological importance.

B. Examples of Minimal Development

Examples of development activity which are of minimal value and suitable for development in conditionally stable dunes and deflation plains include beach and dune boardwalks, fences which do not affect sand erosion or migration, and temporary open-sided shelters.

C. Evaluating Beach and Dune Plans and Actions

Local government should adopt strict controls for carrying out the Implementation Requirements of this goal. The controls could include:

1. requirement of a site investigation report financed by the developer;
2. posting of performance bonds to assure that adverse effects can be corrected; and
3. requirement of re-establishing vegetation within a specified time.

D. Sand By-Pass

In developing structures that might excessively reduce the sand supply or interrupt the longshore transport or littoral drift, the developer should investigate, and where possible, provide methods of sand by-pass.

E. Public Access

Where appropriate, local government should require new developments to dedicate easements for public access to public beaches, dunes and associated waters. Access into or through dune areas, particularly conditionally stable dunes and dune complexes, should be controlled or designed to maintain the stability of the area, protect scenic values and avoid fire hazards.

F. Dune Stabilization

Dune stabilization programs should be allowed only when in conformance with the comprehensive plan, and only after assessment of their potential impact.

G. Off Road Vehicles

Appropriate levels of government should designate specific areas for the recreational use of off road vehicles (ORV's). This use should be restricted to limit damage to natural resources and avoid conflict with other activities, including other recreational use.

APPENDIX B

Clatsop County:

Warrenton Soil and Water Conservation District Regulations, and

Clatsop County Active Dune Overlay District

Warrenton Soil and Water Conservation District Regulations *

Ordinances prescribing land use regulations for the care, treatment, and operation of certain lands designated as Zones 1 and 2 within the Warrenton Dune Soil Conservation District.[16]

WHEREAS, the lands within the Warrenton Dune Soil Conservation District are basic assets of the district and their preservation is necessary to protect and promote the health, prosperity, and welfare of the people in the district; and some of the lands are extremely susceptible to erosion by wind that damages not only the land from which the soil is blown but also the lands and improvements of neighbors; and erosion of such lands can be prevented by the maintenance of a continuous vegetative cover; and, the removal or destruction of even a portion of such cover by any act or use of the lands may result in the initiation of erosion processes that spread to other lands, causing economic loss and a hazard to the use and occupancy of the lands of the district by man or his animals, and (here omitted from this copy of the ordinance is the legal description of Zones 1 and 2. These legal descriptions are available on request, and the attached map gives the general location of district and Zones 1 and 2).

NOW THEREFORE be it ordained by the landowners within the Warrenton Dune Soil Conservation District, and within the area known as Zone 1, that:

Section 1. Erosion will be controlled and the soil stabilized by vegetative and/or mechanical means on all lands of this area. After stabilization, continuous maintenance will be provided.

Section 2. No livestock may be grazed in the area.

Section 3. Vehicular and recurring pedestrian and equestrian traffic will be restricted to hard surfaced (plank, gravel bound with clay, asphalt, or other material of like character) roads or trails.

Section 4. No roads or trails may be built by other than the County, State, or Federal Government without a permit from the Warrenton Dune Soil Conservation District Board of Supervisors.

Section 5. No building may be constructed in the area.

Section 6. No other acts or land uses that result in destruction or serious deterioration of the ground cover will be permitted except under conditions approved by the District Board of Supervisors.

Section 7. Nothing in this ordinance shall be construed as prohibiting construction by Federal or State Governments necessary for national security or public health.

*From U.S.D.A., Soil Conservation Service and OCCDC, 1975, pp. 100-103

Section 8. The district Board of Supervisors is hereby authorized to request the State Soil Conservation Committee to appoint a Board of Adjustment, as provided in Section 109-313, O.C.L.A., consisting of three members who shall not be landowners in said district or of kin within the third degree to any person owning land in said district. Said Board of Adjustment shall have power to authorize variance from the terms of these land use regulations in accordance with substantial justice.

Section 9. Upon the approval of this ordinance by the favorable vote of three-fourths majority of all votes cast by landowners representing two-thirds of the land within the district approving the same, it shall immediately thereupon be in full force and effect.

NOW THEREFORE be it ordained by the landowners within the Warrenton Dune Soil Conservation District, and within the area known as Zone II, that:

Section 1. Erosion shall be controlled and the soil stabilized by vegetative and/or mechanical means on all lands of this area. After stabilization, continuous maintenance will be provided.

Section 2: Livestock may be grazed in the area with a permit from the Warrenton Dune Soil Conservation District Board of Supervisors. Livestock grazed within the area shall be confined by herding or fences to the land described in the permit, and the land shall not be grazed by a class of livestock, a greater number, or in excess of the period specified in the permit.

Section 3. Vehicular traffic and recurring equestrian traffic will be confined to hard surfaced (plant, gravel bound with clay, asphalt, concrete, or other material of like character) roads or trails.

Section 4. Vegetative cover specified by the Board of Supervisors of the district will be established where vegetation is destroyed during construction operations. All excavations, fills, or other disturbed land surfaces shall be prepared for planting and be planted to vegetation specified by the Board of Supervisors of the district during the planting period November through April immediately following such disturbance. After stabilization, continuous maintenance shall be provided.

Section 5. No other acts or land uses that result in destruction or serious deterioration of the ground cover will be permitted except under conditions by the Board of Supervisors of the district.

Section 6. The District Board of Supervisors is hereby authorized to request the State Soil Conservation Committee to appoint a Board of Adjustment, as provided in Section 109-313, O.C.L.A., consisting of three members who shall not be landowners in said district or of kin within the third degree to any person owning land in said district. Said Board of Adjustment shall have power to authorize variance from the terms of these land use regulations in accordance with substantial justice.

Section 7. Upon approval of this ordinance by the favorable vote of three-fourths majority of all votes cast by landowners representing two-thirds of the land within the district approving the same, it shall immediately thereupon be in full force and effect.

Clatsop County Active Dune Overlay District

Section 4.160. A Zone - Active Dune Overlay District. This section applies to all areas identified as active dunes (except for the provisions of Section 4.180) within the unincorporated areas of Clatsop County. (Added by Ordinance 78-26)

4.161. Purpose and Intent. The intent of this section is to regulate actions in active dune areas in order to protect the fragile nature of the dune. Should the regulations of this overlay zone be in conflict with the underlying primary zone or the regulations of the Clatsop Soil and Water Conservation District, the conflict(s) shall be resolved by the application of the more stringent regulation(s).

4.162. Mapping. Active dunes, conditionally stable dunes, and dunes subject to ocean undercutting and wave overtopping are identified on maps accompanying Stability of Coastal Dunes, January, 1978, report by Leonard Palmer.

Dune areas mapped in the study were identified by LCDC criteria (see report). Active dunes were defined by evidence from photographs, photo maps, soils, and landforms, to be active or to show recurrent activity in the context of approximately 100 years. The mapping is not intended to specify site conditions or stability, nor to replace site specific studies. The dune mapping is intended to be a preliminary working designation of areas in which further studies may be required. The boundaries mapped should be changed when on-site conditions are shown to have changed, or when improved data is obtained.

4.163. Definition of Terms. The following definitions are to be used for sections 4.160 and 4.180. Where definitions found in Section 2.020 conflict with the definitions of Section 4.163 those in Section 4.163 shall control.

4.163-1. ACCRETION - The build-up of land along a beach or shore by the deposition of waterborne or airborne sand, sediment, or other material.

4.163-2. BEACH - Gently sloping areas of loose material (e.g. sand, gravel, and cobbles) that extend landward from the low-water line to a point where there is a definite change in the material type or landform, or to the line of vegetation.

4.163-3. BEACH ACCESS, PUBLIC OR PRIVATE - Trails or roads which provide access for the public to the beach.

4.163-4. BREACHING - To make a hole or a gap through an area such as a foredune.

4.163-5. DUNE - A hill or ridge of sand built up by the wind along sandy coasts.

4.163-6. DUNE, ACTIVE - A dune that migrates, grows and diminishes from the force of wind and supply of sand. Active dunes include all open sand dunes, active hummocks, and active foredunes.

4.163-7. FOREDUNE, ACTIVE - An unstable barrier ridge of sand paralleling the beach and subject to wind erosion, water erosion, and growth from new sand deposits. Active foredunes may include areas with beach grass, and occur in sand spits and at river mouths as well as elsewhere.

4.163-8. RECREATION - Any experience voluntarily engaged in largely during leisure (discretionary time) from which the individual derives satisfaction.

4.163-9. RECREATION, LOW INTENSITY - does not require developed facilities and can be accommodated without change to the area or resource. e.g. boating, hunting, hiking, wildlife photography, and beach or shore activities can be low intensity recreation.

4.163-10. STABILIZATION - The process of controlling sand activity (i.e. stilling the movement of sand) by natural vegetative growth, planing of grasses and shrubs, or mechanical means (e.g. wire net, fencing).

4.163-11. STRUCTURE - Anything constructed or installed or portable, the use of which requires a location on a parcel of land.

4.164. Uses Permitted.

(1) Use of equipment needed to help stabilize and maintain the vegetation of the dune.

(2) Scientific study of natural and cultural systems such as dunes, dune stabilization, aquifer monitoring wells, archeological remains.

(3) Wildlife sanctuary.

(4) Low intensity recreation.

(5) Maintenance of existing structures and roads.

4.165. Uses Permitted Subject to Conditions.

(1) Hiking, equestrian and nature trails shall be approved by the Clatsop County Department of Planning and Development.

(2) Private beach access subject to approval of the Clatsop County Department of Planning and Development.

(3) Subsurface sewage disposal systems subject to the approval of the Clatsop County Sanitarian and the revegetation requirements approved by the Clatsop County Department of Planning and Development.

(4) Breaching of sand dune on a temporary basis in an emergency (e.g. fire control) only if the breaching, and restoration after breaching is consistent with sound principles of conservation. A restoration plan shall be approved by the Clatsop County Department of Planning and Development.

(5) Temporary open-sided structures subject to approval by Clatsop County Department of Planning and Development.

(6) Public beach access subject to the approval of the Clatsop County Planning Commission.

4.166. Uses Prohibited.

(1) Breaching of sand dune except for that listed in Section 4.165.

(2) Sand removal.

(3) Structure(s) except for Section 4.165(5).

(4) Grazing of livestock.

(5) Off-road vehicles.

4.167. Conditions for Approval of Uses. The Department of Planning and Development may include but not be limited to the placing of the following conditions on the approval of permits for uses in Section 4.165.:

(1) prescribing the extent of vegetation removal;

(2) prescribing the time, amounts and types of materials and the methods to be used in restoration of dune vegetation;

(3) prescribing setbacks greater than required in the underlying zone in order to comply with the intent of the Clatsop County Comprehensive Plan and the Clatsop County Zoning Ordinance No. 66-2, as amended;

(4) prescribing the location, design and number of proposed uses; and

(5) for the establishment of State public beach access points:

(a) public need must be shown; and, if it is determined that there is a public need, then

(b) the State must satisfactorily prove why this location for the proposed beach access, when compared with other locations best serves the public need.

All conditions shall be found by the Department of Planning and Development to provide for or protect the public health, safety or general welfare, protect the dune, and protect adjacent properties both present and in the future.

Conditions of approval shall be sufficient to protect the property from erosion by wind or water or both, the dune from the loss of stabilizing vegetation, and the permanent drawdown of the groundwater supply.

4.168. Guarantee of Performance. Clatsop County shall require the subdivider or developer of any subdivision to post a performance bond to assure that adverse effects that may occur can be corrected. For the guarantee of performance the following standards shall apply:

(1) Method of Guarantee. The subdivider or developer shall deposit cash, or other instrument readily convertible into cash at face value, either with the County, or in escrow with a bank. The use of any instrument other than cash, and, in the case of an escrow account, shall be subject to the

approval of Clatsop County. The amount of the deposit shall be at least twice the cost, as estimated by the subdivider or developer and approved by the County Engineer, of restoration or construction of required improvements.

In the case of an escrow account, the subdivider or developer shall file with the Department of Planning and Development an agreement between the financial bank and himself guaranteeing the following:

(a) that the funds of said escrow account shall be held in trust until released by Clatsop County and may not be used or pledged by the subdivider or developer as security in any other matter during that period; and

(b) that in the case of a failure on the part of the subdivider or developer to complete said improvements, then the bank shall immediately make the funds in said account available to the County for use in the completion of those improvements.

(2) Inspection and Certification. The County Engineer, or other knowledgeable official as specified by the Department of Planning and Development, shall regularly inspect for defects in the restoration or construction of required improvements. Upon completion of these improvements, the County Engineer shall file with the Department of Planning and Development a statement either certifying that the restoration or improvements have been completed in the specific manner or listing the defects in those improvements.

Upon completion of the restoration or improvments, the subdivider or developer shall file with the Department of Planning and Development a statement stipulating the following:

(a) that all required improvements are complete;

(b) that these improvements are in compliance with the minimum standards specified by the Department of Planning and Development for their construction;

(c) that the subdivider or developer knows of no defects from any cause, in those improvements; and

(d) that these improvements are free and clear of any encumbrance or lien.

(3) Release of Guarantee. If the County Department of Planning and Development and Engineer have certified that the contracted restoration or improvements are complete and free from defect, the County shall authorize the release of the restoration or improvement guarantee.

4.169. Time Limits. Prior to approval of the permit the subdivider or developer and the Department of Planning and Development shall agree upon a deadline for the completion of the required improvements, such deadline not to exceed one year from the time of the permit. The County shall have the power to extend the deadline for improvements for one additional year when the subdivider or developer can present substantial reason for doing so.

The subdivider or developer shall restore the vegetation within the first planting season (October to April) using the amounts and types of materials and methods as prescribed by the Department of Planning and Development.

The timing of the permits should be made so that restoration may be started as early in the planting season as possible.

4.170. Warning and Disclaimer of Liability. The degree of protection from erosion or accretion required by this ordinance is considered reasonable for regulatory purposes. Erosion is occurring from the South Jetty of the Columbia River south approximately three miles. Erosion of the dunes may occur south of this area sometime in the future.

This ordinance does not imply that land outside the A or SA zones or uses permitted within such areas will be free from erosion or accretion. This ordinance shall not create a liability on the part of Clatsop County or by an officer or employee thereof for any damages due to erosion or accretion that result from reliance on this ordinance or any administrative decision lawfully made thereunder.

4.171. Permit Procedures. Application for the construction of all structures and construction of uses permitted subject to conditions in Section 4.165 are required and shall be made to the Planning Director or his designate on forms prescribed by Clatsop County. The applicant shall be required to provide at least the following information:

(1) a map showing the location of the proposed use and surrounding uses including structures, vegetation, etc.;

(2) description of the extent to which a sand dune will be altered as a result of the proposed use; and

(3) other such information as is needed to determine conformance with this ordinance.

4.172. Appeal Procedure.

(1) An appeal of a ruling or interpretation of maps or a requirement of this Ordinance by the Planning Director shall be heard by the Clatsop County Planning Commission in accordance with the provisions of Article 11.

(2) The Planning Commission shall hear and decide appeals when it is alleged there is an error in any requirement, decision or determination in the enforcement or administration of this ordinance.

4.173. Penalties. Any person violating any of the provisions of this ordinance shall be subject to the provisions of ORS 215.180, 215.185 and 215.990. A violation of this ordinance shall be considered a separate offense for each day the violation continues.

Section 4.180 SA Zone - Structures Allowed, Active Dune Overlay District. This section shall apply to all areas identified as active dunes that are committed to development within the unincorporated areas of Clatsop County. (Added by Ordinance 78-26)

4.181. Purpose and Intent. The intent of this section is to regulate actions in active dune areas in order to minimize damage to the fragile nature of the dunes, property and structures that may occur as a result of accretion or erosion.

The purpose of this overlay zone is to comply with the Land Conservation and Development Commission Land Use Planning Goal (#2) Part II Exceptions as it relates to development in the active dune (Beaches and Dunes Goal #18). Should the regulations of this overlay zone be in conflict with the underlying primary zone or the Clatsop Soil and Water Conservation District regulations, the conflict(s) shall be resolved by the application of the more stringent regulation(s).

4.182. Mapping. Active dunes, conditionally stable dunes, and dunes subject to ocean undercutting and wave overtopping are identified on maps accompanying Stability of Coastal Dunes, January, 1978, report by Leonard Palmer.

Dune areas mapped in the study were identified by LCDC criteria (see report). Active dunes were defined by evidence from photographs, photo maps, soils, and landforms, to be active or to show recurrent activity in the context of approximately 100 years. The mapping is not intended to specify site conditions or stability, nor to replace site specific studies. The dune mapping is intended to be a preliminary working designation of areas in which further studies may be required. The boundaries mapped should be changed when on-site conditions are shown to have changed, or when improved data is obtained.

4.183. Definition of Terms. The definitions described in Section 4.163 shall also pertain to Section 4.180. Where definitions found in Section 2.020 conflict with definitions in Section 4.163, those in 4.163 shall control.

4.184. Uses Permitted Subject to Conditions.

(1) Uses permitted, accessory uses and conditional uses listed in the primary zone subject to Sections 4.185 and 4.186.

(2) Hiking, equestrian and nature trails shall be approved by the Clatsop County Department of Planning and Development and Sections 4.186 and 4.188.

(3) Private beach access subject to approval of the Clatsop County Department of Planning and Development and Sections 4.187 and 4.188.

(4) Subsurface sewage disposal systems subject to the approval of the Clatsop County Sanitarian and the revegetation requirements approved by the Clatsop County Department of Planning and Development and Sections 4.187 and 4.188.

(5) Breaching of sand dune on a temporary basis in an emergency (e.g. fire control) only if the breaching, and restoration after breaching is consistent with sound principles of conservation. A restoration plan shall be approved by the Clatsop County Department of Planning and Development and comply with Sections 4.187 and 4.188.

(6) Temporary open-sided structures subject to approval by Clatsop County Department of Planning and Development and Sections 4.187 and 4.188.

(7) Public beach access subject to the approval of the Clatsop County Planning Commission.

4.185. Uses Prohibited.

(1) Breaching of sand dune except for that listed in Section 4.165.

(2) Sand removal.

(3) Grazing of livestock.

(4) Off-road vehicles.

4.186. Conditions for Approval of Uses. The Department of Planning and Development may include but not be limited to the placing of the following conditions on the approval of permits for uses in Sections 4.184 and 4.185:

(1) prescribing the extent of vegetation removal;

(2) prescribing the time, amounts and types of materials and the methods to be used in restoration of dune vegetation;

(3) prescribing setbacks greater than required in the underlying zone in order to comply with the intent of the Clatsop County Comprehensive Plan and the Clatsop County Zoning Ordinance No. 66-2, as amended;

(4) prescribing the location, design and number of proposed uses; and

(5) for the establishment of State public beach access points:

(a) public need must be shown; and, if it is determined that there is a public need, then

(b) the State must satisfactorily prove why this location for the proposed beach access, when compared with other locations best serves the public need.

All conditions shall be found by the Department of Planning and Development to provide for or protect the public health, safety or general welfare, protect the dune, and protect adjacent properties both present and in the future.

Conditions of approval shall be sufficient to protect the property from erosion by wind or water or both, the dune from the loss of stabilizing vegetation, and the permanent drawdown of the groundwater supply.

4.187 Guarantee of Performance. Clatsop County shall require the subdivider or developer of any subdivision to post a performance bond to assure that adverse effects that may occur can be corrected. For the guarantee of performance the following standards shall apply:

(1) Method of Guarantee. The subdivider or developer shall deposit cash, or other instrument readily convertible into cash at face value, either with the County, or in escrow with a bank. The use of any instrument other than cash and, in the case of an escrow account, shall be subject to the approval of Clatsop County. The amount of the deposit shall be at least twice the cost, as estimated by the subdivider or developer and approved by the County Engineer, of restoration or construction of required improvements.

In the case of an escrow account, the subdivider or developer shall file with the Department of Planning and Development an agreement between the financial bank and himself guaranteeing the following:

(a) that the funds of said escrow account shall be held in trust until released by Clatsop County and may not be used or pledged by the subdivider or developer as security in any other matter during that period; and

(b) that in the case of a failure on the part of the subdivider or developer to complete said improvements, then the bank shall immediately make the funds in said account available to the County for use in the completion of those improvements.

(2) Inspection and Certification. The County Engineer, or other knowledgeable official as specified by the Department of Planning and Development, shall regularly inspect for defects in the restoration or construction of required improvements. Upon completion of these improvements, the County Engineer shall file with the Department of Planning and Development a statement either certifying that the restoration or improvements have been completed in the specific manner or listing the defects in those improvements.

Upon completion of the restoration or improvements, the subdivider or developer shall file with the Department of Planning and Development a statement stipulating the following:

(a) that all required improvements are complete;

(b) that these improvements are in compliance with the minimum standards specified by the Department of

Planning and Development for their construction;

(c) that the subdivider or developer knows of no defects from any cause, in those improvements; and

(d) that these improvements are free and clear of any encumbrance of lien.

(3) Release of Guarantee. If the County Department of Planning and Development and Engineer have certified that the contracted restoration or improvements are complete and free from defect, the County shall authorize the release of the restoration or improvement guarantee.

4.188. <u>Time Limits</u>. Prior to approval of the permit the subdivider or developer and the Department of Planning and Development shall agree upon a deadline for the completion of the required improvements, such deadline not to exceed one year from the time of the permit. The County shall have the power to extend the deadline for improvements for one additional year when the subdivider or developer can present substantial reason for doing so.

The subdivider or developer shall restore the vegetation within the first planting season (October to April) using the amounts and types of materials and methods prescribed by the Department of Planning and Development.

The timing of the permits should be made so that restoration may be started as early in the planting season as possible.

4.189. <u>Warning and Disclaimer of Liability</u>. The degree of protection from erosion or accretion required by this ordinance is considered reasonable for regulatory purposes. Erosion is occurring from the South Jetty of the Columbia River south approximately three miles. Erosion of the dunes may occur south of this area sometime in the future.

This ordinance does not imply that land outside the A or SA zones or uses permitted within such areas will be free from erosion or accretion. This ordinance shall not create a liability on the part of Clatsop County or by an officer or employee thereof for any damages due to erosion or accretion that result from reliance on this ordinance or any administrative dicision lawfully made thereunder.

4.190. <u>Permit Procedures</u>. Application for the construction of all structures and construction of uses permitted subject to conditions in Section 4.165 are required and shall be made to the Planning Director or his designate on forms prescribed by Clatsop County. The applicant shall be required to provide at least the following information:

(1) a map showing the location of the proposed use and surrounding uses including structures, vegetation, etc.;

(2) description of the extent to which a sand dune will be altered as a result of the proposed use; and

(3) other such information as is needed to determine conformance with this ordinance.

4.191. <u>Appeal Procedure</u>.

(1) An appeal of a ruling or interpretation of maps or a requirement of this Ordinance by the Planning Director shall be heard by the Clatsop County Planning Commission in accordance with the provisions of Article 11.

(2) The Planning Commission shall hear and decide appeals when it is alleged there is an error in any requirement, decision or determination in the enforcement or administration of this ordinance.

4.192. <u>Penalties</u>. Any person violating any of the provisions of this ordinance shall be subject to the provisions of ORS 215.180, 215.185 and 215.990. A violation of this ordinance shall be considered a separate offense for each day the violation continues.

APPENDIX C

Tillamook County:

Working Paper, Draft II, Beaches and Dunes Goal #18 and

Information for People Who Own Property On Active Foredunes

WORKING PAPER

DRAFT POLICIES

A. POLICIES - GEOLOGY AND GEOLOGIC HAZARDS

(1) The removal of sand and gravel from beaches except for extenuating circumstances shall be prohibited. Such material is involved in the longshore transport and its removal from this system is likely to enhance erosion somewhere else along the coast.

(2) The removal of sand and gravel from the backdune areas is prohibited except under unusual circumstances in order to preserve the stable nature of these landforms. If sand is removed it should be taken only from the least sensitive areas or the backdune. Disturbed areas must be revegetated.

(3) Filling in the deflation plain is prohibited since it alters the flood plain function of these land formations, alters groundwater infiltration and changes the hydrolic characteristics of the dune system, affecting plant communities and ultimately the stability of the dune system.

(4) The stabilization of accreted sand in association with jetties or groins shall be prohibited except where necessary for the maintenance of these structures. Unnecessary stabilization of active sand areas oftentimes interferes with the sand budget of the coastal zone and may affect the processes which maintain the protective foredune barrier.

(5) Log debris plays an important role in the formation and maintenance of foredunes. Therefore, driftwood removal from sand areas and beaches for both individual and commercial purposes should be regulated so that dune building processes and scenic values are not adversely affected.

B. POLICIES - FLOOD HAZARDS

(1) Development in areas subject to ocean flooding shall be prohibited. An exception shall be taken to those areas that are "irrevocably" committed to development.

(2) Where development within the beach and dune flood areas is allowed, all new construction and substantial improvements shall be constructed by methods and practices that minimize flood damage (flood proofing).

(3) Flood regulations shall be based on the most current and reliable flood data and meet the requirements established by the Federal Insurance Administration.

C. POLICIES - GROUNDWATER AND WATER QUALITY

(1) The withdrawal of groundwater from the dune area shall be limited to levels which will inusre that a proposed activity(ies) will not result in the drawdown of the groundwater supply which could lead to any of the following: loss of stabilizing vegetation, loss of water quality, saltwater intrusion into the water supply or result in the drawdown of dune lakes.

(2) In order to avoid groundwater polution, development in dune areas with high water tables and/or impermeable subsurface soil horizons shall be allowed only where sanitary sewer systems are available.

(3) To assure that recharge areas for groundwater aquafirs are protected from polution, waste discharge operations such as land fills, septic tanks and industrial waste lagoons are not recommended for these areas.

(4) Draining the deflation plain wet areas is discouraged since this will affect the water table level of adjacent dunes, their plant communities and ultimately dune stability.

STANDARDS - GROUNDWATER AND WATER QUALITY

Steps for preventing saltwater intrusion include conducting adequate hydrology studies to define the proper spacing and yield of water wells and a commitment to base development on the results of these studies.

D. POLICIES - WILDLIFE HABITAT

(1) Sandspits in Tillamook County shall be managed to enhance the preservation of their values as recreational, scenic and wildlife habitats.

(2) Due to their poor suitability for development and high value as wildlife habitats, wet deflation plains to the greatest extent possible shall be maintained in their natural state.

(3) Areas of importance for rare species should not be designated for any vehicle activity; if such an area is nearby, management techniques should be employed to protect it.

(4) To reduce disruption in identified nesting areas of the rare snowy plover, apprioriate management agencies should implement a closure period to the more remote (few access points) beach areas for the nesting period April through June.

STANDARDS - WILDLIFE HABITAT

Waterfowl habitat in the reflation plain can be greatly enhanced by planting hannchen barley for feed. (OCC&DC p. 26)

E. POLICIES - DEVELOPMENT:

(1) Residential developments and commercial and industrial buildings are prohibited in areas designated as active or conditionally stable foredunes. Foredunes which are subject to wave overtopping, plains) that are subject to ocean flooding, except for areas where Tillamook County is requesting an "exception" to the Beaches and Dunes Goal No. 18.

(2) Site specific investigations by a qualified person such as a geologist, soil scientist or geomorphologist may be required by the county prior to the issuance of new developments, or building permits in open sand areas on the ocean front in steep hillsides of dunes and in any other dune areas which may be subject to wind erosion or other hazard potential.

(3) No foredune shall be breached or modified from its natural condition except as part of a dune stabilization program or as part of an authorized sand-bypass program. Removal of the foredunes barrier causes increased ocean flooding of inland areas.

(4) Extensive modification of other dunes is strongly discouraged because such activities are difficult to stabilize.

(5) Development in active sand areas is strongly discouraged and will be allowed only after the area has been stabilized by vegetative plantings.

(6) The use of pavement and other hard surfaced coverings to stabilize active sand areas is discouraged.

(7) Roads in dune areas shall, as much as possible, be routed along troughs between dune ridges. Roads shall not be located in the vegetative area along the face or top of the foredune.

STANDARDS:

(1) During construction in sand areas slopes should not be excavated to steepness of greater than 30 degrees. This is the natural angle of repose for sand and excavations with slopes greater than this are highly subject to slumping.

(2) Vegetated slopes of steepnesses greater than 30 degrees in dune areas should not be cleared. As the slope of bare sand will then exceed its natural angle or repose and a slump or slide will occur.

(3) Grading of the dune landform must be kept to a minimum with all banks leveled to a slope not exceeding 30 degrees. Due to the shallow angle of repose of unconsolidated sand.

(4) Adequate setbacks for structures must be provided for by considering the rate of erosion together with the anticipated life of any structures.

(5) To maintain the aesthetic value and visual integrity of beach and dune areas subject to new development all service lines shall be placed underground.

(6) Removal of vegetation during construction in any sand area shall be kept to the minimum required for building placement or other valid purpose.

(7) Removal of vegetation should not occur more than 30 days prior to grading or construction.

(8) Permanent revegetation shall be started at the site as soon as practicable after construction. Final grading or utility placement time limitations will be dependent upon circumstances.

(9) All setbacks shall be measured from the line of erosion not from the state zone line or property boundaries.

(10) The linear arrangement of structures on dune ridges is discouraged. As this arrangement leads to variations in air flow characteristics which in turn can affect the stability of the dune system.

(11) Any proposals for development in beach and dune areas must be accompanied by a description of the dune stabilization program.

F. POLICIES - RECREATION

(1) Because of their sensitivity and exceptional importance for their value as recreational areas, scenic resources and wildlife habitat, all sandspits in public ownership shall maintain a low development posture. The management of these areas as Natural or Conservation units is greatly facilitated by their relative isolated position along the coast.

(2) Access trails to the beach should be clearly marked to reduce the number of people meandering through the dunes looking for access to the beach, trespassing on private property and breaking down sensitive plant communities in the process.

(3) Because of the sensitive nature of active and conditionally stable dunes, vehicular traffic and recurring pedestrian and equestrian traffic shall be, where practicable, limited to hard surface roads and trails.

(4) Public safety hazards and annoyance factors indicate that ORV's are often incompatible with pedestrian and equestrian use. With increasing numbers of people participating in these activities, it is necessary in some areas such as Sand Lake to separate these uses and designate areas for off road vehicle use.

(5) The open sand areas at Sand Lake under State Forestry Department jurisdiction shall be maintained in its natural unstabilized state in order to preserve this open dune system for its scenic and recreational values.

(6) To maintain the ecological and aesthetic qualities of Sand Lake, ORV use shall be controlled within a special management area. The development of a ORV management plan is recommended. The plan shall consider designated ORV use areas, user capacity, management technicques, access control and adjoining land use compatibility conflicts.

STANDARDS - RECREATION

In areas of high pedestrian traffic or great fragility, slightly elevated boardwalks are suggested as an effective means of traffic containment.

Additionally, revisions to the policies were recommended by the various Citizen Advisory Committees and other agencies and organizations.

Tillamook County
OFFICE OF PLANNING COMMISSION
Tillamook, Oregon 97141

INFORMATION FOR PEOPLE WHO OWN PROPERTY ON ACTIVE FOREDUNES

QUESTION: WHAT IS AN "ACTIVE FOREDUNE"?

An unstable barrier ridge of sand paralleling the beach and subject to wind erosion, water erosion, and growth from new sand deposits. Active foredunes may include areas with beach grass, and occur in sand spits and at river mouths as well as elsewhere.

QUESTION: HOW DOES THE NEW OREGON BEACHES AND DUNES GOAL AFFECT ME?

In most cases, the goal prohibits residential development and commercial and industrial buildings on active foredunes, conditionally stable foredunes subject to ocean undercutting or wave overtopping, and on deflation plains subject to ocean flooding. (SEE page 2 for cases where special conditions apply)

In addition, the goal requires that "local governments and state and federal agencies shall base decisions on plans, ordinances and land use actions in beach and dune areas, other than older stabilized dunes, on specific findings that shall include at least:

a) the type of use proposed and the adverse effects it might have on the site and adjacent areas;

b) temporary and permanent stabilization programs and the planned maintenance of new and existing vegetation;

c) methods for protecting the surrounding area from any adverse effects of the development; and

d) hazards to life, public and private property, and the natural environment which may be caused by the proposed use."

Other important provisions require local governments and state and federal agencies to:

1) regulate actions in beach and dune areas to minimize the resulting erosion;

2) protect the groundwater from drawdown;

3) issue permits for beach front protective structures (ie.; rip rap) only where development existed on January 1, 1977.

QUESTION: HOW DOES THE NEW OREGON BEACHES AND DUNES GOAL AFFECT ME IN TERMS OF ITS EFFECTIVE DATE; JANUARY 1, 1977?

CASE #1: If a building permit was issued prior to January 1, 1977:

The Beaches and Dunes Goal does NOT apply

CASE #2: If a building permit was NOT issued prior to January 1st but the individual lot owner demonstrated intent to develop his property through documented permit applications, contract obligations, or purchase agreements (ie.; application for a building permit, contracts for architectural designs or engineering feasibility studies, or purchase of rip rap, etc.):

The Beaches and Dunes Goal DOES apply...
However, approval of building permits can be granted based on demonstrated intent prior to January 1, 1977, provided that other provisions of the goal are complied with.

CASE #3. If a building permit was NOT issued and intent to develop property could NOT be demonstrated prior to January 1st, and if special circumstances exist which may warrant that certain provisions of the goal be waived:

The Beaches and Dunes Goal DOES apply...
However, approval of building permits can be granted if a valid need for an exception can be demonstrated based on the exceptions clause contained in Statewide Planning Goal #2. All other goal provisions would remain in effect.

CASE #4: If none of the above conditions can be satisfied:

The Beaches and Dunes Goal DOES apply in its entirety. Building permits can not be granted until the foredune is stabilized and adequate hazard protection is provided.

QUESTION: WHAT DOES THE EXCEPTIONS CLAUSE IN STATEWIDE PLANNING GOAL #2 REQUIRE?

A public hearing must be held. Compelling reasons and facts must be provided to show why the exception should be granted including reasons stating why the use should be allowed; what alternative locations in the area could be used for the proposed development; what the long term environmental, economic, social and energy consequences will be; and how the proposed development will be compatible with adjacent uses.

APPENDIX D

Cannon Beach Comprehensive Plan

Manzanita Zoning Ordinance No. 78-6

Rockaway Zoning Ordinance No. 143

CANNON BEACH COMPREHENSIVE PLAN *

HAZARDS POLICIES

1. The City shall make reasonable efforts to protect life and property from natural disasters and hazards. Measures employed by the City shall be the Plan, Zoning and Subdivision Ordinances, the Uniform Building Code (Chapter 70) and other city ordinances.

2. As reliable information on the location and nature of building hazards becomes available, it shall be included in the Comprehensive Plan background data, and shall form the basis for City policies regulating development in these areas.

3. A "Master Map" delineating areas of natural hazards shall be kept on file in City Hall, and shall be available to inform citizens of the locations of hazards, The Master Map shall contain the most up-to-date information available on mass movement, ocean or stream flooding, weak foundations soils, or other hazards the Planning Commission or City Council may designate.

AREA SPECIFIC POLICIES

1. The Curves Area (Tolovana Hill):

   Further development within the large active landslide on either side of Hemlock must be carefully planned and closely monitored.

2. The North End Area:

   a. Topographic map coverage is important for the evaluation of the area's buildability. At the present time, this coverage is not feasible due to the dense vegetation that covers most of the area. Proposed developments, through their site investigations, should provide more detailed topographic mapping.

   b. Development could be allowed on certain steep slopes where the thick basalt sill occurs as bedrock near enough to the surface for footings to be anchored in solid, fresh basalt without extensive (preferably no) excavation of soil. Efforts shall be made to retain the natural conditions of steep slopes.

   c. The remainder of the north end area shall be designated low density, with the allowable units per acre based on percentage of slope.

3. Beach Frontage:

   a. Excavation of sand from the beach shall be prohibited. This practice oversteepens sections of the seaward slope of the dunes and exposes them to erosion by storm waves, and to a lesser extent, by high tides. The blowing of sand up onto Ocean Avenue could better be controlled by maintaining adequate vegetation cover between the street and the sand buffer. Removal or destruction of vegetation in this area shall be strictly prohibited.

* From Morgan, 1978.

b. In order to control foot traffic across protective dune barriers and to reduce blowing onto the street and adjacent property, access trails to the beach shall be maintained and clearly marked.

OVERALL POLICIES: GEOLOGIC HAZARDS

1. A site specific investigatión performed by a ualified expert shall be a prerequisite for the issuance of any building permit in the following areas, and delineated on the Master Map:

   a. Those areas consisting of landslide topography developed in Tertiary sedimentary rocks (TOMS).

   b. Any property containing, or adjacent to all or part of, an active landslide.

   c. Any property having beach frontage.

   d. The area south of Maher Street underlain by the Astoria Formation (Tma units).

2. Development requirements for the City are:

   a. Structures should be planned to preserve natural slopes. Cut and fill methods of leveling lots shall be discouraged.

   b. Access raods and driveways shall follow the slope contours to reduce the need for grading and filling.

   c. Removal of vegetation shall be kept to a minimum for stabilization of slopes.

   d. Drainage patterns shall not be altered in steeper areas. Roof drains shall be channeled into natrual drainage or storm sewers.

   e. No development shall be allowed to block stream drainageways, or to increase the water level or water flow onto adjacent property.

FLOOD HAZARD POLICIES

1. The City shall continue its participation in the Federal Flood Insurance Program, thourgh the enactment and enforcement of a Flood Hazards Ordinance. All new construction and substantial improvements shall be planned to minimize flood damage.

2. Where development within the floodplain is allowed, assurance to the City shall be given that the development will not be expected to raise adjacent flood heights and increase public safety hazards.

3. Development in areas subject to severe ocean erosion or flooding (the velocity zone) shall be constructed in such a way that hazards are minimized. A site specific investigation by a qualified expert shall be a prerequisite for all construction in the velocity zone.

4. Shore protective devices (seawalls, riprap) shall be planned by a qualified person so that it is permanent, and does not adversely affect adjacent property.

5. Filling of wetlands or natural drainages shall be prohibited unless it is adequately demonstrated that it will not affect adjacent property, and the wetlands area is not, in the view of State or Federal resource agencies, valuable biologically.

SAND DUNE CONSTRUCTION POLICIES

1. In accordance with the State Beaches and Dunes Goal (#18), construction on active foredunes, on other dunes which are conditionally stable and are subject to ocean undercutting or wave overtopping, and on interdune areas (deflation plains) that are subject to ocean flooding, shall be prohibited.

2. Permitted uses in these areas shall be those which are of very low intensity, (such as raised wooden walkways), which do not contribute to the removal of sand or vegetation, which could be easily removed in the event of ocean flooding or other hazards, and are of minimal value.

3. Removal of vegetation during construction in any sand area shall be kept to the minimum required for building placement or other valid purpose. Removal of vegetation should not occur more than 30 days prior to construction. Permanent revegetation shall be started on the site as soon as practical after construction, final grading or utility placement. Storage of sand or other materials should not suffocate vegetation.

4. In open sand areas which are being revegetated, and in open sand areas created during construction, revegetation must be closely monitored and carefully maintained, including restriction on pedestrian traffic. In all other sand areas from which vegetation is removed, the revegetation program should return the area to its original level of stability. A revegetation program with set time limits should be included in the developer's application for building permits for subdivision.

5. Site specific investigations by a qualified expert shall be required for the issuance of building permits in open sand areas, on hillsides in sand areas regardless of the type of dune or its present stability, and in those conditionally stable dunes not subject to ocean hazard, but which in the view of the building official have potential for wind erosion or other damage. Site reports shall be paid for by the developer, and the City may submit the reports to State and Federal agencies for evaluation.

6. Excavation and grading in sand areas shall be carefully controlled by the building official, through enforcement of Chapter 70 of the Uniform Building Code and the above policies.

7. The developer or party initiating action in sand areas shall be responsible for preventing adverse impacts on adjacent property, city streets, or utilities. Where necessary, the City may cause such impacts to be corrected at the expense of the developer, and place a lien on the property.

8. Breaching of foredunes shall only be done in extreme cases and when necessary for an emergency such as fire fighting or cleaning up oil spills.

9. Wells in dune areas shall not be permitted, in order to prevent the drawdown of groundwater and possible destruction of vegetation.

BEACHFRONT PROTECTIVE STRUCTURES POLICIES

1. In accordance with the Beaches and Dunes Goal, criteria for placement of beachfront protective structures shall provide that:

   a. Visual impacts are minimized;

   b. Access to the beach is maintained;

   c. Impacts on adjacent property are minimized;

   d. Long-term or recurring costs to the public are avoided.

2. The previous criteria shall apply to protective structures both on the public beach and east of the State zone or vegetation line.

3. Protective structures shall be properly engineered to reduce the need for future maintenance, and shall be the minimum necessary to protect the shoreline. Riprap shall be preferred over concrete seawalls as a protective device, and be as unobtrusive as possible.

4. Lots or parcels which have been subdivided shall be considered "developed" under the meaning of the State Goal and the Plan.

MANZANITA ZONING ORDINANCE NO. 78-6 *

Article 4. Supplementary Provisions

Section 4.050 Dune Construction Requirements.

(1) Removal of vegetation during construction in any sand area shall be kept to the minimum required for building placement or other valid purposes. Removal of vegetation should not occur more than 30 days prior to grading or construction. Permanent re-vegetation shall be started on the construction site as soon as practical after construction, final grading or utility placement. Storage of sand and other materials should be done so as not to suffocate vegetation.

(2) In open sand areas which are being re-vegetated, and in open sand areas created during construction, re-vegetation must be closely monitored and carefully maintained, including restrictions on pedestrian traffic. In all other sand areas from which vegetation is removed, the minimum acceptable re-vegetation program should return the area to its pre-construction level of stability (such as conditionally stable, or stabilized). This would entail the planting of trees in addition to ground cover such as beach grass. A re-vegetation program with set time limits should be included in the developers application for building permits or subdivisions.

(3) Site-specific investigations by a qualified engineering geologist or soils engineer may be a prerequisite for the issuance of building permits in open sand areas, on hillsides of over 20% , in sand areas regardless of the type of dune or its present stability, and in thos conditionally stable dunes not subject to ocean hazard, but which in the view of the building official have potential for wind erosion or other damage. Site investigations shall be done at the developer's expense. The City may submit any site reports to the State Department of Geology and Mineral Industries or other agency to assess its completeness.

(4) Excavation and grading in sand areas shall be carefully controlled by the building official, either through enforcement of Chapter 70 of the Uniform Building Code or the above policies.

* From Morgan, 1978.

ROCKAWAY ZONING ORDINANCE NO. 143 *

Section 4.044. DUNE CONSTRUCTION POLICY.

(1) Removal of vegatation during construction in any sand area shall be kept to the minimum required for building placement or other valid purposes. Removal of vegetation should not occur more than 30 days prior to grading or construction. Permanent re-vegetation shall be started on the construction site as soon as practical after construction, final grading or utility placement. Storage of sand and other materials should be done so as not to suffocate vegetation.

(2) In open sand areas which are being re-vegetated, and in open sand areas created during construction, revegetation must be closely monitored and carefully maintained, including restrictions on pedestrian traffic. In all other sand areas from which vegetation is removed, the minimum acceptable revegetation program should return the area to its pre-construction level of stability (such as conditionally stable, or stabilized.) This would entail the planting of trees in addition to ground cover such as beach grass. A revegetation program with set time limits should be included in the developers application for building permits or sub-divisions.

(3) Site-specific investigations by a qualified expert (refer to the appendix for guidelines) may be a prerequisite for the issuance of building permits in open sand areas, on hillsides in sand areas regardless of the type of dune or its present stability, and in those conditionally stable dunes not subject to ocean hazard, but which in the view of the building official have potential for wind erosion or other damage. Site investigations shall be done at the developer's expense. The City may submit any site reports to the State Department of Geology and Mineral Industries or other agency to assess its completeness.

(4) Excavation and grading in sand areas shall be carefully controlled by the building official, either through enforcement of Chapter 70 of the Uniform Building Code or the above policies.

*From Morgan, 1978.

A System Of Classifying & Identifying Oregon's Coastal Beaches & Dunes

Oregon Coastal Zone Management Association, Inc.

This report was prepared as part of a larger document addressing various beach and dune planning and management considerations and techniques. Other segments of the document and additional materials are:

I. BACKGROUND ON BEACH AND DUNE PLANNING:

Background of the Study

An Introduction to Beach and Dune Physical and Biological Processes

Beach and Dune Planning and Management on the Oregon Coast: A Summary of the State-of-the-Arts

II. BEACH AND DUNE IDENTIFICATION:

A System of Classifying and Identifying Oregon's Coastal Beaches and Dunes

III. PHYSICAL AND BIOLOGICAL CONSIDERATIONS:

Physical Processes and Geologic Hazards on the Oregon Coast

Critical Species and Habitats of Oregon's Coastal Beaches and Dunes

IV. MANAGEMENT CONSIDERATIONS:

Dune Groundwater Planning and Management Considerations for the Oregon Coast

Off-road Vehicle Planning and Management on the Oregon Coast

Sand Removal Planning and Management Considerations for the Oregon Coast

Oregon's Coastal Beaches and Dunes: Uses, Impacts and Management Considerations

Dune Stabilization and Restoration: Methods and Criteria

V. IMPLEMENTATION TECHNIQUES:

Beach and Dune Implementation Techniques: Findings-of-Fact

Beach and Dune Implementation Techniques: Site Investigation Reports

*Beach and Dune Implementation Techniques: Model Ordinances**

VI. ANNOTATED BIBLIOGRAPHY:

Beach and Dune Planning and Management: An Annotated Bibliography

VII. EDUCATIONAL MATERIALS:

Slide show: *Managing Oregon's Beaches and Dunes*

Brochure: *Planning and Managing Oregon's Coastal Beaches and Dunes*

*Prepared under separate contract between Oregon Department of Land Conservation and Development and the Bureau of Governmental Research, Eugene.

Illustrations prepared by Lorraine Morgan, Newport, Oregon
Cover photo by Christianna Crook, Newport, Oregon

A SYSTEM OF CLASSIFYING AND IDENTIFYING OREGON'S COASTAL BEACHES AND DUNES

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PREFACE

The following report presents the results of an in-depth analysis of beach and dune identification and classification systems conducted by the Oregon Coastal Zone Management Association, Inc. This report constitutes one element of an overall analysis of planning for and managing beaches and dunes as required by Oregon's Beaches and Dunes Goal.

This report was prepared by Christianna Crook, OCZMA Beaches and Dunes Study Team Research Associate, with assistance from other Study Team members composed of Carl Lindberg, Project Director, Wilbur Ternyik, Project Coordinator, Arlys Bernard, Project Secretary, and Kathy Fitzpatrick, Project Administrator.

In addition, valuable review and comments were made by the Beaches and Dunes Steering Committee composed of:

R. A. Corthell, U.S. Soil Conservation Service
Steve Stevens, U.S. Army Corps of Engineers
Sam Allison, Oregon Department of Water Resources
Peter Bond and John Phillips, Oregon Department of Transportation, Parks and Recreation Division
Bob Cortright, Oregon Department of Land Conservation and Development
Jim Lauman, Oregon Department of Fish and Wildlife
Jim Stembridge, Oregon Department of Soil and Water Conservation
Steve Felkins, Port of Coos Bay
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Cathy Mecone, Coos-Curry Council of Governments
Marilyn Adkins, City of Florence Planning Department
Phil Bredesen, Lane County Planning Department
Steve Goeckritz, Tillamook County Planning Department
Oscar Granger, Lincoln County Planning Department
Curt Schneider, Clatsop County Planning Department

Additionally, OCZMA extends special appreciation to the following individuals for their valuable input and direction and for their significant contributions to this report:

Bill Burley, Program Biologist, The Oregon Natural Heritage Program of the Nature Conservancy
Don Leach, District Conservationist, U.S.D.A., Soil Conservation Service

Dr. Paul Komar, Department of Oceanography, Oregon State University
Cathy Mecone, Planning Research Associate, Coos-Curry Council of Governments
Dr. Leonard Palmer, Department of Earth Science, Portland State University
Dr. James Stembridge, Coastal Resource Specialist, Oregon State Soil and Water Conservation Commission, and
Wilbur Ternyik, Owner/Operator, Wave Beachgrass Nursery

Finally, OCZMA expresses its sincere appreciation to the University of Washington Press for permission to reprint illustrations from Vascular Plants of the Pacific Northwest by C. Leo Hitchcock, et. al., (1955-1969).

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I. INTRODUCTION

Beaches and dunes are found on those accumulations of sand which occur intermittently along the Oregon coast. They range in size from small pocket beaches between headlands to expansive dune sheets more than twenty miles long and three to four miles wide. Varying combinations of physical factors (e.g. wind, vegetation, and moisture, etc.) are capable of producing widely diverse beach and dune landforms. Each landform exhibits discrete physical capabilities as well as characteristic sensitivies to man's activities.

Dune forms exhibit varying states of stability. Areas of *open sand* occur where dune topography is controlled only by sand and wind. Lightly vegetated areas are considered to be in an *active* state and are continuously subject to erosion and accretion. Dunes are *conditionally stabilized* when they have sufficient vegetative cover to withstand wind erosion. Other dune forms can be *surface stabilized* or *older* (semi-cemented) *stable*. That is, they may exhibit vegetation with a thin layer of soil, or may have vegetation and extensive soil layer with semi-cemented underlying sands.

This report classifies, describes and discusses the physical and biological nature and general capabilities of coastal Oregon sand landform types. In addition, a checklist of physical and biological[1] features characteristic of each type is included to assist with field identification. A glossary of terms used in this report is presented in the concluding section.

II. BEACH

A relatively narrow, sloping zone of unconsolidated materials extending from the low tide line landward to the uppermost line of effective wave or tidal action.

A. Geomorphology

Beach materials range in size from fine sand, to pebbles and even small boulders and are supplied from the erosion of coastal cliffs, the reworking of ancient and recent coastal sand deposits, and from riverine sediment loads. Sand supply and beach formation processes occur in seasonal cycles in which beaches commonly experience sand removal during the winter and are rebuilt by the more gentle wave action associated with summer weather activity. Beaches are the coastline's

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[1] Illustrations indicate the degree of magnification or reduction.

primary defense against the erosive action of storm waves.

Sand dunes, cliffs and drift log accumulations may occur at the landward side of beaches. Some parts of the coastline are repeatedly interrupted with headlands, creating small pockets of cobble beaches. Elsewhere the seaward margins of vast dune sheets create extensive beaches.

1. Stable beaches

In terms of sand availability, beaches may be stable, eroding or accreting. A stable form is one which experiences neither a net loss nor gain in beach materials on an annual basis. Gentle summer waves replace the same amount of sand on the beach as was lost offshore during winter storms. Beaches which are presently stable include Sand Lake in Tillamook County and the region between the mouth of the Umpqua in Douglas County and mouth of the Coquille River in Coos County.

2. Eroding beaches

An eroding beach is one which annually experiences net sand loss. This can result from continuous excessive erosion, diminishing beach sand supplies, or both. Erosion occurs primarily during vigorous winter storms and may be heightened by such factors as a high spring tide which effectively increases wave height. A reduction in beach sand supply may result from dams, riprap, jetties, commercial removal, or other structures or activities which modify beach material transport or near shore currents.

Eroding beaches can often be recognized in their earlier stages by the development of a steeper than usual profile (Figure 1). Some

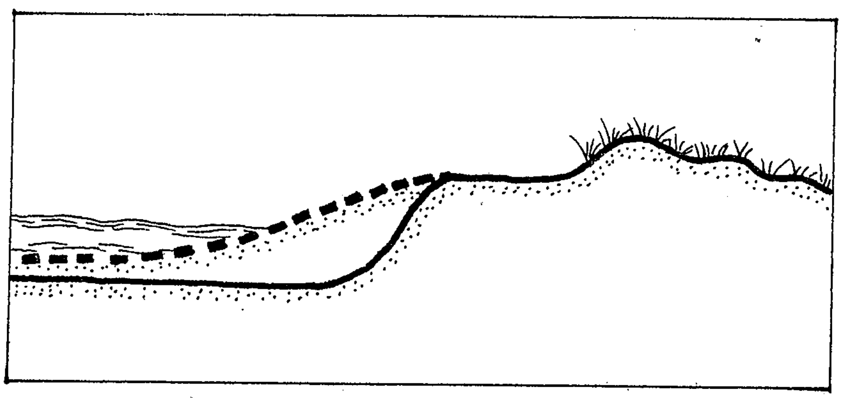


Figure 1. Steepened profile characteristic of an eroding beach.

eroding beaches may contain noticeable eroded embayments, or cusps, which are the result of local rip currents carrying sand away from the beach (Figure 2). Beaches presently in an eroding state include the beach from Peter Iredale Park, north to the Columbia River south jetty in Clatsop County and the area between Blacklock Point and Floras Lake in Curry County.

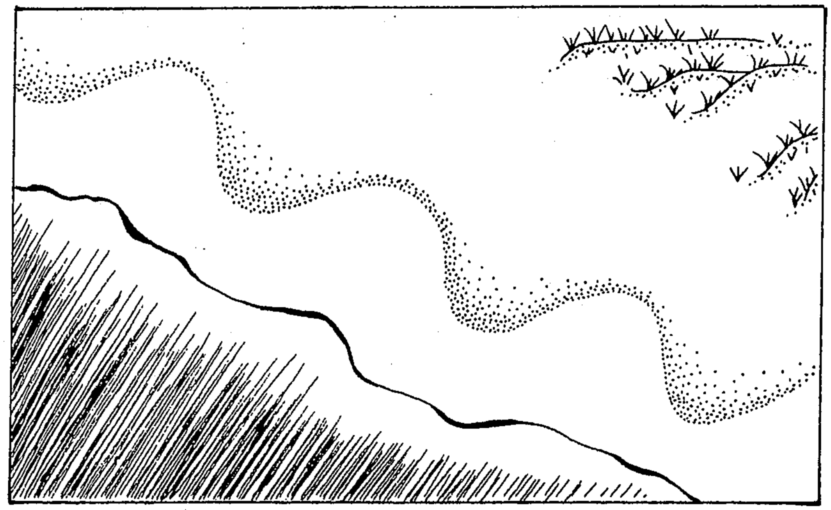


Figure 2. Beach cusps.

3. Accreting beaches

Any beach which has a low-tide margin experiencing net seaward growth due to an annual increase in sand supply is considered to be accreting. The development of small persistent dunes seaward of the foredune is indicative of this sand accumulation process. With continued accretion, the developing dunes will eventually grow and join to form a new foredune seaward of the previous one. Accretion at a site may be the result of escalated erosion elsewhere, beach or spit migration, natural and/or induced changes in off-shore currents, or structures and activities which modify beach material transport. To a limited extent, a beach may experience accretion due to the sand-trapping ability of dune grass. This is only likely to occur, however, when the near shore environment already favors accretion. Examples of accreting beaches include the area adjacent to the community of Surf Pines in Clatsop County, the north end of South Beach in Lincoln County, and just north of Gold Beach in Curry County.

B. Vegetation

High winds, waves and cyclic tidal inundation severely restrict vegetative growth in the beach zone. However, many types of seeds germinate easily in wet sand and a few hardy species may be found on the higher beach slopes in the summer and fall (Wiedeman, et. al., 1974, p. 25). Such plants are not found growing in great profusion. In fact, it may be that only one or two species, if any, will occur in a given beach area. These may occur as isolated individuals, and will commonly experience burial or destruction during the period of winter storms.

Three species which occur most commonly on the beach include American sea rocket (Cakile edentula), European sea rocket (Cakile maritima) and honkenya (Honkenya peploides). Although not peculiar to beaches, European beachgrass (Ammophila arenaria), sea lyme-grass (Elymus mollis) and seashore bluegrass (Poa macrantha) are occasionally found in this zone.

C. Attractions and Limitations

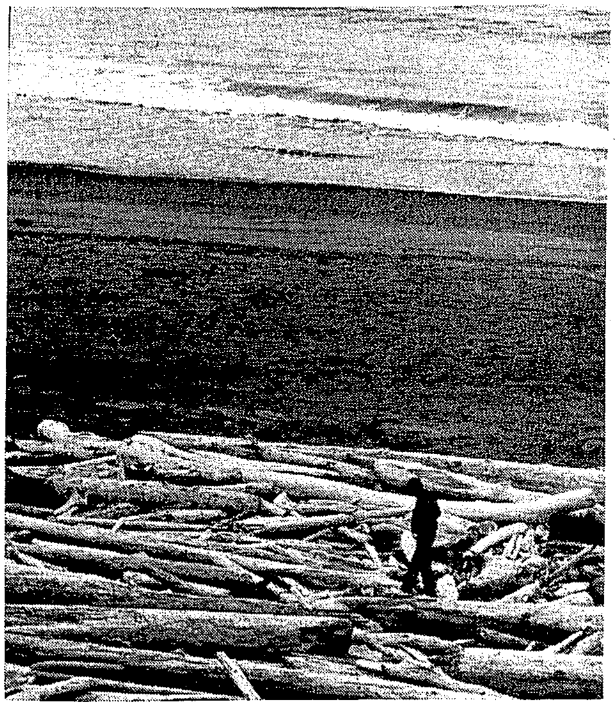
The beach is a highly attractive site for numerous recreational activities ranging from beachcombing to operation of off-road vehicles. It lends itself well to both solitary and group activities and, as a geologic feature, seems to be relatively tolerant of most transient activities. Management of this landform should consider such issues as (1) the desirability of allowing vehicle traffic and significant pedestrian use in the same areas, and (2) harrassment of shore bird species by various recreational activities.

D. Identification Checklist

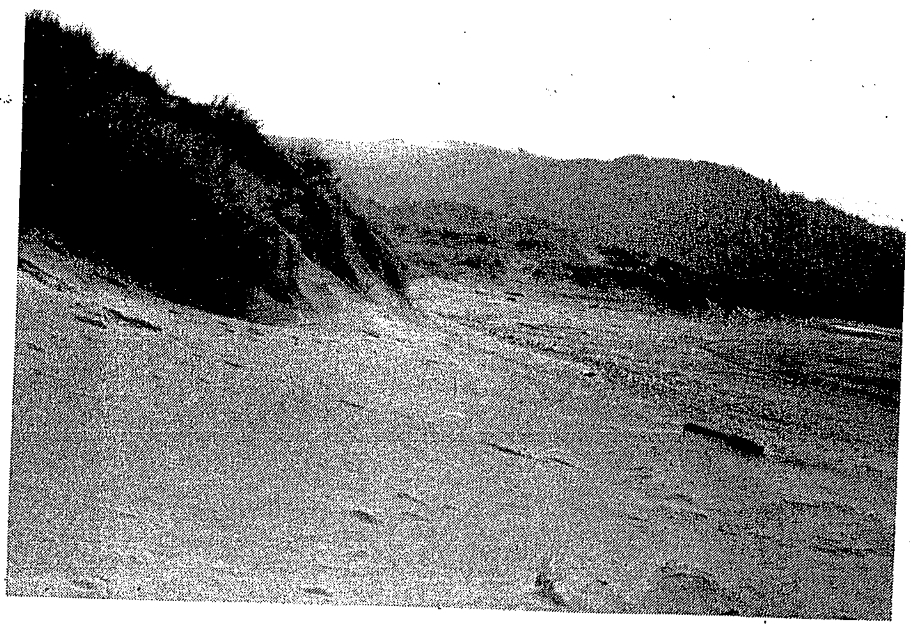
The beach can be recognized by the following characteristics:

1. The landward boundary of the beach may be characterized by one of the following:

   a. drift log accumulations,

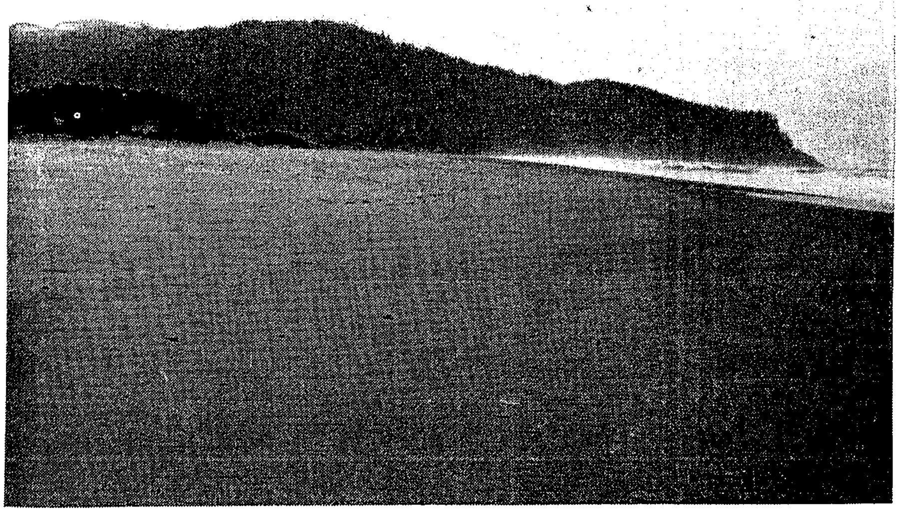


   b. foredune ridge, or

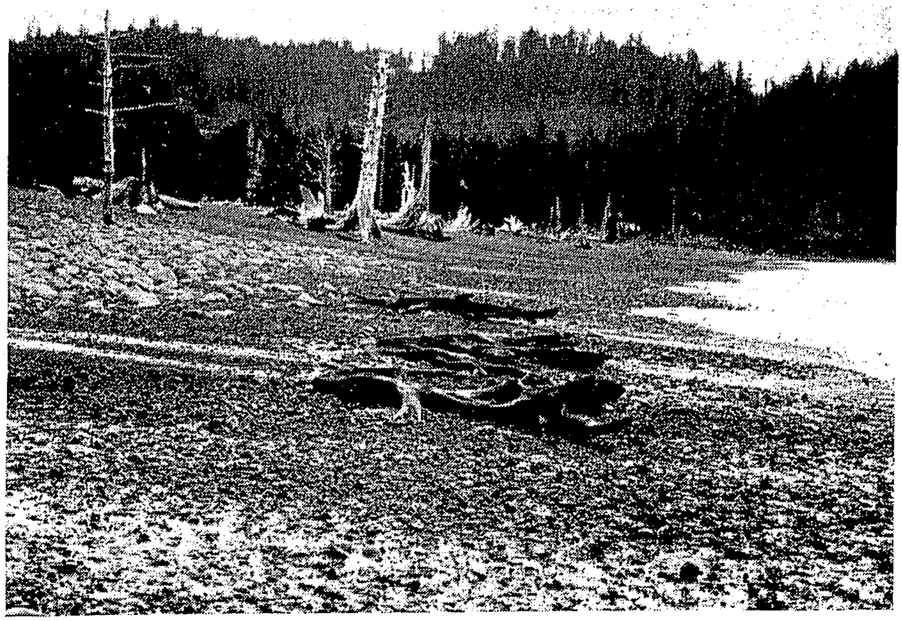


c. cliffs

2. Beaches may consist of fine to medium grained sands and exhibit a relatively gentle slope.



3. A steeper slope profile is exhibited by those beaches which consist of pebbles and/or boulders.

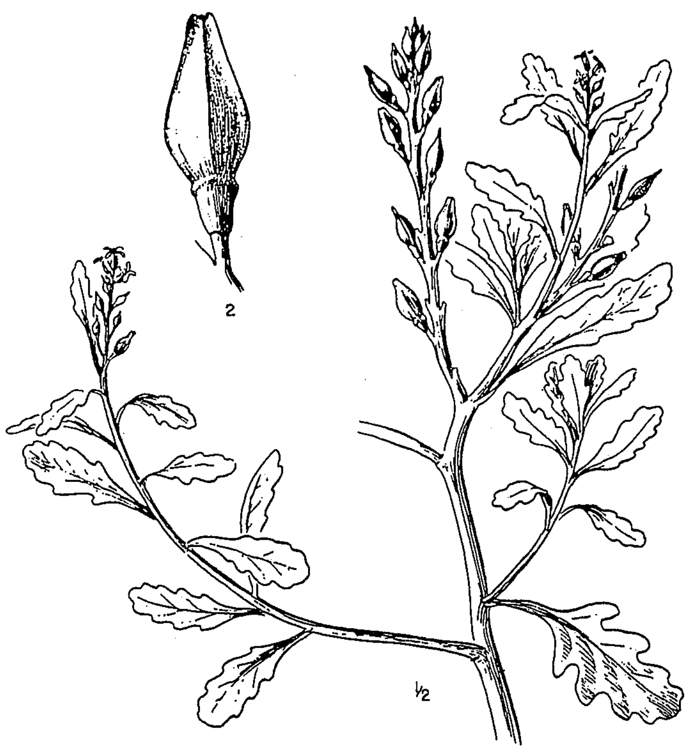


4. Erosion is sometimes caused by stationary rip-currents which eat embayments or cusps into the beach and foredune.

5. Accreting beaches may often be recognized by the development of embryo dunes seaward of the foredune.

6. The most commonly occurring beach vegetation includes the following:

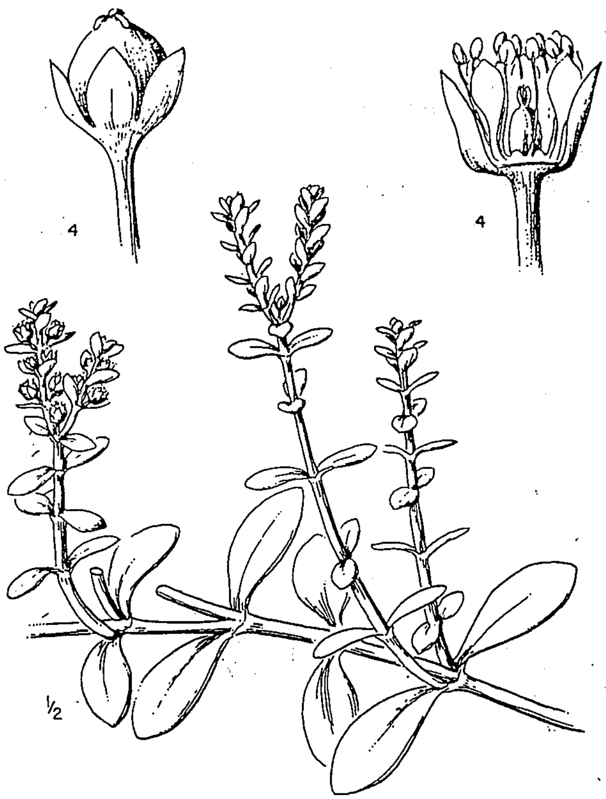
   a. American sea rocket (Cakile edentula),



flowers - purple to white

b. European sea rocket (Cakile maritima), similar to Cakile edentula except for the fruit, and

c. Honkenya (Honkenya peploides).



flowers -
greenish to
white

III. FOREDUNE

First ridge of sand situated immediately above the high tide line and parallel to the beach.

A. Geomorphology

The present day foredune of the Oregon coast has developed primarily in the last forty years as a result of the introduction of European beachgrass (Ammophila arenaria). First introduced for sand stabilization in the Coos Bay area in 1910 and the Clatsop Plains in 1935, this species became naturalized to the coastal sand areas. It spread along the coast forming a nearly continuous barrier ridge along the shore. European beachgrass prefers sites of continuous sand deposition. It grows seaward until it is halted by wave action at the high tide line. Embryo dunes form here at the landward edge of the beach in conjunction with vegetation and drift log accumulations where the velocity of the wind decreases suddenly, depositing the sand load (Figure 3). Continued

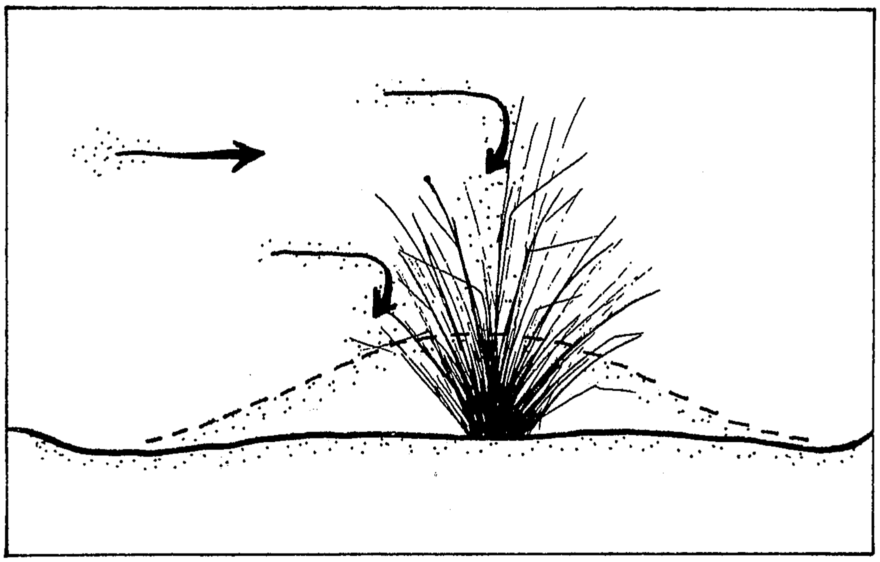


Figure 3. Sand deposition around a beach grass windbreak.

deposition may lead to the burial of the original obstacle. The driftlogs remain buried forming the base of the foredune but European beachgrass (Ammophila arenaria) can survive seasonal sand burial of up to three feet and for that reason is the primary foredune building agent. As sand builds up around the base of the plant, new roots and shoots grow from the stem joints (Figure 4). This traps more wind-blown sand above, while holding underlying sand within the complicated root network below.

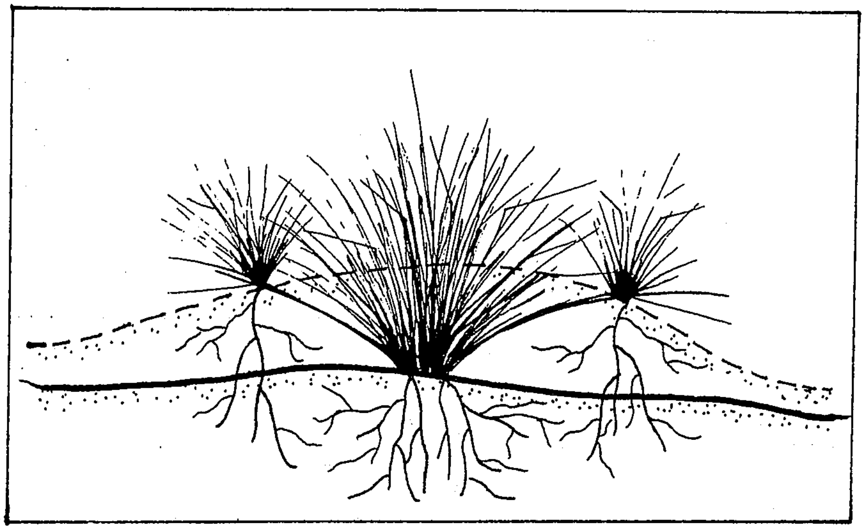


Figure 4. As European beachgrass is buried, new shoot and root growth develops at the dune surface.

The dune thus increases in height and width until it merges with adjoining dunes to form a barrier ridge along the upper beach. This dune-ridge area stops and holds most of the sand blowing in from the beach and continues to grow until it reaches the maximum height dictated by local conditions, usually up to twenty-five or thirty feet. It may be bounded on the east by deflation plains, interior dunes, cliffs, marshes, lakes or estuaries.

The foredune is a naturally occurring geomorphic feature which, to some degree, acts as a dike during ocean storms. It's function transcends that of a simple barrier-wall because it has a sponge-like ability to absorb and mute the force of storm waves. Hitting the foredune, wave energy is dissipated over, around and, most critically into the dune. However, while it can act as an effective shock absorber, the foredune can occasionally sustain considerable damage during storms and may be unable to provide sufficient storm protection to inland sites, thus allowing adjacent deflation plains or hummock dunes to be exposed to the full force of maritime storms. In such instances, the area of potential hazard is extended beyond the foredune to include additional inland sites. Any excavation into, or construction modification of the foredune may increase this hazard potential.

Foredunes are among the most dynamic of landforms and will naturally vacillate between periods of being active (subject to wind and wave erosion and breaching) and being conditionally stable (wind stable but subject to wave erosion and breaching).

The term "foredune" is applied to this dune ridge wherever it occurs along the Oregon coast. This feature varies considerably in appearance, however, and to some degree in function, between the north coast (Clatsop County) and the central-south region.

The foredune ridge which occurs in the central and southern counties commonly varies between ten to thirty feet in height, is twenty to fifty feet wide at the base and often appears as a distinctive sea-wall ridge particularly when viewed from the beach. Storm hazard in this area is primarily associated with erosive storm waves and wind, impact from solid debris carried by the waves, and flooding of inland sites.

The foredune in the Clatsop area is commonly an extremely broad, low appearing feature. While it may reach heights of more than twenty-five feet, the gradient is so gentle, often five degrees or less, that it has a less distinctive sea-wall appearance. Storm hazard on the north coast (north of Seaside) is more commonly associated with inundation from sand than from erosion or debris impact. Wave run-up may be considerably reduced by the extensive traverse associated with the long, shallow, off-shore area and the extreme width of the foredune. However, storm-velocity winds are capable of transporting generous quantities of sand available in this region considerably inland. The gentle gradient common to Clatsop foredunes may also offer less obstruction to the wind. Thus, the "functional" width of the foredune (or the area impacted by maritime storms) in the Clatsop area can be as great as 800 feet depending on local conditions (Leach, 1978). The "foredune" under this designation, may contain more than one "ridge" so the term "foredune area" may be more applicable (Ternyik, 1978). Furthermore, while storm associated sand deposition can cause sand-blasting type damage and may result in subsequent excavation costs, this activity may be more aptly designated as "nuisance" rather than true "hazard" to life or property.

1. Active foredunes

Sand dunes are in an active state when they possess insufficient vegetative cover to retard wind erosion. In this condition the sand dune is experiencing active accretion and/or erosion.

On a static or accreting beach, an active foredune will commonly evolve towards the conditionally stable state. As the active foredune grows in height (up to thirty feet), it becomes an increasingly effective barrier and progressively less sand is deposited on the lee side of the dune and other sites inland. This offers somewhat greater protection from storm winds, but also seriously limits all fresh beach sand supplies to interior open sand areas.

Active foredunes may be most numerous in central and north coast areas. They occur, for example, in Clatsop County west of Slusher and Sunset Lakes and in Tillamook County at Neskowin North.

2. Conditionally stable foredunes

When foredunes exhibit sufficient vegetative cover to retard the erosive effects of the wind, they are termed conditionally stable. Obviously, the stability of a given foredune is conditional upon the maintenance of the vegetative cover.

While the conditionally stable foredune may not have any greater resistance to wave erosion than does an active foredune, it appears to recover more quickly from wave overtopping (Ternyik, 1978). However, any conditionally stable sand dune is prone to reactivation upon disturbance of the vegetative cover.

Examples of conditionally stable foredunes presently occur between Sunset beach and Gearhart in Clatsop County and at the community of Bayshore in Lincoln County.

B. Vegetation

1. Active foredunes

The active foredune receives such a substantial sand supply that it is occupied almost exclusively by European beachgrass (Ammophila arenaria). Some native dune grasses such as sea lyme-grass (Elymus mollis) may be found here but occur less commonly as they are less tolerant of continual sand burial.

2. Conditionally stable foredunes

The increasing height of the conditionally stable foredune restricts the inland passage of salt spray and sand. A new environment is thus created on the crest and the lee side of the foredune which is reflected in the vegetation at this site. European beachgrass (Ammophila arenaria), the most significant species which occurs on the foredune, becomes less important because it prefers the more fertile sites of sand deposition. Other species less tolerant of salt spray and sand deposition become established. The first to become established include, among others, such herbs as beachpea (Lathyrus japonicus), coast strawberry (Fragaria chiloensis) and seashore lupine (Lupinus littoralis). Later successional species may include such woody shrubs as salal (Gaultheria shallon), or kinnikinnick (Arctostaphylos uva-ursi) and an occasional shore pine (Pinus contorta).

The lee side of a foredune may exhibit vegetation characteristic of conditional stability and yet be experiencing erosion and undercutting on its windward side. Such circumstances indicate that the foredune was formerly in a conditionally stable state long enough for some vegetative succession to take place, and has only recently begun to experience erosion. The remaining foredune ridge has apparently been able to provide sufficient protection to the lee side to maintain existing vegetation. Should the oceanward side experience temporary in-filling with logs, sand and beach grass during the summer it could deceptively give the appearance of a completely conditionally stable foredune.

C. Attractions and Limitations

While the foredune may not be a primary recreational attraction in itself, it nonetheless experiences moderate recreational traffic. This is partially because it is a barrier which must be traversed in order to reach the beach. It is also used as a sheltered 'base camp' from which forays to the beach are made. However, because of its hummocky, semi-stable surface and the sharp tips of the European beachgrass, pedestrian traffic usually follows open pathways. This activity, referred to as "trailing", results in the development of open mobile sand trails. However, the continual replenishment of fresh sand in active dune areas commonly maintains sufficient fertility for beach grass regeneration. Thus, trailing is not necessarily a serious problem unless it is desirable for the active foredune to become conditionally stable (OCCDC, 1975). Conversely, the trailing which results from the passage of motorbikes and other off-road vehicles inhibits beach grass regeneration and creates troughs from which blowouts can develop.

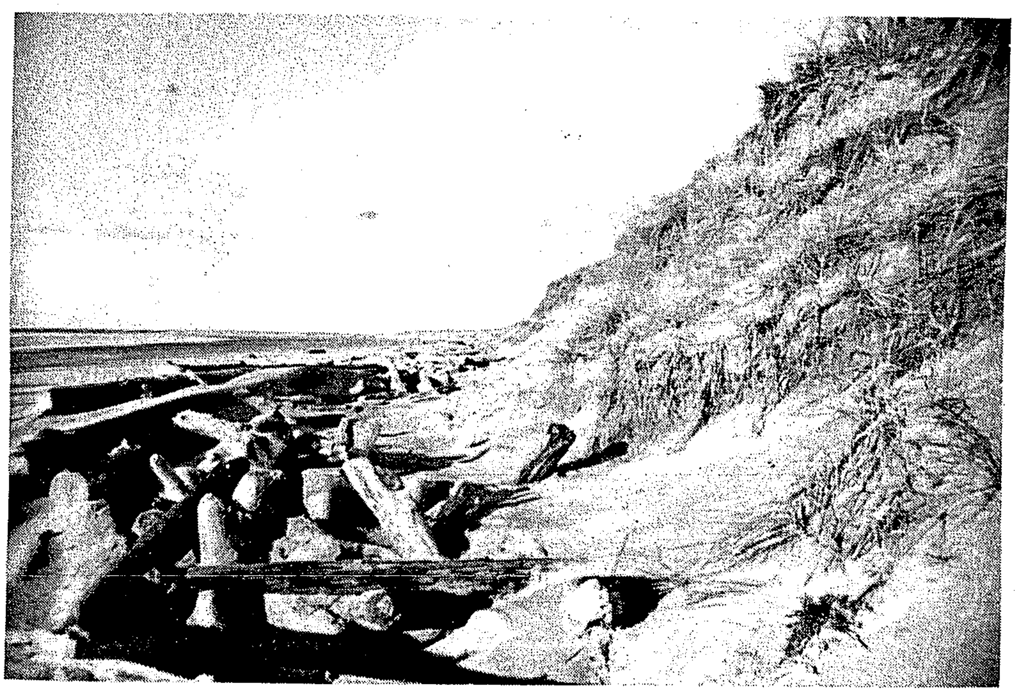
The proximity of this landform to the ocean renders it at once highly attractive and yet extremely hazardous as a site for permanent structures. Construction of permanent structures which either project onto the beach or require any excavation of the foredune endangers the site and adjacent areas. Erosion intensification, interruption of natural sand movement, and wind-blown mobile sands are potential hazards associated with such disturbance. Additionally, the installation of riprap to protect structures impedes the natural flow of beach and foredune materials, possibly resulting in beach starvation at the site or elsewhere. Goal 18 specifically addresses the problem of development on active and other foredunes. No active dune, by definition, should harbor permanent structures as they may be subject to inundation or undermining due to moving sand. Permanent structures should be reserved for permanent landforms. Management of this landform should consider the highly dynamic mobile nature of this land/sea interface area.

D. Identification Checklist

The foredune can be identified by the following characteristics:

1. A sparsely or thickly vegetated sand dune ridge five to twenty-five feet high, running parallel to the beach.

2. The foredune is bordered by the beach and possibly drift logs on the west.



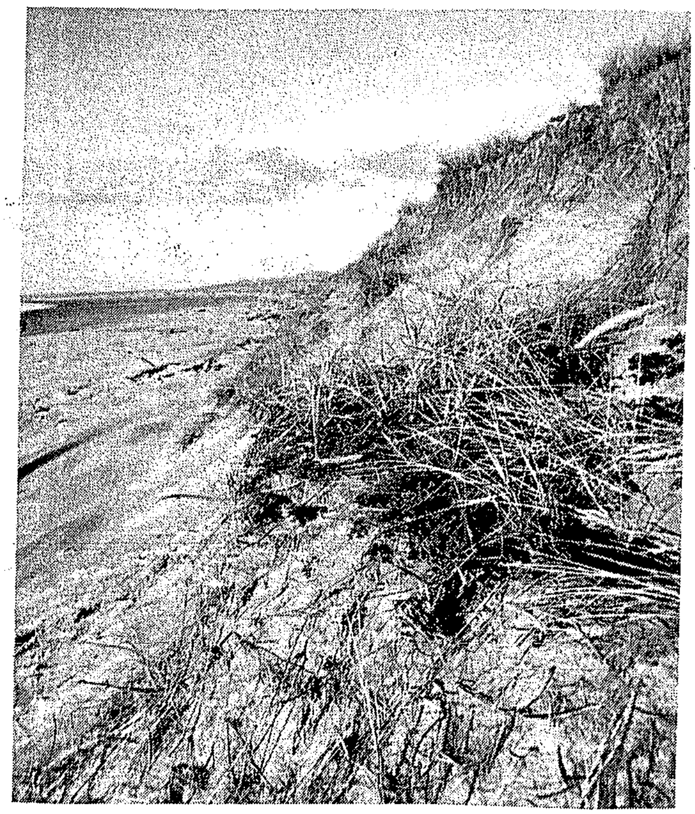
3. It commonly occurs adjacent to:

   a. hummock dunes, or

   b. the deflation plain on the east.

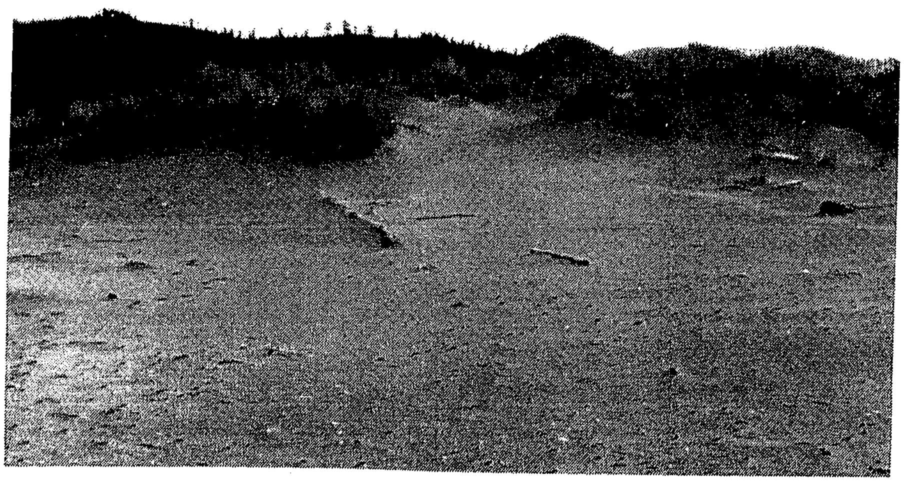
4. The active foredune may exhibit storm surge cuts. Logs and debris may be found here.

5. An eroding, formerly conditionally stable foredune may continue to exhibit vegetation characteristics of its conditionally stable state. (Coast strawberry is shown on the eroding face of a formerly conditionally stable foredune.)



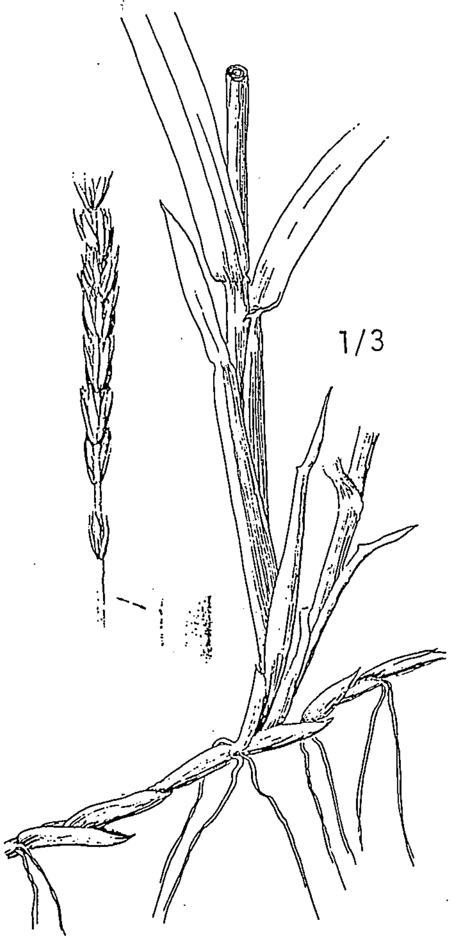
6. Drift logs may be exposed at the base of the windward face of the active foredune, particularly in the winter.

7. The vegetative cover of the active foredune is rather sparse and consists almost exclusively of European beachgrass (Ammophila arenaria).



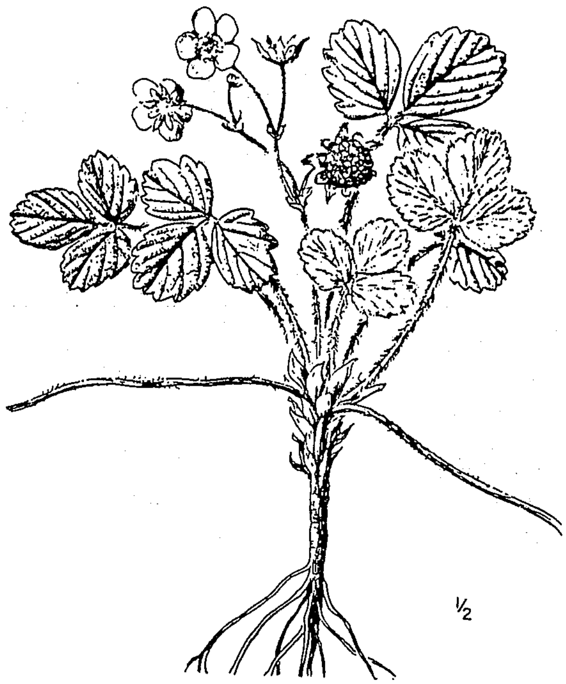
8. The conditionally stable foredune exhibits a very dense vegetative cover.

9. Sea lyme-grass (Elymus mollis) may also occur occasionally on the foredune in lesser amounts.



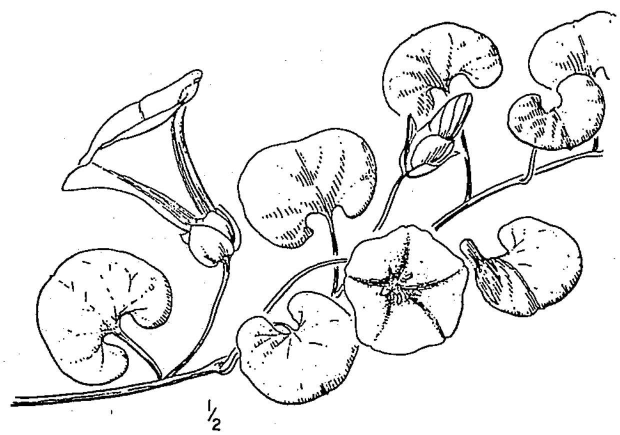
10. Species of the pioneer community found on the lee side of the conditionally stable foredune include:

a. coast strawberry (Fragaria chiloensis),



flowers - white to pinkish

b. beach morning-glory (Convolvulus soldanella),



flowers - light pink to rose

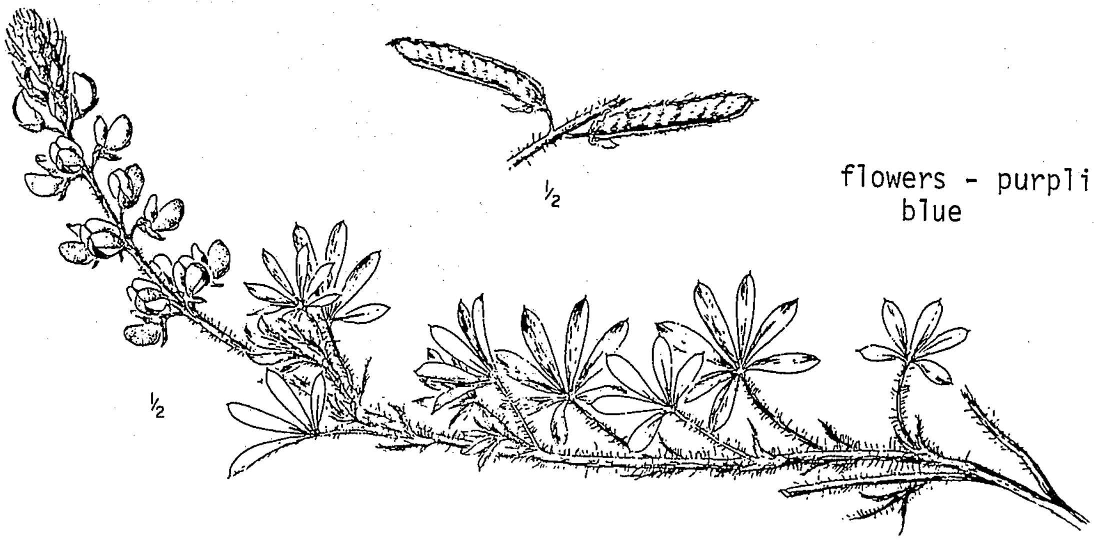
c. beachpea (Lathyrus japonicus), and

d. gray beachpea (Lathyrus littoralis).

flowers - white
to pink or
purple

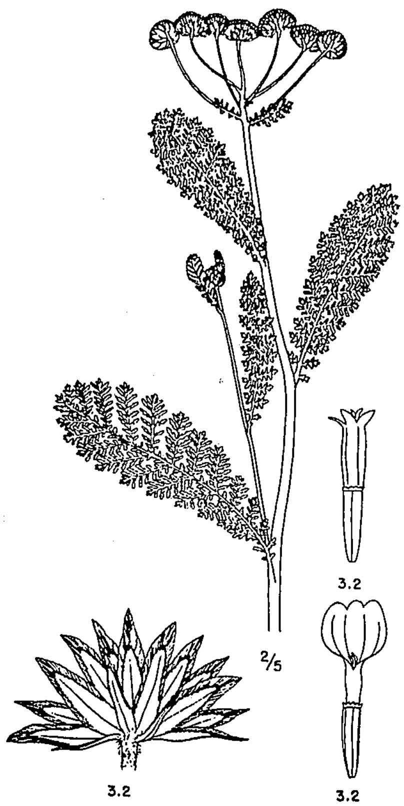
11. Four species appearing later in succession include:

a. seashore lupine (Lupinus littoralis),



flowers - purplish blue

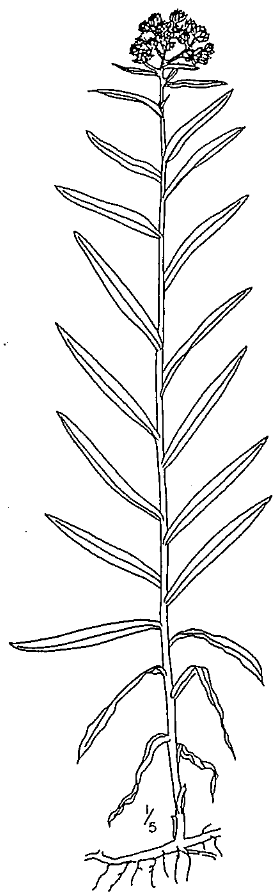
b. seaside tansy (Tanacetum douglasii),



flowers - yellow

c. western bracken fern (<u>Pteridium aquilinum</u>)

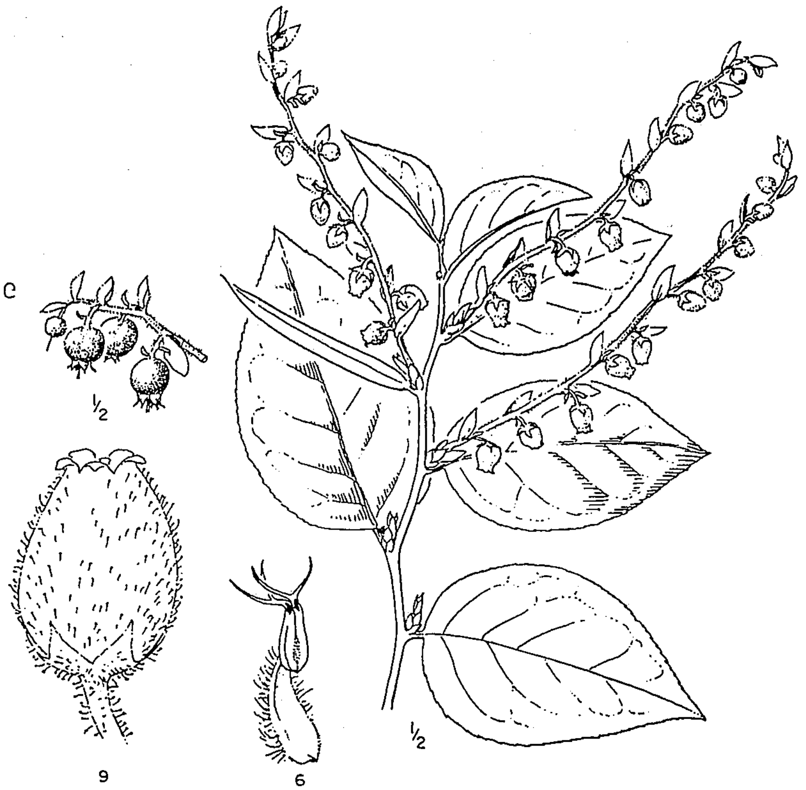
d. pearly everlasting (<u>Anaphalis margaritacea</u>)



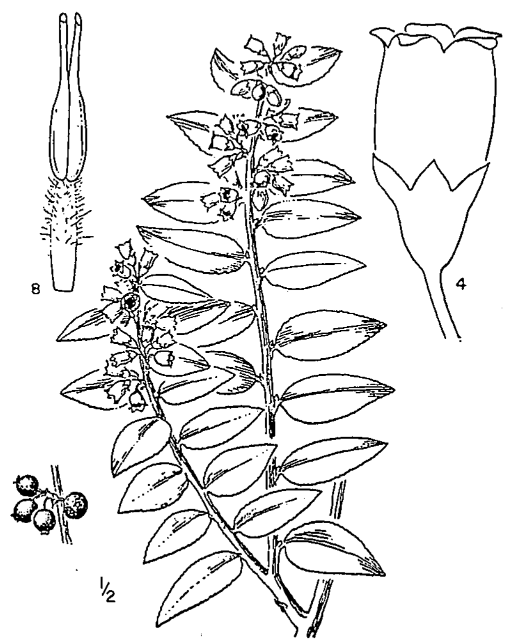
heads - white

12. By the time the later successional species appear, many of the pioneer species are no longer apparent. The following shrub species belong to this latter successional group:

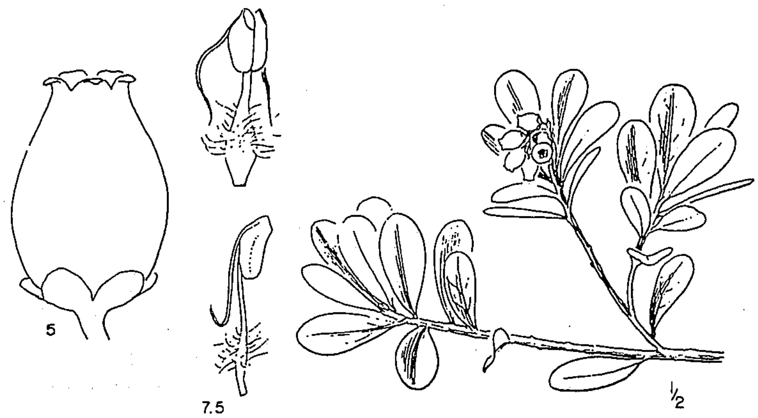
    a. salal (<u>Gaultheria shallon</u>),



    b. evergreen huckleberry (<u>Vaccinium ovatum</u>),



c. kinnikinnick (Arctostaphylos uva-ursi)



flowers - white to pink

d. hairy manzanita (Arctostaphylos columbiana)

flowers white to pale pink

IV. INTERDUNE FORMS

Interdune forms include those low areas between dunes which are often subject to the controlling factors of wind action, and/or high water table.

A. Deflation Plain

Broad plain which develops immediately inland from the foredune and is wind scoured to the level of the summer water table.

1. Geomorphology

A deflation plain is created by wind removal of dry sand particles inland from the foredune. Sand is thus removed only down to the lowered summer water table, because groundwater moisture binds sand particles together at this level. This may result in standing water during the winter when the water table is naturally higher. Sand transported inland from the deflation plain is deposited in interior dune regions. The best conditions for development of this landform probably occur behind a conditionally stable foredune, where the inland flow of sand, which could otherwise contribute to dunal development at this site, is cut off and the wind has more available energy for transport. If an active foredune exists, sand supplies are more readily passed over the ridge to form hummock dunes or open-sand dunes.

Examples of old, inactive deflation plains occur in some areas considerably inland from the foredune area. These are commonly occupied by forest communities and the water table is still quite high. These features probably developed adjacent to a foredune, but merged inland by subsequent beach accretion.

2. Vegetation

Components of the vegetation communities in the deflation plain vary according to specific site factors and the stage of successional development. In the early successional stages, grass, rush, and sedge communities occupy progressively wetter sites. Later successional stages are characterized by a low scattered shrub community, followed by the development of tall shrub thickets and eventually a shore pine forest (U.S.D.A., 1972, pp. 84-98). Water stands at, or near the surface most of the year in these sites.

The grass community occurs where water stands on the surface for two to three months of the year (vegetation covers about 80% of the ground). A few scattered shrubs and dwarfed shore pine are occasionally found in this community.

The rush community is found in sites where the water table stands on the surface for three or four months of the year (vegetation covers about 90% of the ground). Isolated shrub and tree seedlings also occur here. Coast willow (*Salix hookeriana*) seedlings are the most numerous.

Water stands on the surface of the sedge community for at least six months of the year. Vegetation covers about 95% of the ground.

3. Attractions and limitations

The primary attractions of the deflation plain appear to be the viewing of waterfowl and, when drained, the development of housing. Many deflation plain marsh communities provide habitat for a number of waterfowl, which is lost when the site is developed. Even when drained, the water table remains quite high and septic tanks, drainfields, and other buried structures may not be appropriate. Flotation and failure of such structures could occur with resulting pollution.

4. Identification check-list

The deflation plain may be identified by the following features:

1. It is a low plain bordered on its ocean side by a foredune.

2. The deflation plain may be bordered on the eastern boundary by:

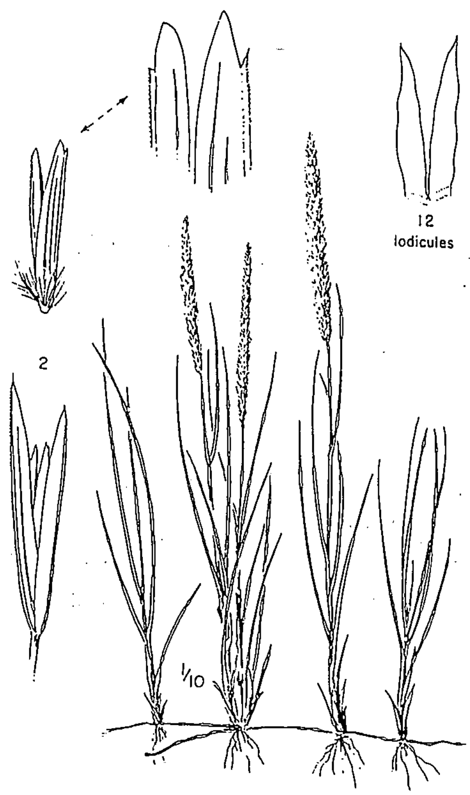
   a. hummock dunes or,

   b. transverse-ridge dunes.

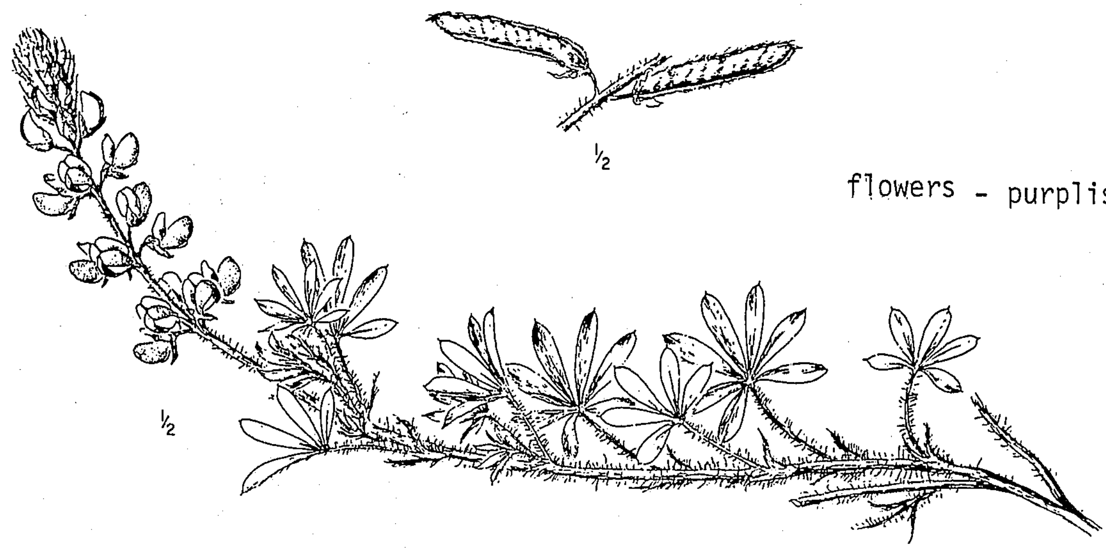
3. It may contain standing water several months of the year.

4. Important species of the deflation plain grass community include:

a. European beachgrass (<u>Ammophila arenaria</u>),

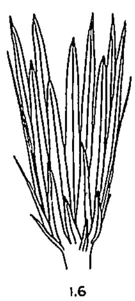


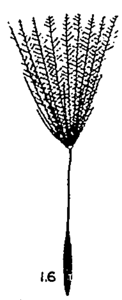
b. seashore lupine (Lupinus littoralis)

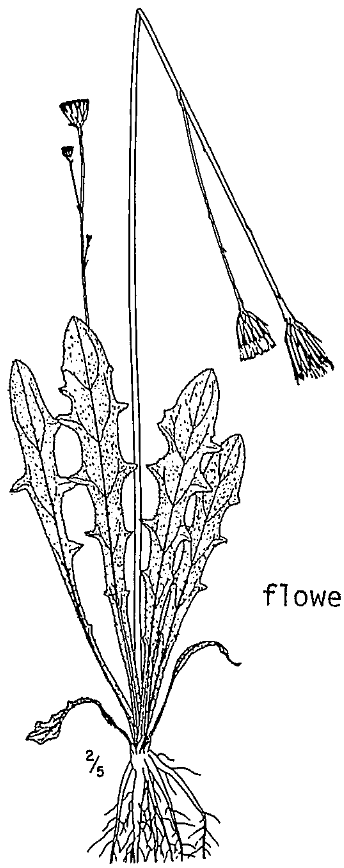


flowers - purplish blue

c. false dandelion (Hypochoeris radicata)

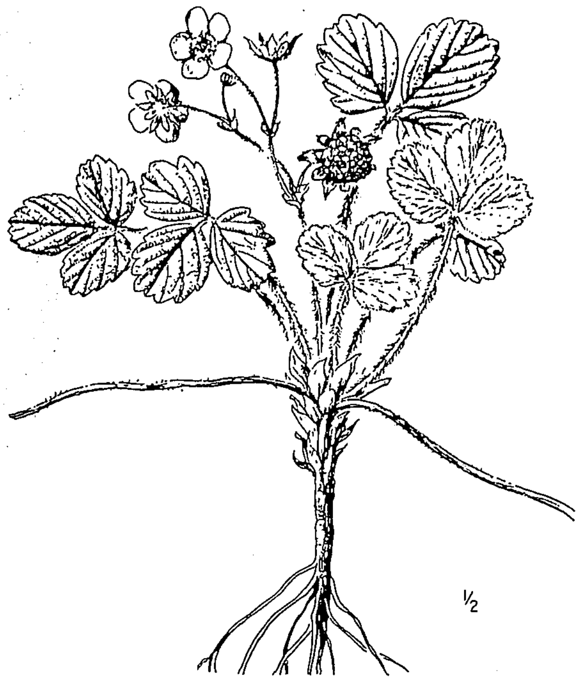






flowers - yellow

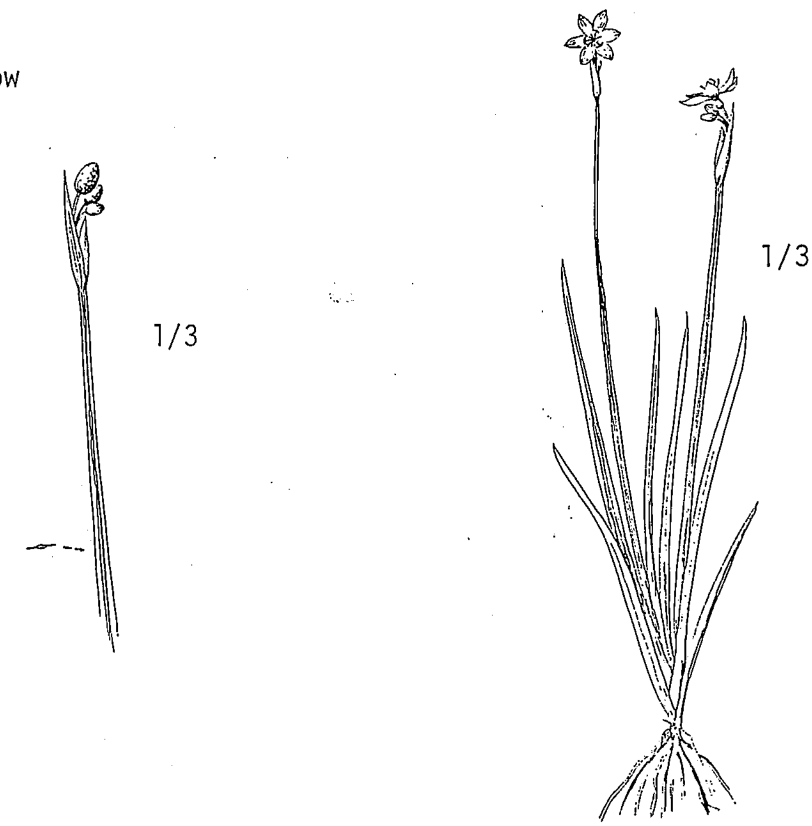
d. coast strawberry (<u>Fragaria chiloensis</u>)



flowers - white to pinkish

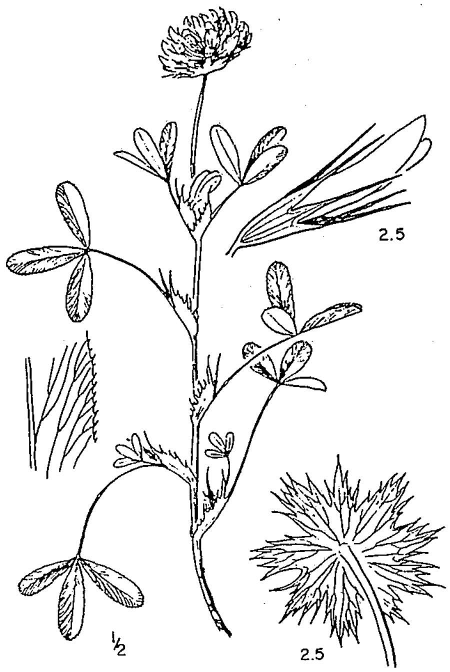
e. yellow-eyed grass (<u>Sisyrinchium californicum</u>)

flowers - yellow



5. The following plants are most common in the rush community:

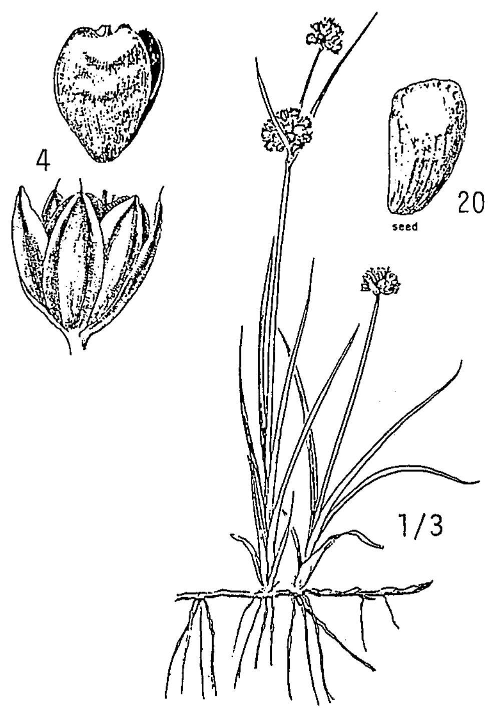
   a. spring-bank clover (Trifolium wormskjoldii).



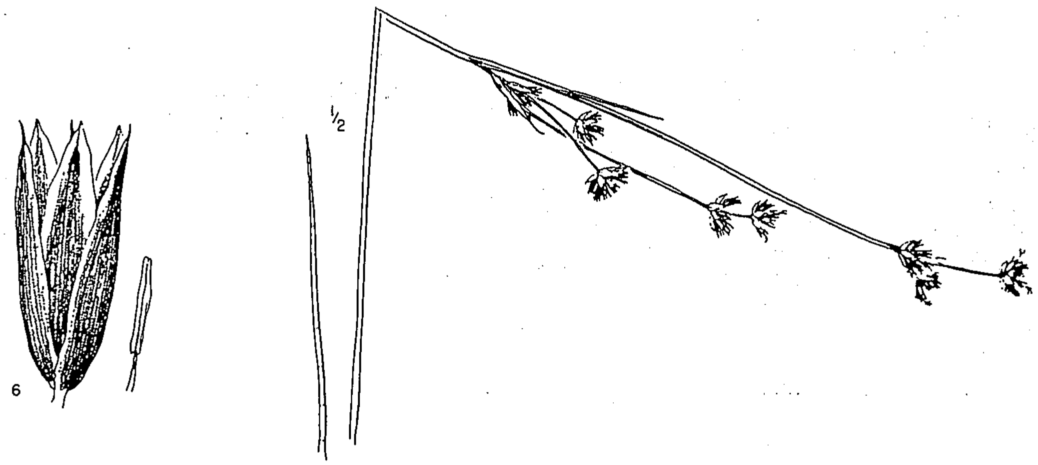
flowers - purplish-red often white-tipped

   b. Rushes are important here. (They may be identified by a round stem.)

      (1) sickle-leaved rush (Juncus falcatus)



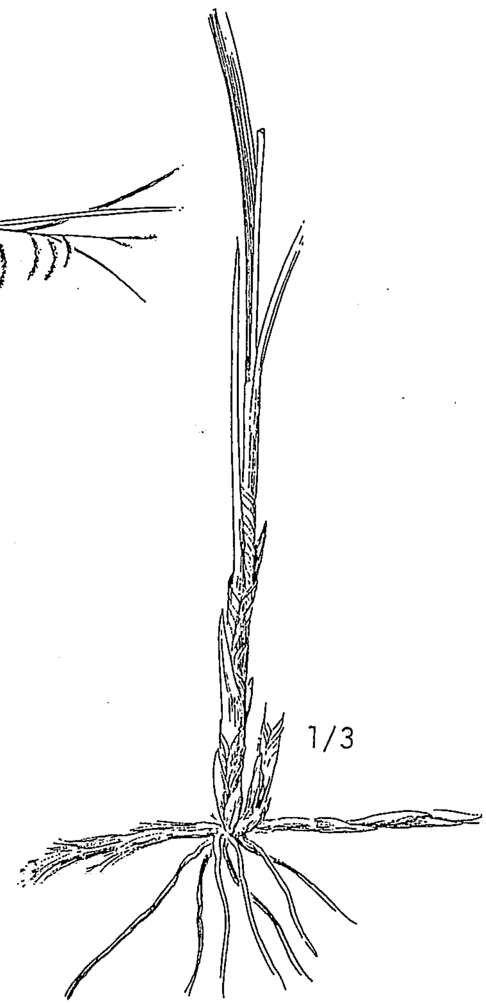
(2) brown-headed rush (Juncus nevadensis)



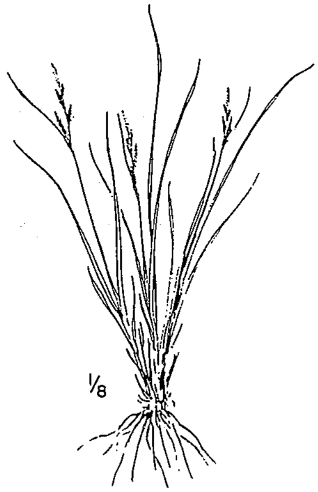
6. The most important species of the sedge community are:

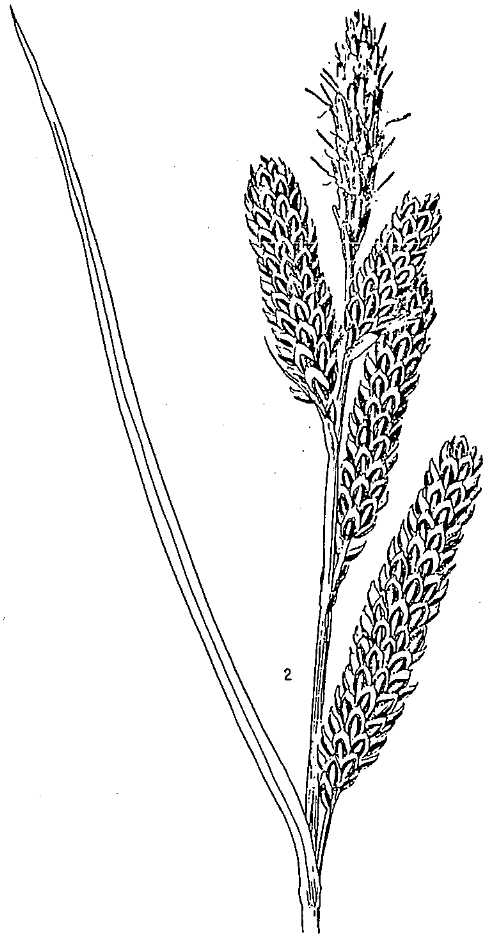
   a. Sedges (which have stems with edges) are the most critical species. They include:

      (1) slough sedge (Carex obnupta)

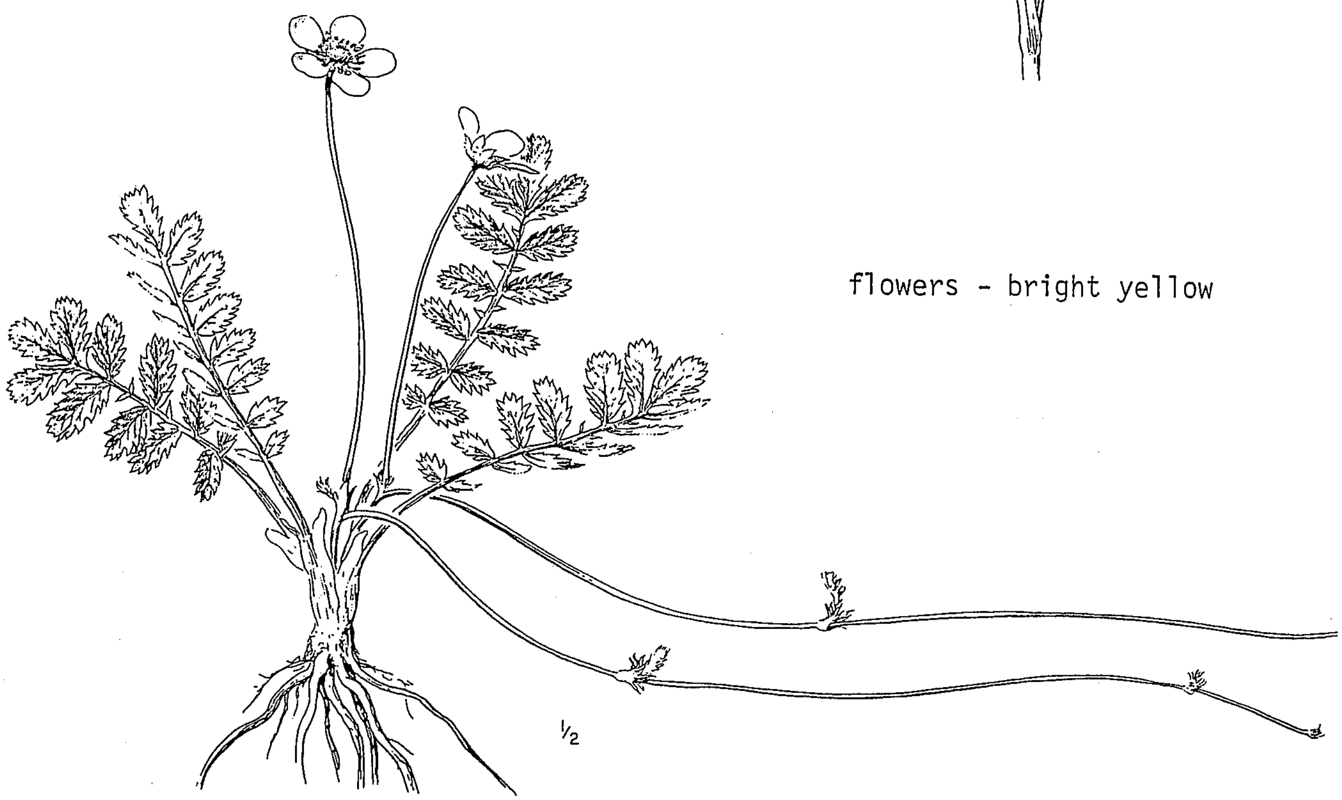


(2) hindis sedge (<u>Carex hindsii</u>)



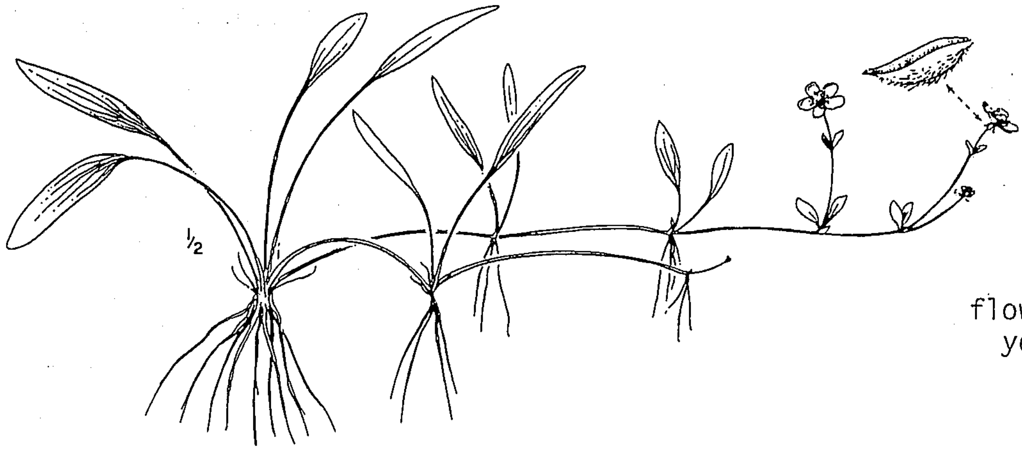


b. Pacific silver weed (<u>Potentilla pacifica</u>)



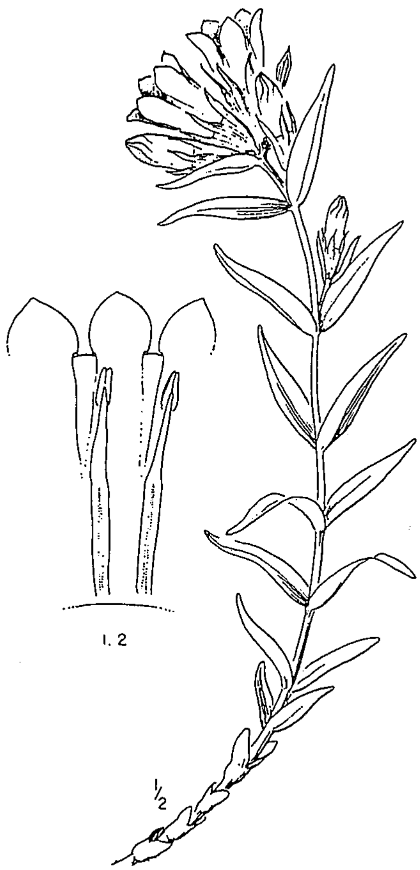
flowers - bright yellow

c. creeping buttercup (Ranunculus flammula)



flowers - yellow

d. king's gentium (Gentiana sceptrum)



flowers - blue to purplish-blue

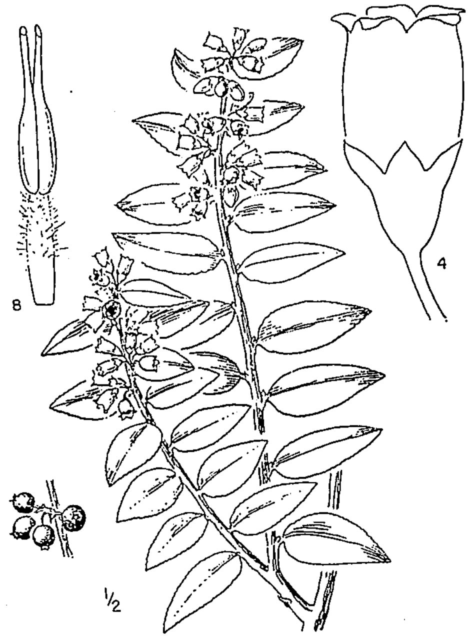
7. The low, scattered shrub community is characterized by the following species up to six feet in height:

   a. coast willow (Salix hookeriana) dominates,

   b. salal (Gaultheria shallon),

flowers -
white to pink

c. evergreen huckleberry (<u>Vaccinium ovatum</u>),

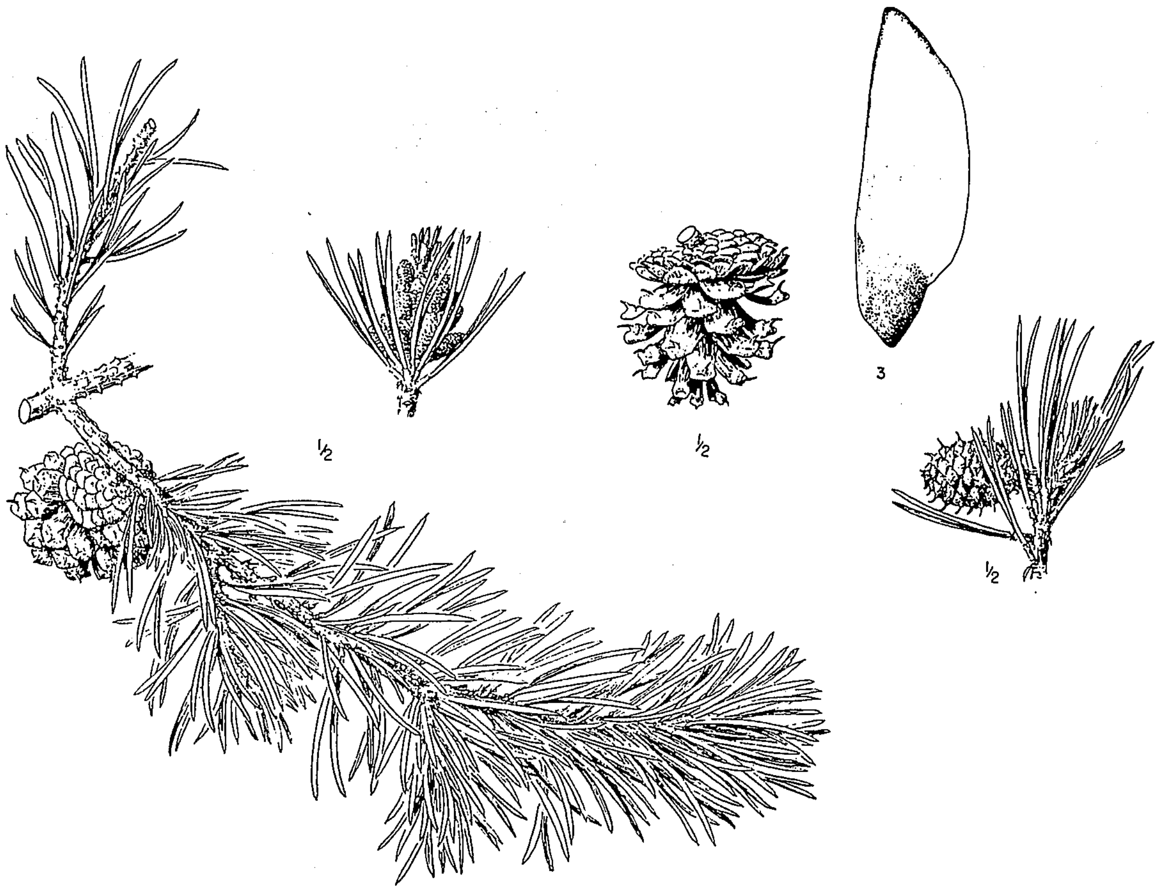


flowers - white to pink

d. wax myrtle (<u>Myrica californica</u>), and

fruit - reddish-brown

e. shorepine saplings (<u>Pinus contorta</u>).

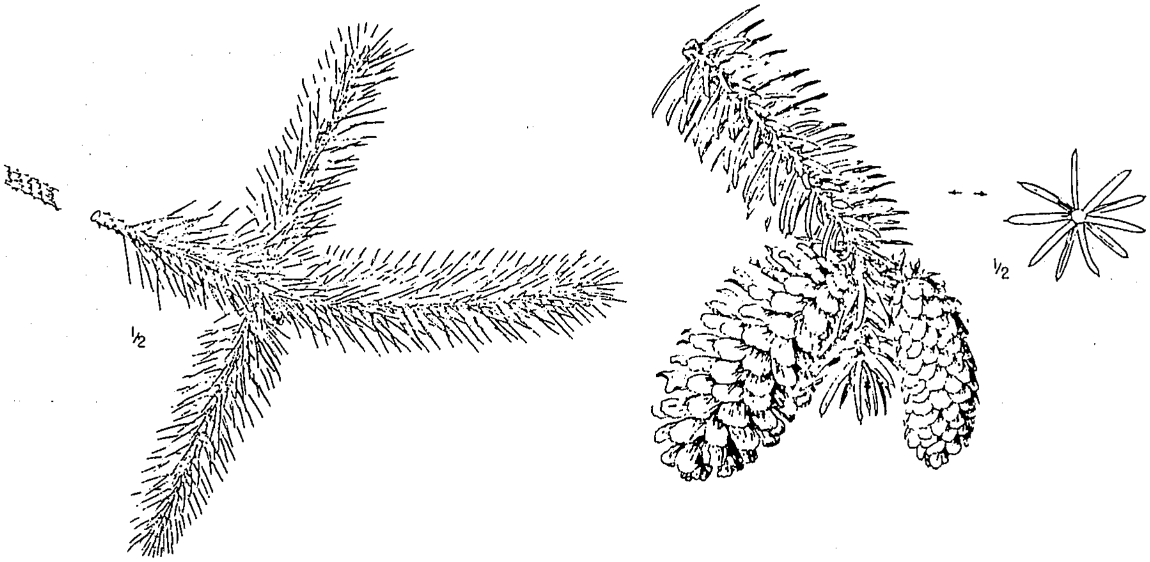


8. The tall shrub thickets follow the low, scattered shrub association and is composed of the foregoing shrubs and trees ranging in height from six to twenty feet.

9. The next successional stage on the deflation plain is the shorepine forest. The plant community includes the following:

   a. shorepine dominates (<u>Pinus contorta</u>). See drawing above.

b. sitka spruce (Picea sitchensis)



c. occasionally trees of:

(1) wax myrtle (Myrica californica), and

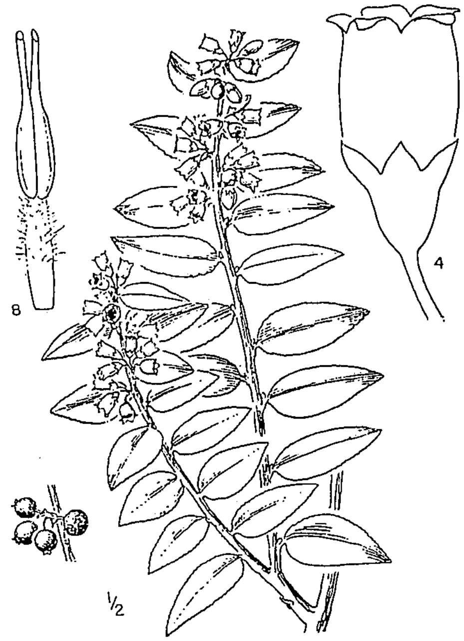
(2) coast willow (Salix hookeriana)

d. a sparce occurrence of shrubs:

(1) salal (Gaultheria shallon), and

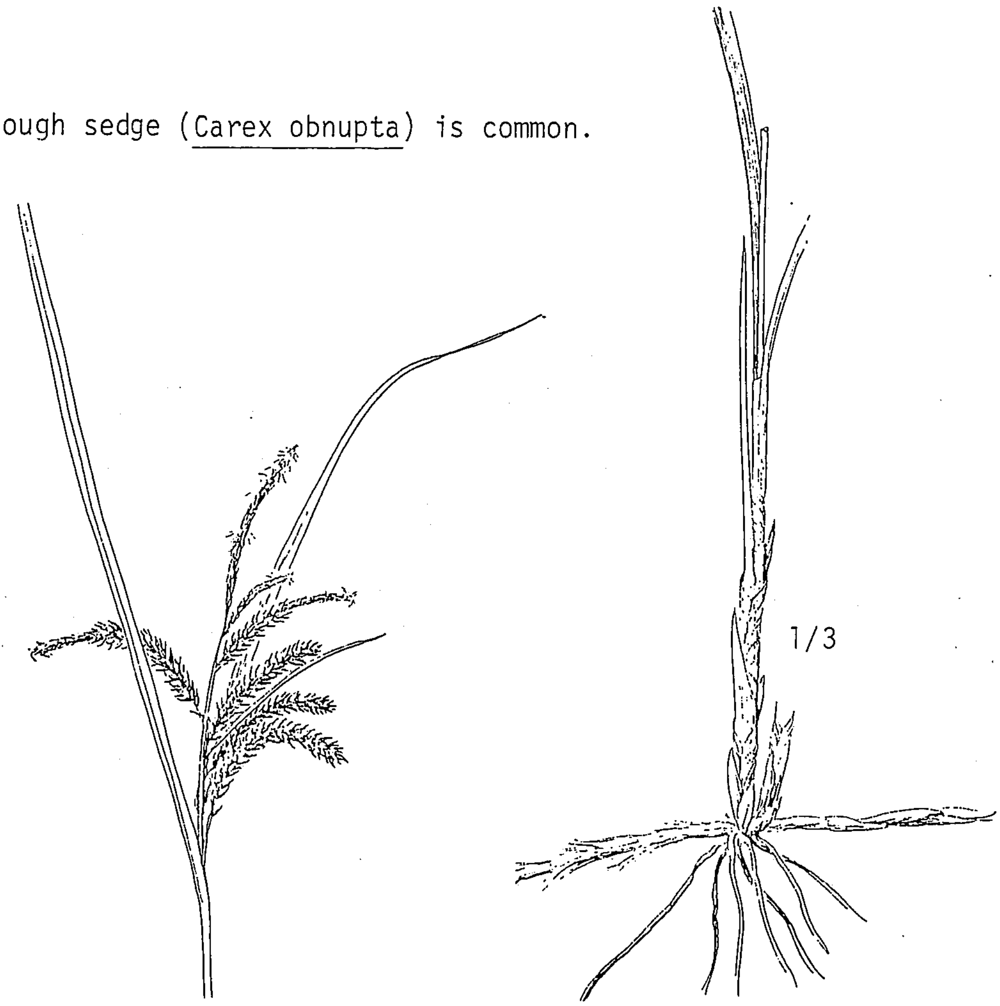
flowers - white to pink

(2) evergreen huckleberry (Vaccinium ovatum)



flowers - white to pink

e. slough sedge (Carex obnupta) is common.



B. Seasonally Wet Interdune Area

Interdune sites which are commonly occupied by standing water only part of the year.

1. Geomorphology

Low lying sites which contain surface water during some part of the winter are found in association with many sand landform types. Swales between oblique-ridge dunes, the basal area between hummock or transverse-ridge dunes, and low areas within older stable dune units, all provide examples of sites which may be wet part of the year. Water table is probably high even during the summer when all trace of surface water has disappeared.

2. Vegetation

Although the surface can range from bare sand through marsh associations to mature forest, some vegetative cover is most common. Any of those communities occurring in the deflation plain may be found here. Some sites may exhibit mottled clayey soils indicative of prolonged saturation.

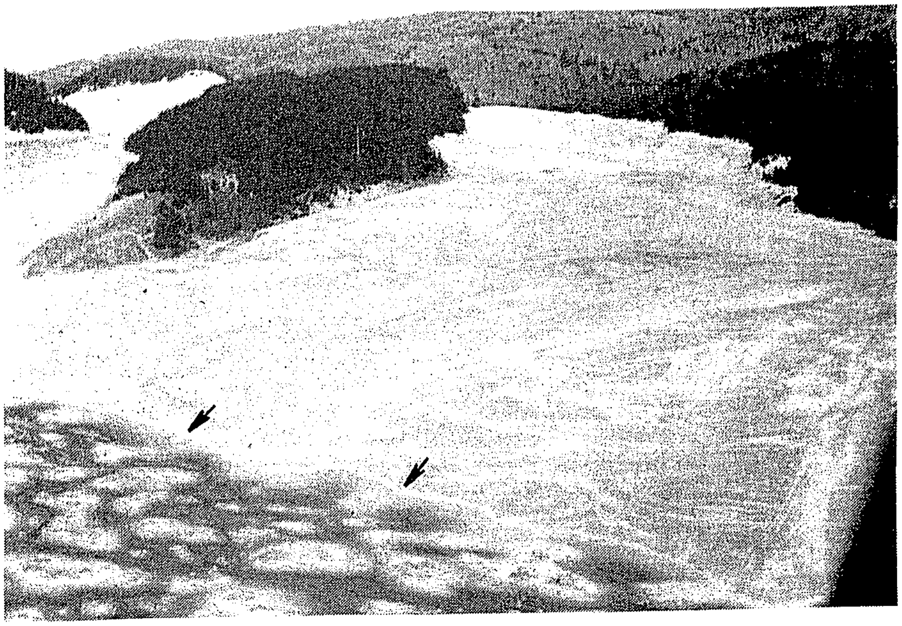
3. Attractions and limitations

Characteristic attractions and limitations of these sites would be similar to those of the deflation plain. Any development proposals for occasionally wet areas in older stable dune forms should address the potential water table limitations here.

4. Identification check-list

Occasionally wet interdune sites may be identified by the following characteristics:

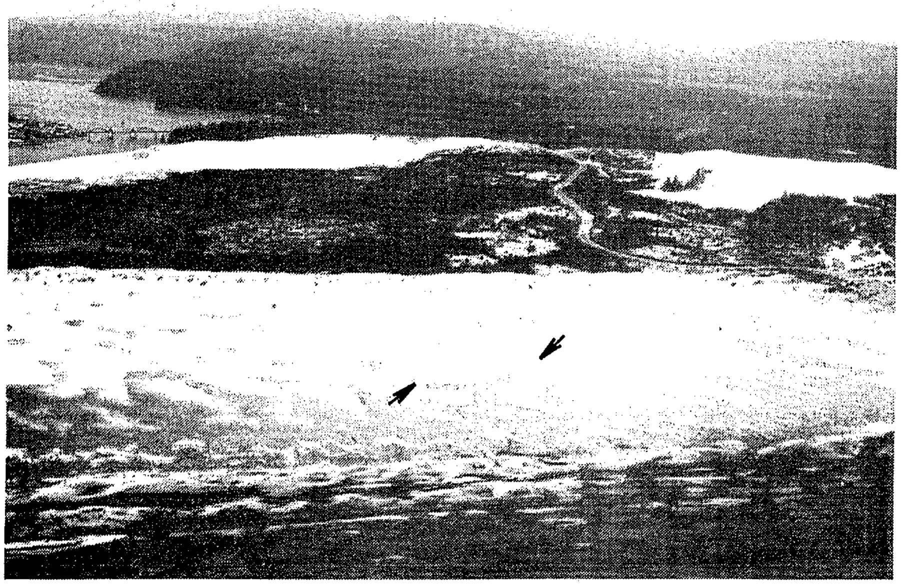
1. The site exhibits standing surface water during only part of the



2. Occasionally wet interdune areas may occur as follows:

   a. vegetated areas between open sand dune ridges,

b. nonvegetated sites between open sand dune ridges, or



c. swales between parallel-ridge dunes,

d. low sites in older forested dunes (may be affected by underlying impermeable iron lenses), or

e. swales between hummock dunes which may be a functional extension of the adjacent deflation plain.

V. INTERIOR DUNE FORMS - VEGETATED

A. Hummock Dunes

Fields of vegetated sand dune mounds most commonly occuring inland from the foredune or deflation plain.

1. Geomorphology

Hummock dunes, like the foredune, are primarily created by the mound building activities of European beachgrass (Ammophila arenaria). These dunes form as fields of hillocks rather than linear ridges because there is no natural linear vegetation and sand accumulation boundary (such as the beach), and sand supply and wind patterns are rendered inconsistent and discontinuous by the foredune barrier ridge.

Hummock dunes most commonly occur either immediately inland from the active foredune or inland from the deflation plain. Sand is supplied from either or both of these source regions. Patches of hummock dunes are also found within open sand areas on occasion. In general, hummock dunes range from ten to thirty feet in height and twenty to thirty feet at the base. In their active form they may be only sparcely vegetated and thus actively migrating. Active hummock dunes occur in the south-western region of Bayocean Spit in Tillamook County and west of Lily Lake in Lane County. A vegetative cover sufficient to make hummock dunes wind stable creates a conditionally stable form, examples of which are found at the north end of Bayocean Spit in Tillamook County and at South Beach in Lincoln County.

2. Vegetation

The most prevalent vegetation found on hummock dunes is European beachgrass (Ammophila arenaria). Other secondary components include seashore lupine (Lupinus littoralis), seashore bluegrass (Poa macrantha), and coast strawberry (Fragaria chiloensis). Later successional growth is similar to that on the lee side of the conditionally stable foredune and may frequently exhibit shrubs or dwarfed trees in the more protected sites. The depressions in those hummock dune areas which have a high winter water table may be occupied by marsh vegetation including sedges and rushes.

3. Attractions and limitations

This area has attractions to both pedestrian and off-road vehicle recreation. Some areas have been used for home sites.

The proximity of active hummock dunes to the active foredune and their natural interaction is of critical importance. Often one blends into the other imperceptably and the boundary is somewhat hypothetical. One cannot be managed in isolation from another.

Hummock areas are often used by off-road vehicle recreationalists but limited visibility can create hazards, particularly for pedestrians.

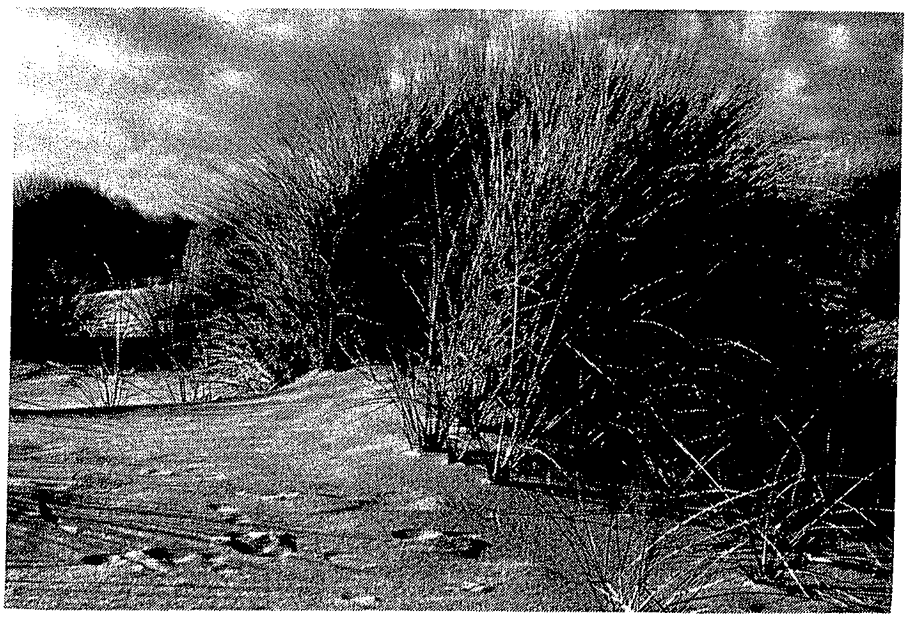
Those areas which have a high winter water table may develop "quicksand-like" conditions in the low areas (U.S.D.A., 1972, p. 76). High water table areas are also highly sensitive to development and would be particularly unsuitable for either septic tanks or buried pipelines due to the possibility of structure flotation and failure (Ibid, p. 83).

High wind scour and blowout potential also limit the development possibilities of this dune landform. Stabilization planting should be undertaken and consistently maintained during and after any construction.

4. Identification check-list

Hummock dunes can be identified by the following characteristics:

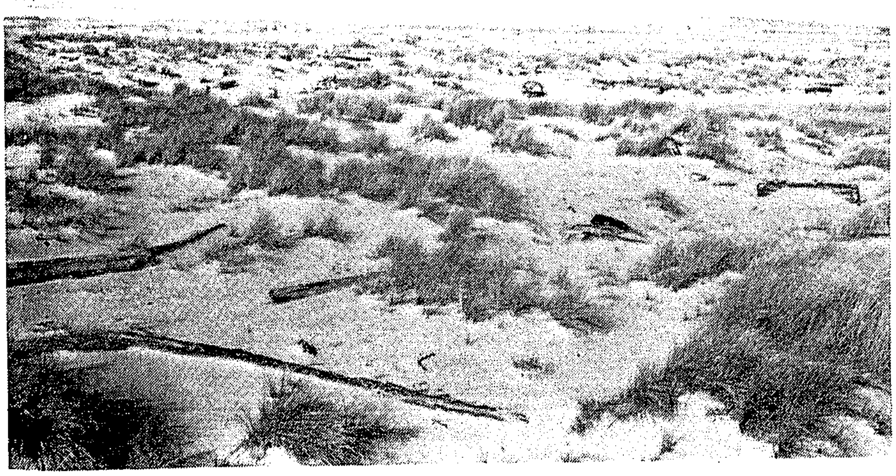
1. Hummock dunes occur where clumps of vegetation cause deposition of windblown sand



2. They occur as fields of individual, vegetated sand hummocks

3. Hummock dunes occur either:

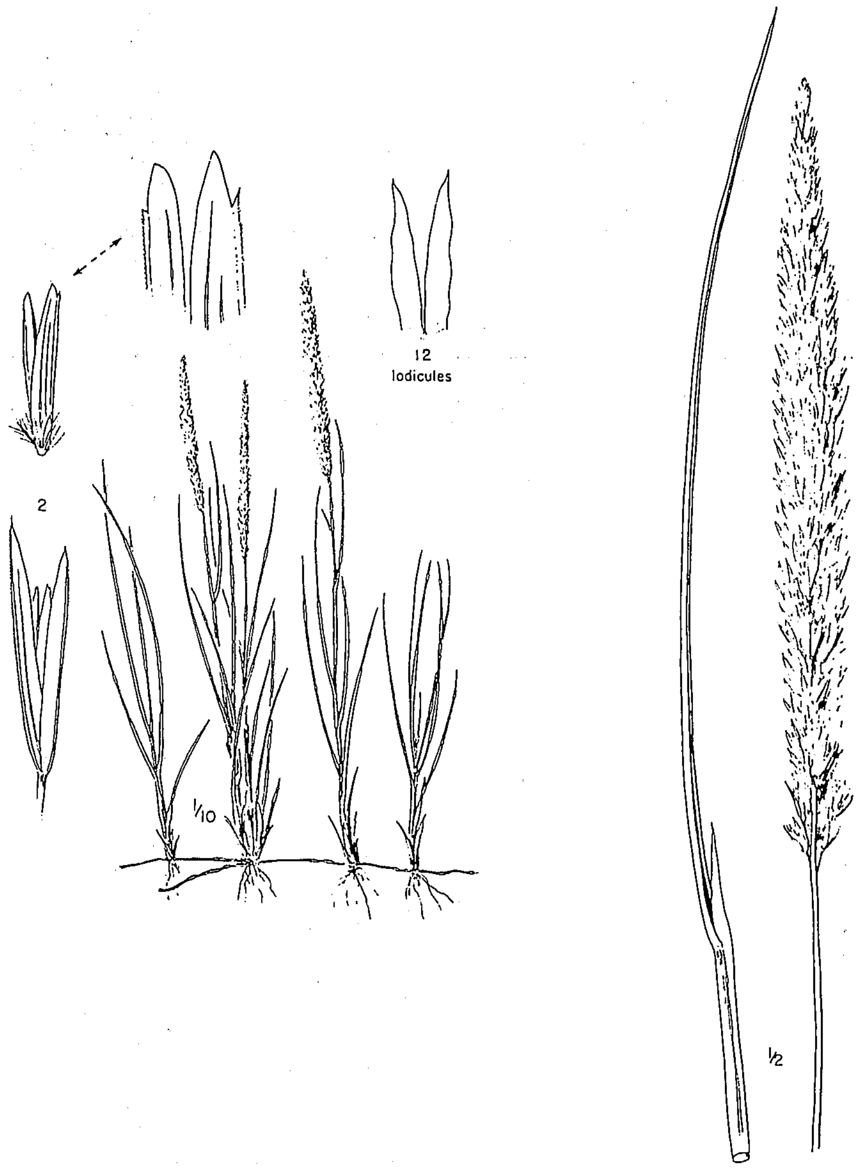
   a. leeward of an active foredune, or



b. inland from the deflation plain, or

c. in isolated hummock fields within open sand areas.

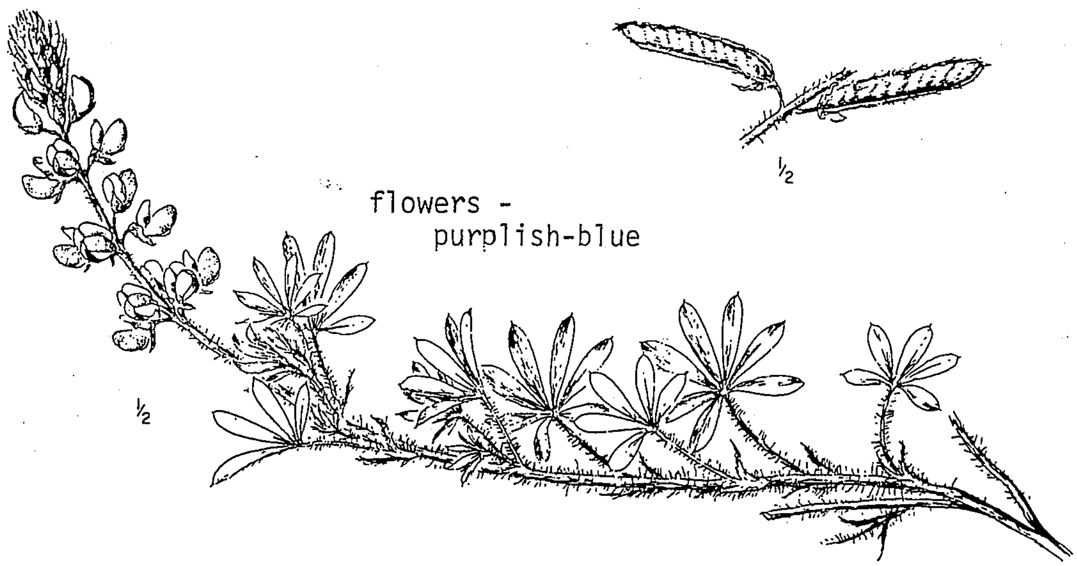
4. European beachgrass (Ammophila arenaria) forms the primary component of the vegetation community of active hummocks.



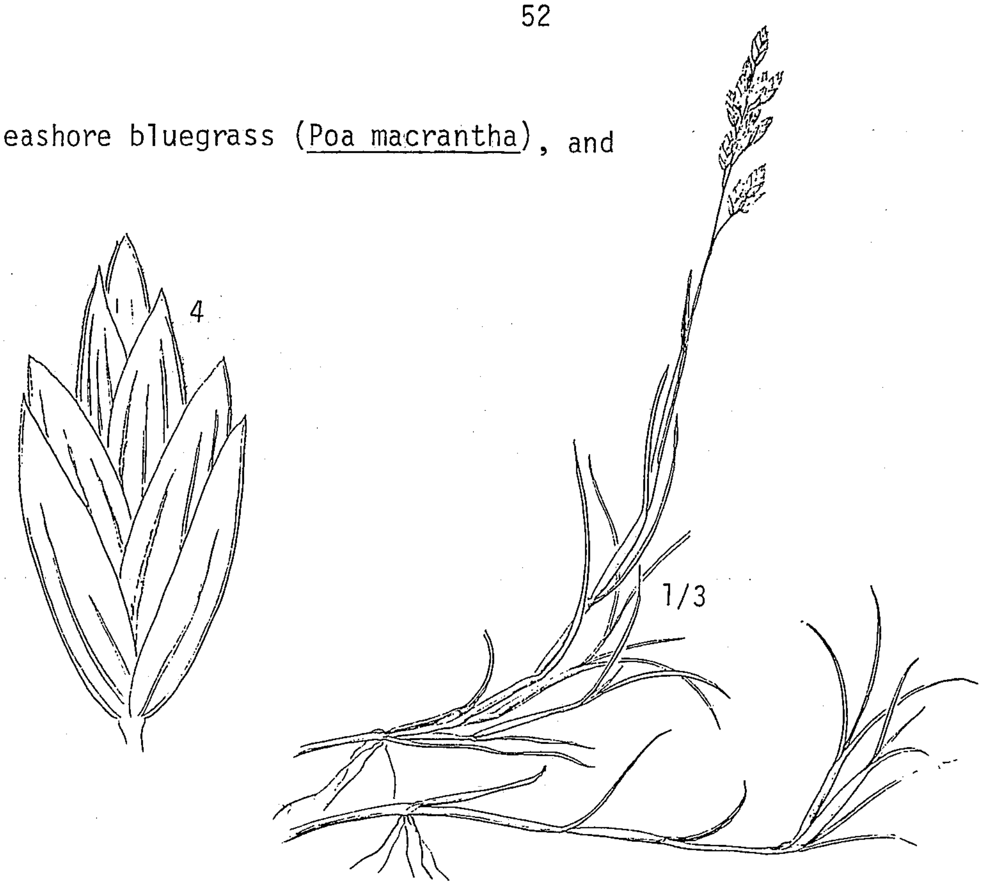
5. Other species which may occur here include:

a. sea lyme-grass (<u>Elymus mollis</u>)

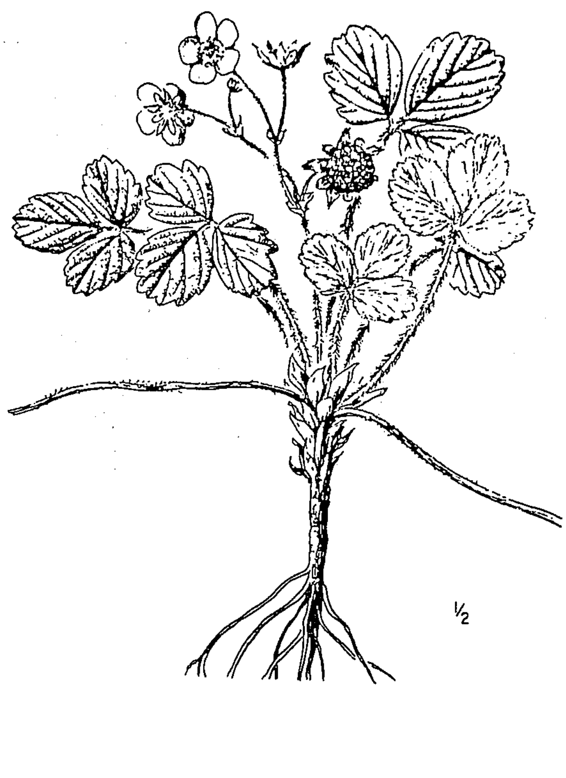
b. seashore lupine (<u>Lupinus littoralis</u>)



c. seashore bluegrass (Poa macrantha), and



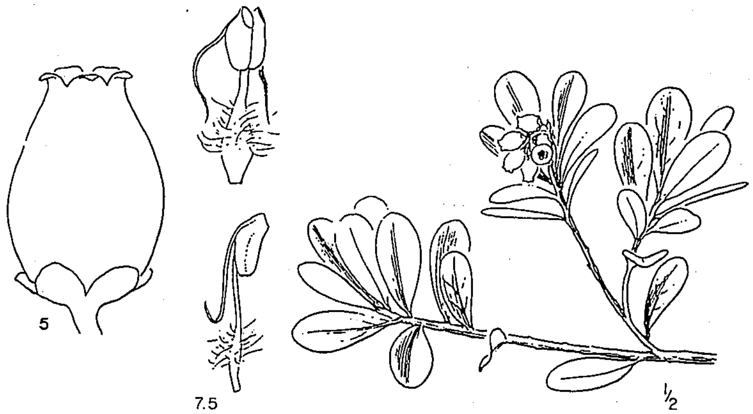
d. coast strawberry (Fragaria chiloensis).



flowers - white to pinkish

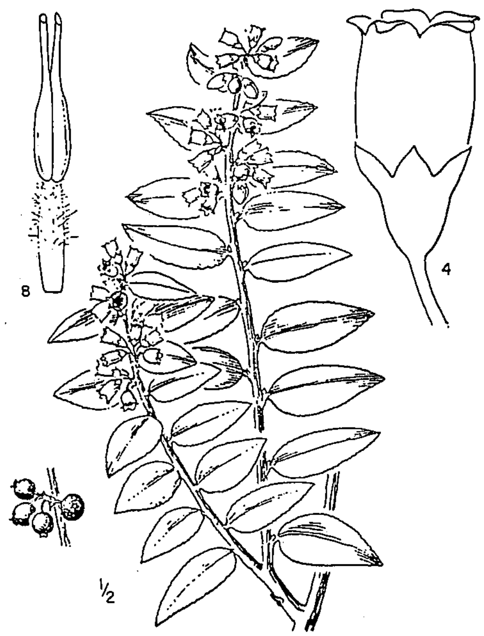
Hummock dune areas which have experienced prolonged successional growth indicating conditional stability may display the following species:

a. kinnikinnic (Arctostaphylos uva-ursi),



flowers - white to pink

b. evergreen huckleberry (Vaccinium ovatum),

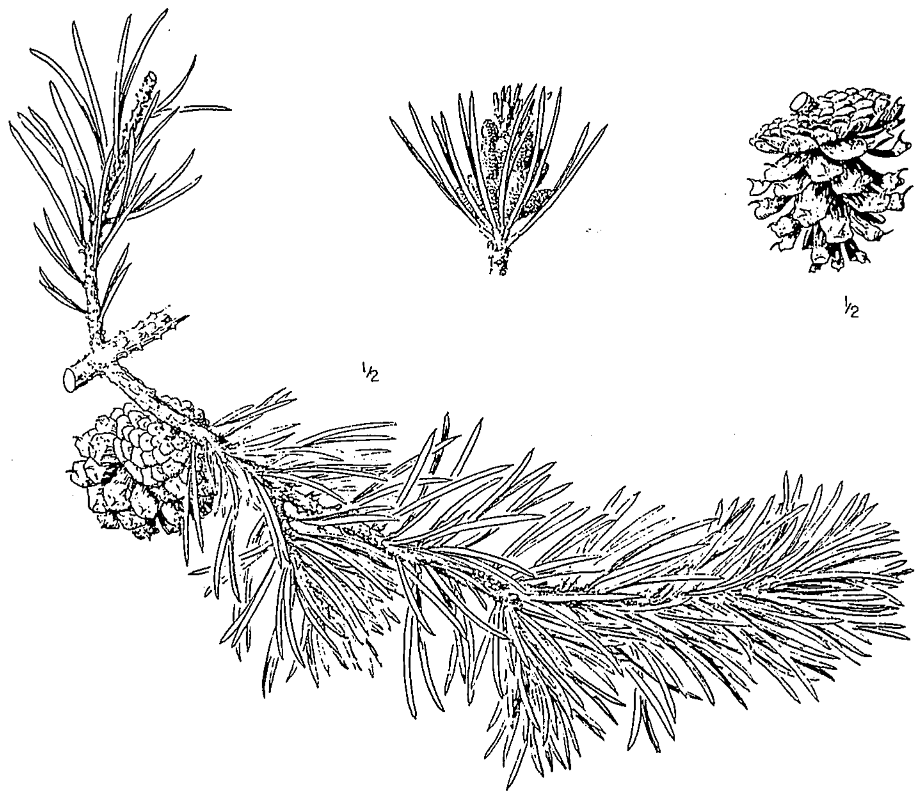


flowers - white to pink

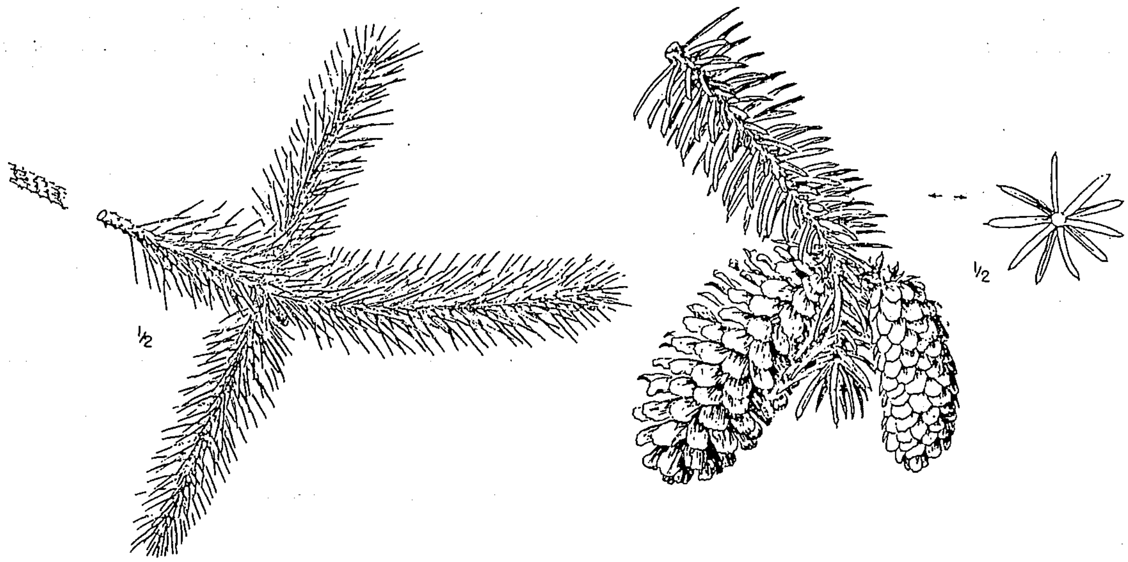
c. salal (Gaultheria shallon),

flowers -
white to pink

d. shore pine (Pinus contorta), and



e. sitka spruce (Picea sitchensis).



B. Surface Stabilized Dunes

Dunes of any form which possess a weakly developed thin soil and underlying unconsolidated sands.

1. Geomorphology

These dunes have been stabilized with vegetation long enough for soil to begin forming. This process may have taken hundreds or possibly a few thousand years.

Surface stable dunes are wind stable so long as the weakly developed soil is not seriously disturbed. The underlying sand materials are prone to reactivation, particularly if excavations are oriented toward prevailing winds. Parabola dunes commonly occur in this landform. Occasionally, buried soils and iron bands may impede permeability. Surface stable dunes occur in the central portion of the Tillamook Spit in Tillamook County and are intersperced throughout the dune sheets in Lane, Douglas and Coos Counties.

2. Vegetation

Forest associations occur most commonly in this unit although meadow communities are not unknown. Native herbs, shrubs and trees, not unlike the later successional species found on conditionally stable foredunes, are found here although species proportions, size of individuals and biomass density are considerably different. Because of the favorable environment provided by an abundance of moisture, mild climates and surrounding forest productivity, coastal forests, particularly the shrub layer, may be nearly impenetrable.

3. Attractions and limitations

The forested surface-stabilized dunes offer attractive sites for a number of man's activities because they are sheltered and somewhat more stable than most other dune forms. Such reactional activities as camping and picnicking, as well as the placement of dwellings and other structures, are popular activities.

Caution must be used in developing these sites, however, because of some inherent limitations. The dunes are only surface stabilized and are prone to reactiviation if the surface vegetation and soil are disturbed. Furthermore, windfallen trees are common along the edge of new clearings posing potential hazard for development.

Many surface stable dunes are underlain by older, buried soils and iron lenses which restrict vertical permeability. This is typical of the subsurface stratigraphy in open dune sand and older stable dunes as well. Septic tank viability could be threatened by local high water due to these impermeable lenses.

Water drawdown could also be a problem in this unit if stabilizing vegetation is affected. Pollution of the groundwater is also a potential problem for the development of this landform.

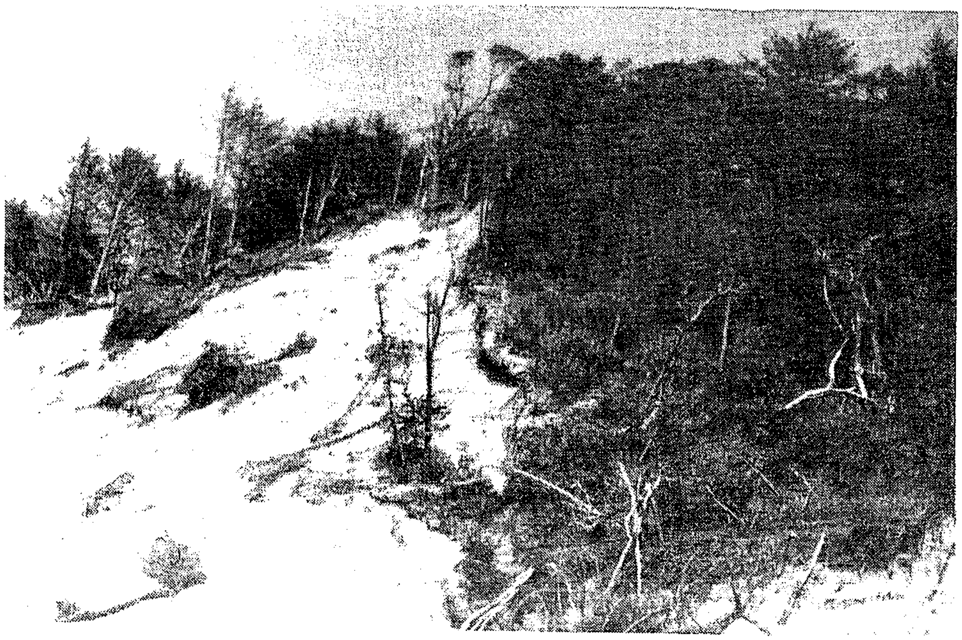
4. Identification check-list

Surface-stable dunes can be identified by the following characteristics:

1. Dunes having a thin, weakly developed soil.

2. The sands underlying the soil are unconsolidated and will easily reactivate with sufficient disturbance.

3. Forests most commonly cover the surface-stable dunes.

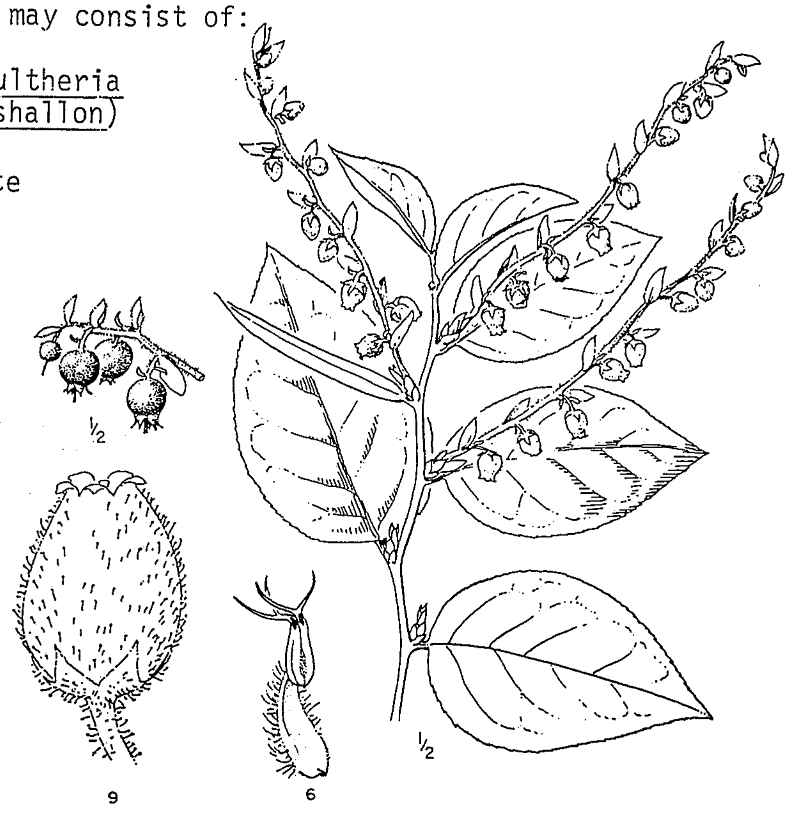


4. The forested, surface-stable dune is characterized by the following vegetation:

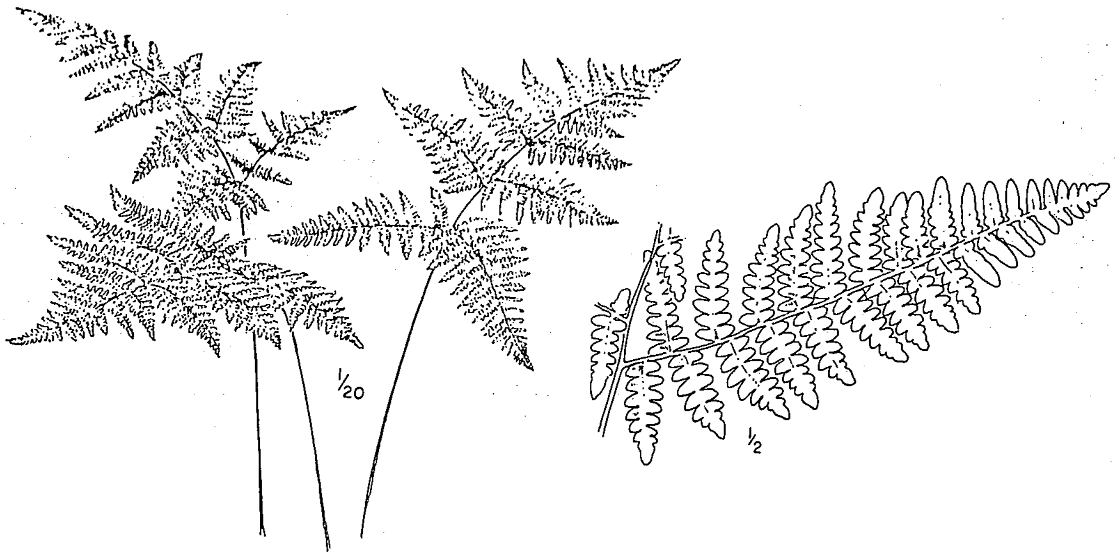
   a. The understory may consist of:

      (1) salal (<u>Gaultheria shallon</u>)

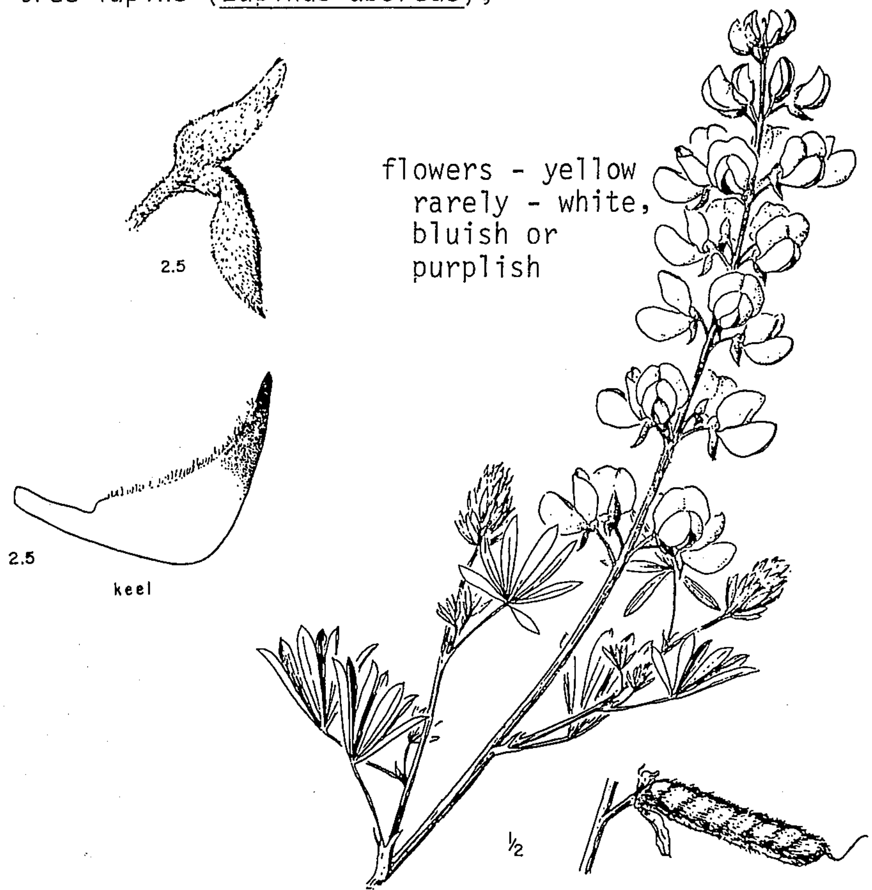
      flowers - white to pink



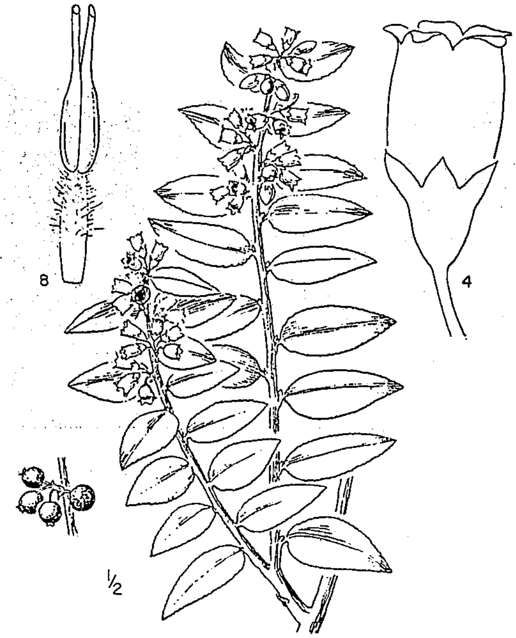
(2) western bracken fern (<u>Pteridium aquilinum</u>)



(3) tree lupine (<u>Lupinus aboreus</u>),

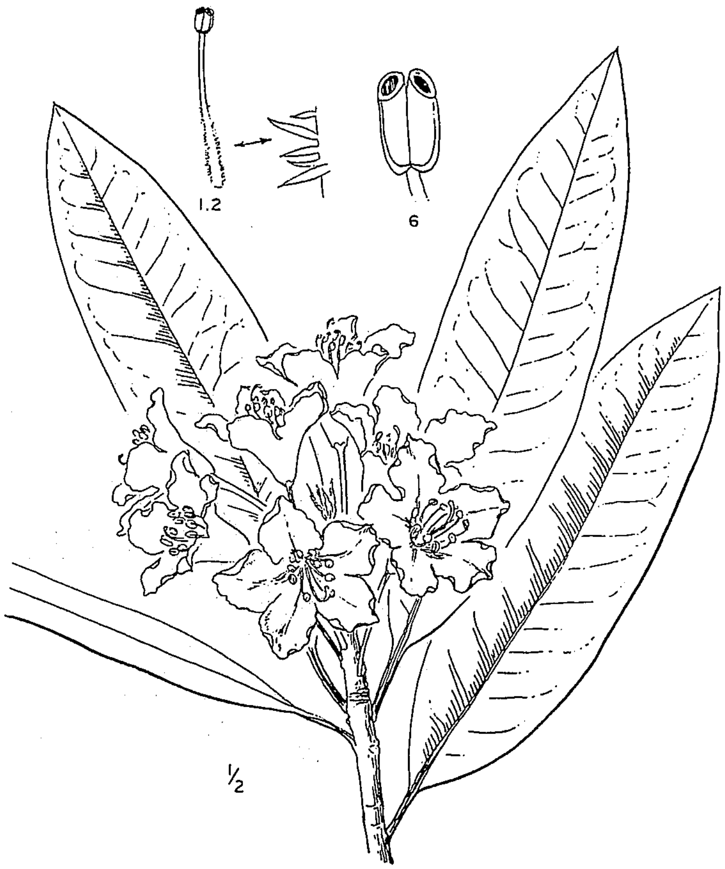


(4) evergreen huckleberry (Vaccinium ovatum) and



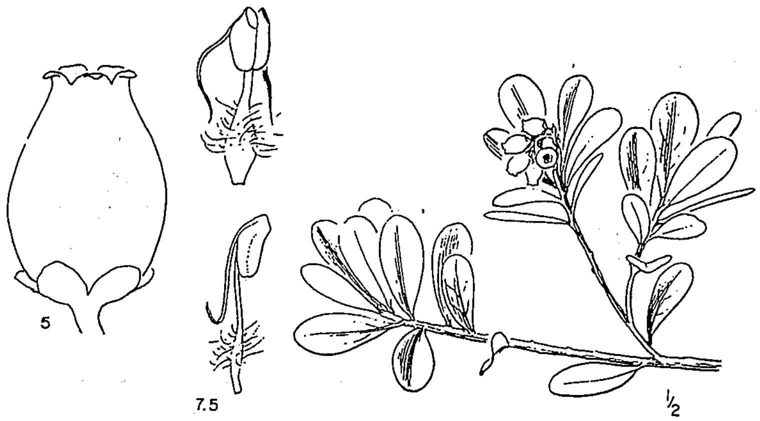
flowers - white to pink

(5) western rhododendron (Rhododendron macrophyllum).



flowers - pink to deep rose rarely white

(6) The more open sites may contain kinnikinnick (Arctostaphylos uva-ursi) and

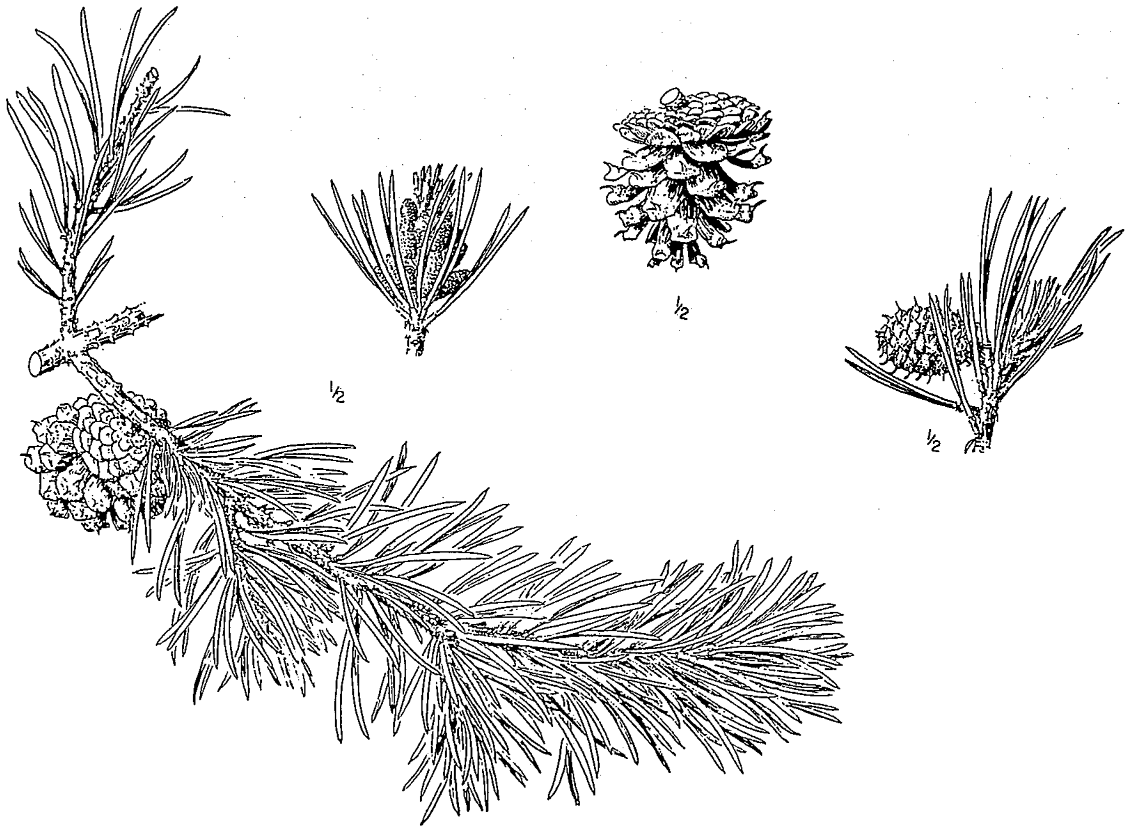


flowers - white to pink

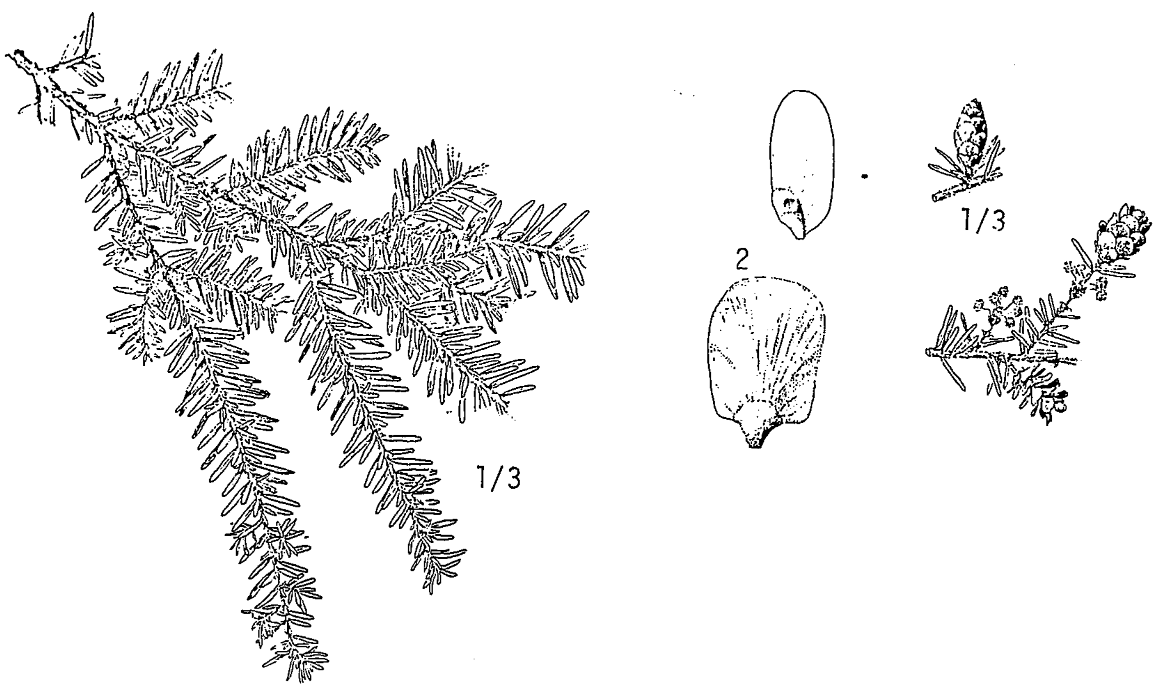
(7) hairy manzanita (Arctostaphylos columbiana).

flowers - white to pale pink

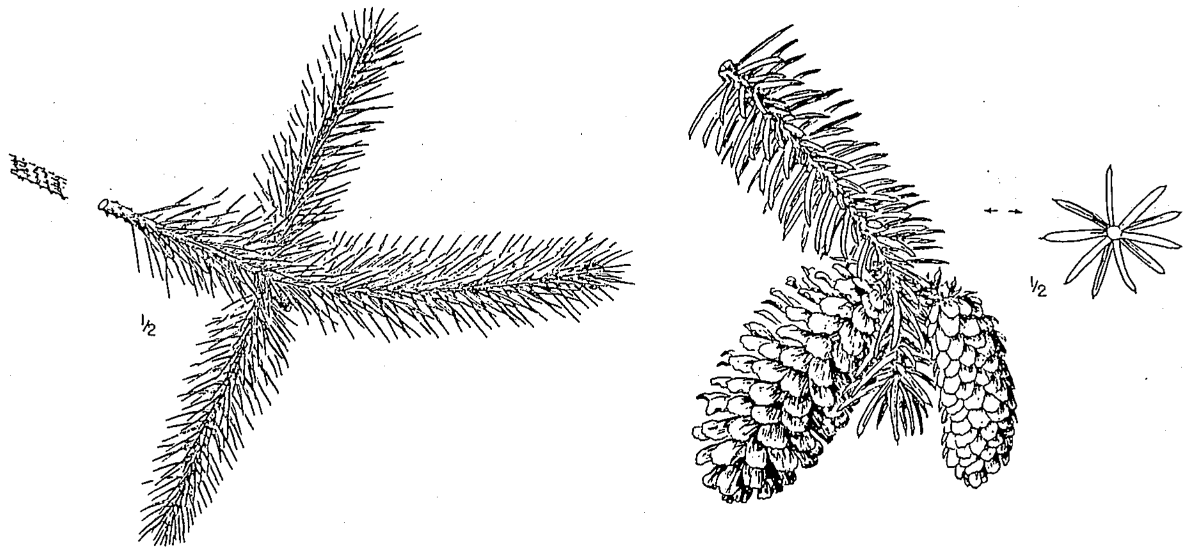
b. The forest canopy consists primarily of shore pine (<u>Pinus contorta</u>) but also may include:



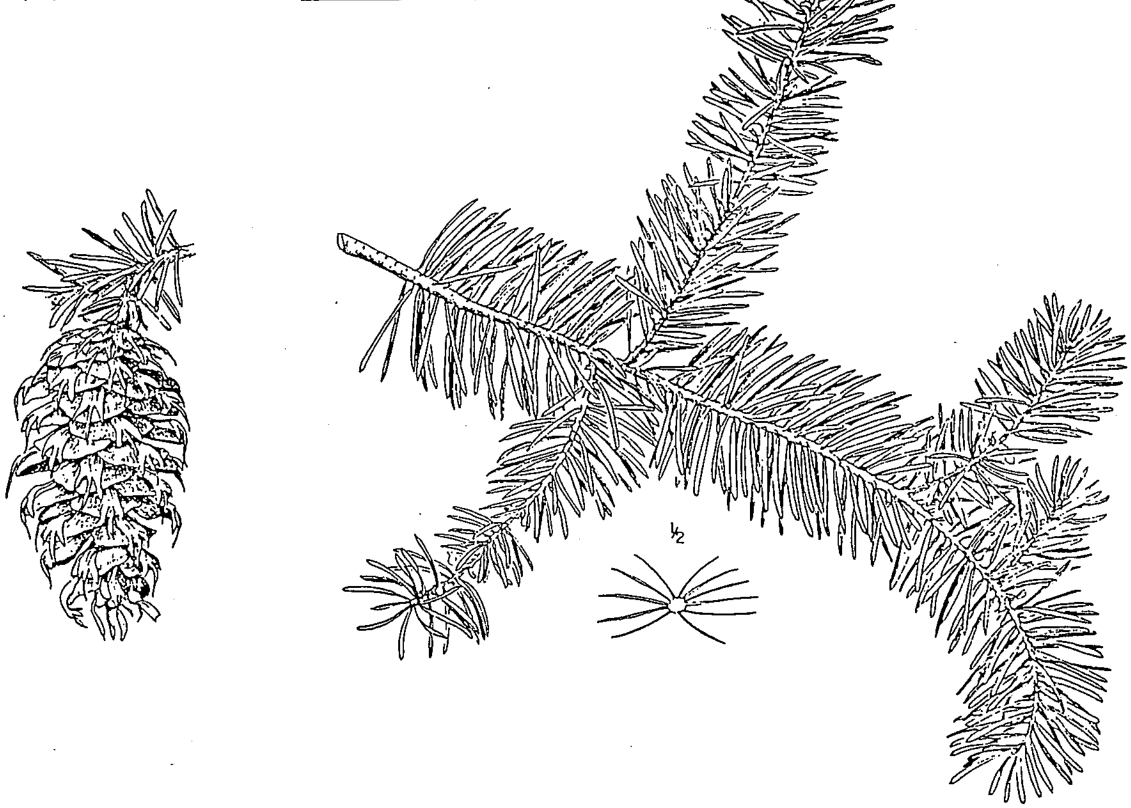
(1) Western hemlock (<u>Tsuga heterophylla</u>) in moist sites,



(2) sitka spruce (Picea sitchensis)

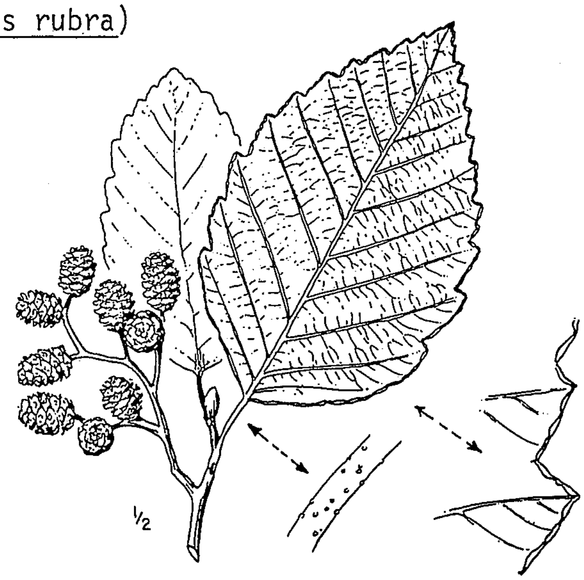


(3) douglas-fir (Pseudotsuga menziesii)



(4) western red cedar (Thuja plicata) and

(5) red alder (Alnus rubra)



C. Older Stable Dunes

Older sand dunes of any form which possess both a deep, well-developed soil and moderately cemented underlying sand.

1. Geomorphology

This dune type has been stabilized with a vegetative cover long enough for a relatively deep soil to develop and for the underlying sands to acquire some stability. The sub-surface sands exhibit varying degrees of cementation. The iron bands and buried soils which are found in the surface stable dune occur more frequently here and are more pervasive.

Although these sands will form a cliff where excavated, sloughing and landsliding are common. This is often intensified when saturation occurs due to subsurface impermeable iron lenses.

This landform may contain layers of loose sand overlying or underlying the semi-cemented strata but it is wind stable throughout the cemented layers.

2. Vegetation

Forests, often the coastal climax forest, most commonly occur here although natural grass areas may be found as well. The same species as occur in the surface-stable dune classification also occur here. A more even mixture of forest species is often found with less predominance of shore pine, and the forest canopy may be more dense with a resulting less dense shrub layer.

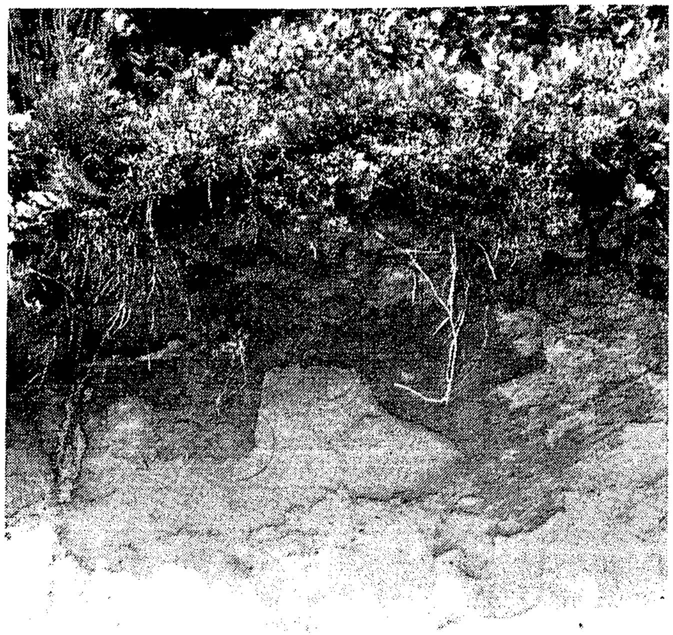
3. Attractions and limitations

The older stable dune presents an attractive site for recreational activities and residential development. The limitations associated with mobile sands do not exist with this landform. When excavated, the semi-cemented sands will maintain a cliff and are wind stable. However, sloughing is common, particularly in the winter months. This tendency is accentuated during groundwater recharge months by the impermeable iron bands which commonly run horizontally through this unit. Infiltering groundwater is concentrated above these bands, saturating the sands causing collapse where cliffs exist. This same phenomenon, which forms a perched water table, results in conditions highly unfavorable to septic tank siting, consequently, septic tank failure is not uncommon in this landform.

4. Identification check-list

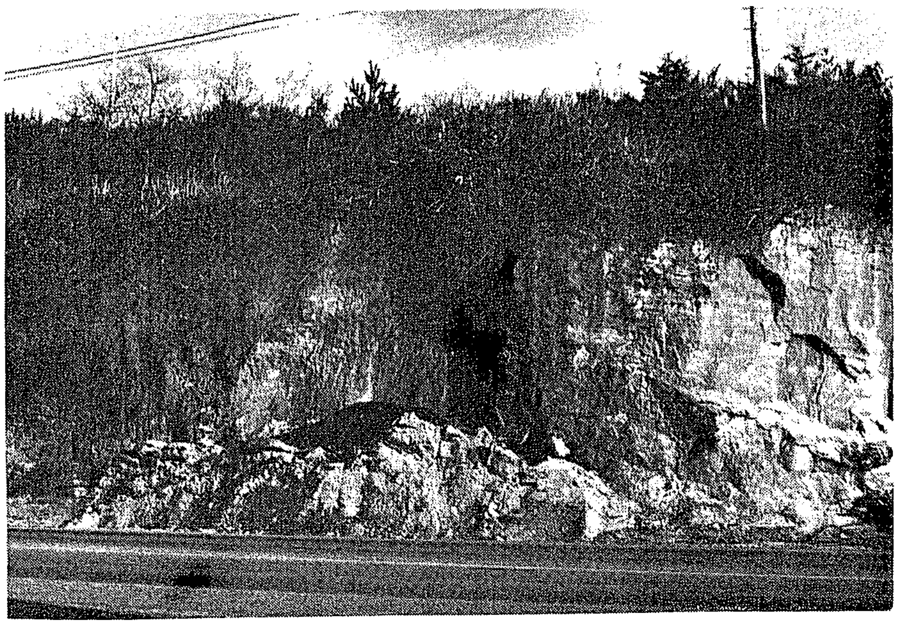
Older stable dunes can be identified by the following characteristics:

1. The presence of a moderately well developed soil.



2. The underlying sands are somewhat consolidated and often exhibit horizontal iron bands which offer varying resistance to erosion and impede vertical percolation of groundwater.

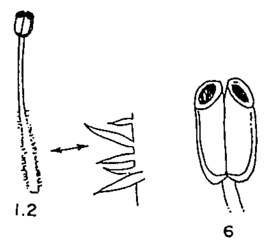
3. Underlying sands will form a cliff where cut, but sloughing is common.



4. Vegetation species which occur on the older-stable dune are essentially the same as the surface-stable dune but species proportions vary. Shore pine and salal are less dominant. The following species are common to this landform:

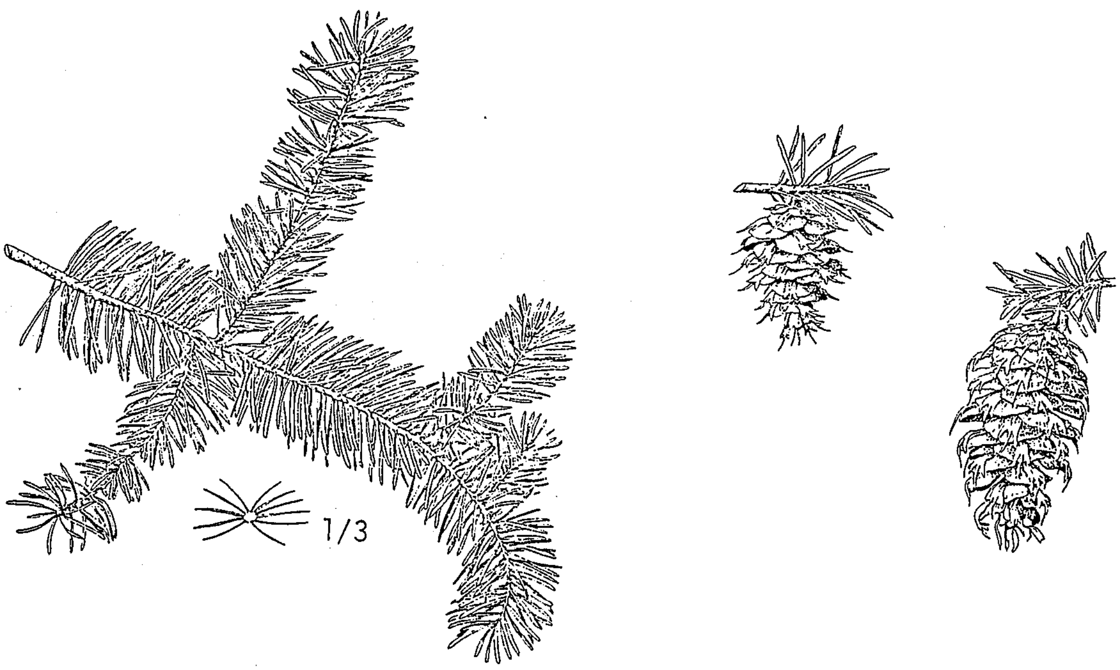
   a. western rhododendron (<u>Rhododendron macrophyllum</u>)

   flowers - pink to deep rose, rarely white

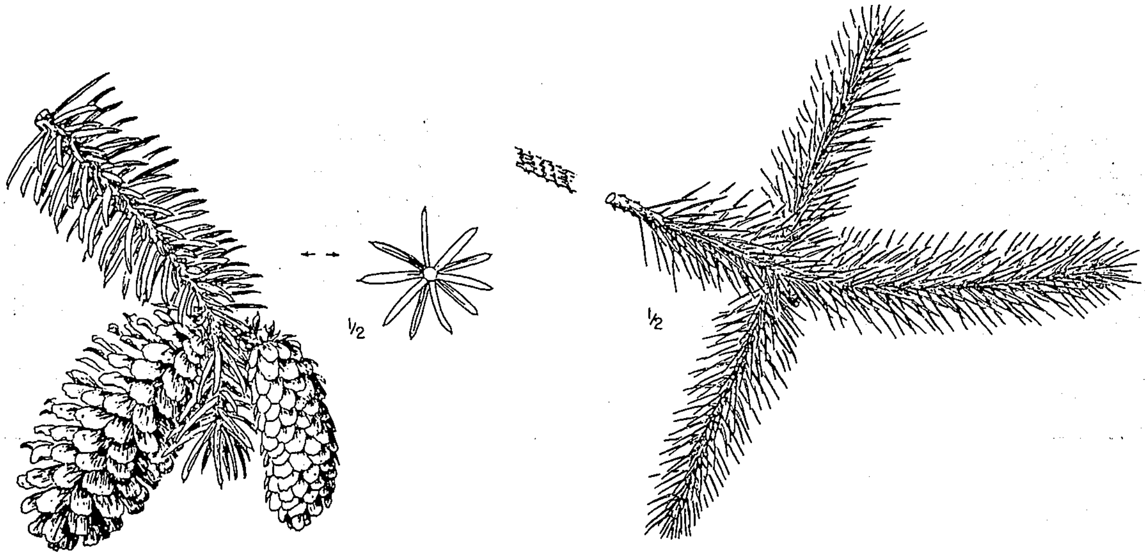


b. western hemlock (Tsuga heterophylla)

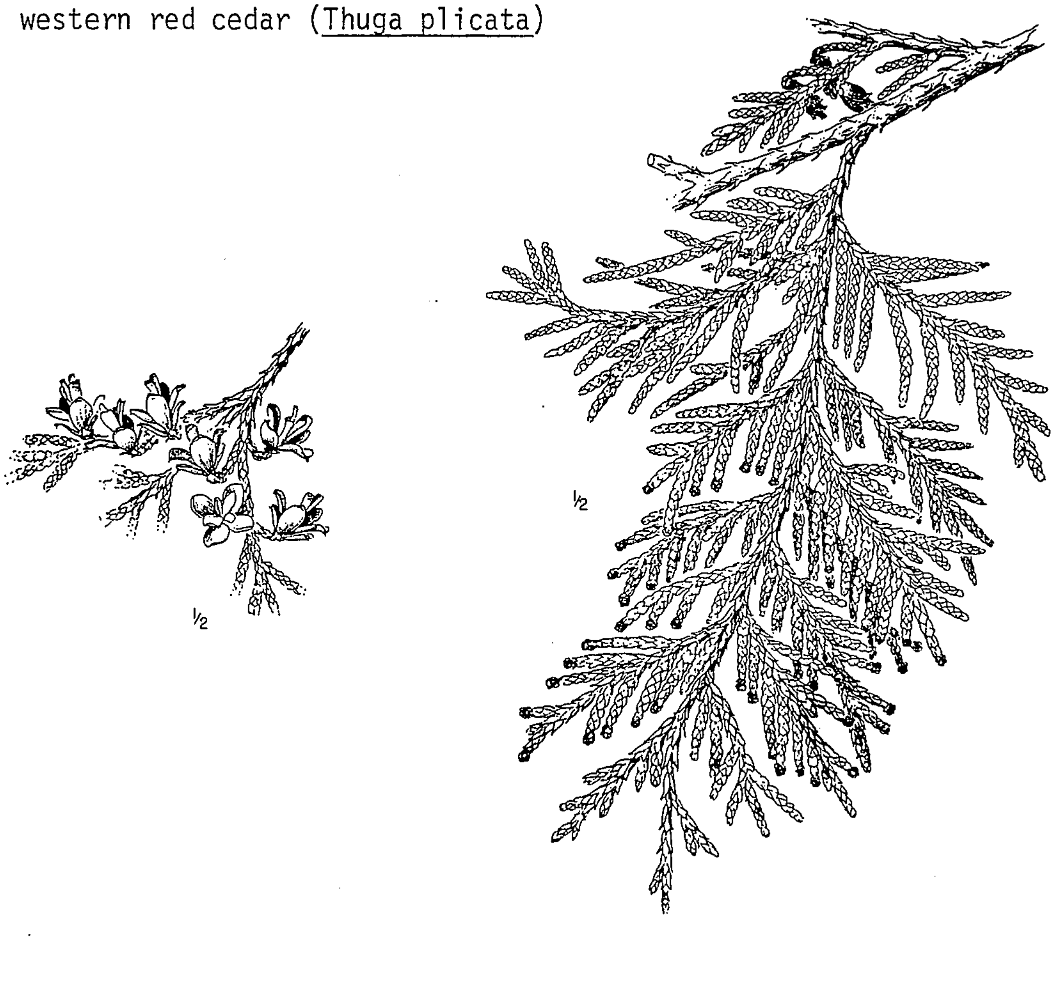
c. douglas-fir (Pseudotsuga menziesii)



d. sitka spruce (Picea sitchensis)



e. western red cedar (Thuga plicata)



D. Parallel-Ridge Dunes

Multiple sand dune ridges which occur more or less parallel to, and inland from, the foredune.

1. Geomorphology

Each ridge in a group of parallel-ridge dunes originally formed as a foredune on an accreting beach. As the beach grew seaward, vegetation advanced to keep pace with the upper beachline. New dune mounds and eventually a new foredune developed oceanward of the previous one. Continued accretion resulted in the eventual development of a series of parallel ridges bordering the beach. The sand dunes of the Clatsop Plains are classic examples of this type. Here the dunes are very broad, gently sloping features aligned in a general north-south direction, parallel to the beach. Other, often discontinuous examples occur in association with accreting beach areas, such as in those areas of jetty construction. Parallel-ridge dunes appear to be developing at the north end of South Beach in Lincoln County. A very pronounced example of this feature occurs adjacent to the north end of Heceta Beach in Lane County. These are extremely steep ridges, unlike the Clatsop Plains variety.

2. Vegetation

Vegetation associations in parallel-ridge dunes become increasingly diverse and mature progressing inland, and range from European beachgrass (Ammophila arenaria) on the existing foredune, landward through native herbs, shrubs and forest species, many of which have been planted through sand stabilization projects (e.g. Clatsop Plains).

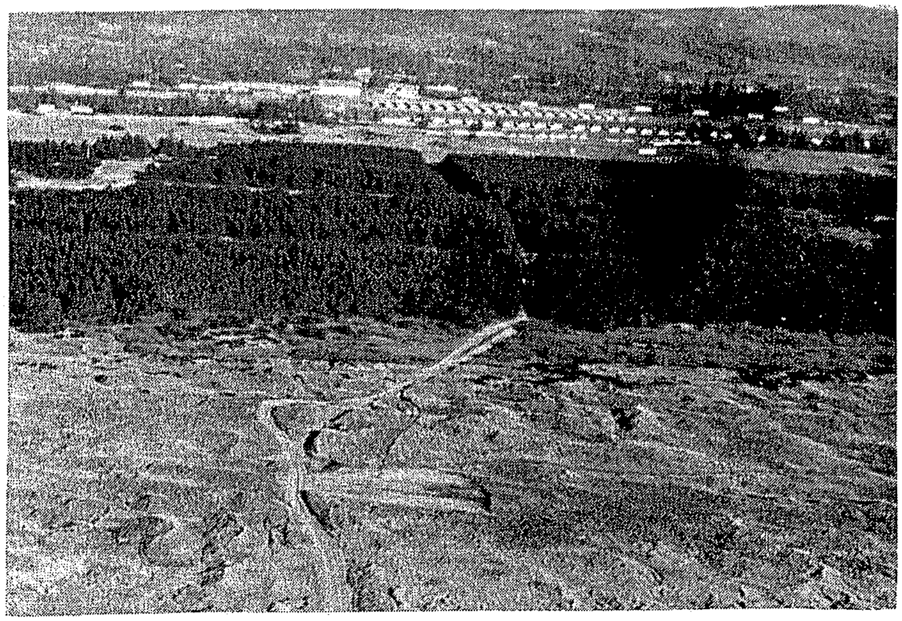
3. Attractions and limitations

This landform probably has the same attractions and limitations as conditionally stable hummock dunes and surface stabilized dunes. Due to reactivation of a major portion of the sand in the Clatsop Plains, most examples of this landform are in a conditionally-stable state although areas of surface-stabilized conditions do occur.

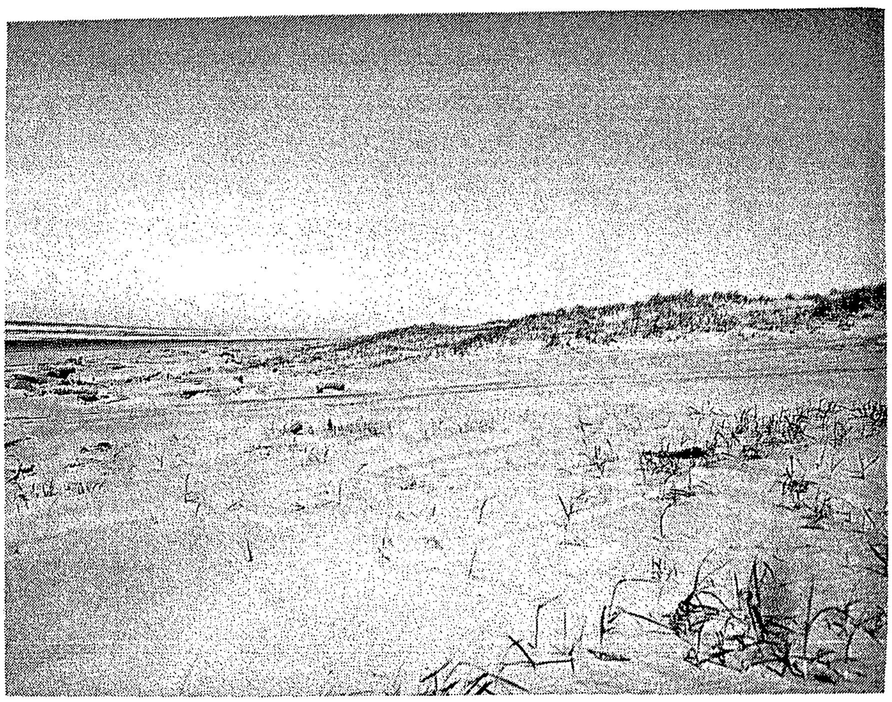
4. Identification check-list

Parallel-ridge dunes can be identified by the following characteristics:

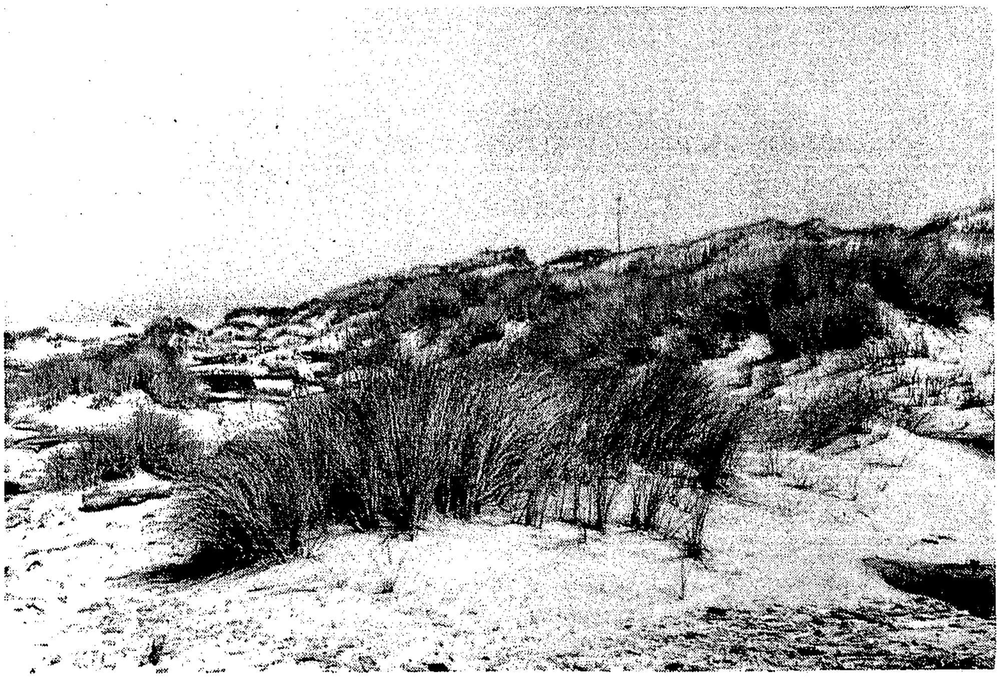
1. They occur in groups, running more or less parallel to the beach.



2. The Clatsop Plains variety commonly possess a very gentle angle of slope, whereas limited occurrences on the central and south coast are steeper.



3. Because they occur in a region of accreting beaches, portions of a newly forming foredune may occur seaward of the present foredune.



VI. INTERIOR DUNES - NONVEGETATED

This category includes those large areas of active sand which are located primarily on the sand sheets (sand deposits of considerable depth and breadth overlying subsurface coastal terraces) along the central Oregon coast. These dunes are mostly vegetation free and therefore, are formed primarily in response to wind and sand supply. Moisture and topographic factors provide morphological controls of secondary importance.

The western boundary of open dune sand areas is generally located east of the deflation plain, but is occasionally found immediately adjacent to the foredune. The western section is essentially a nonvegetated equivalent of the hummock dunes. Open sand areas derive their sand supply from the deflation plain and foredune (Figure 5). However, open sand

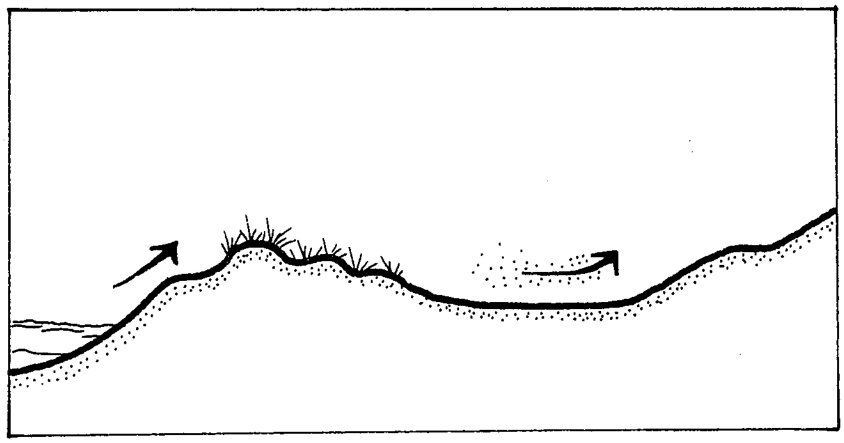


Figure 5. Beach, foredune and deflation plain supply sand to interior open sand areas.

landforms located downwind from conditionally stable foredunes or vegetated deflation plains could dwindle due to sand starvation because little sand escapes beyond these well-vegetated landforms. Open sand dunes move inland under the influence of onshore winds while the sand supply is captured by the foredune. Consequently, open sand areas are growing ever smaller, as increasingly large deflation plains are formed in their wake.

The pattern of dune development and reactivation is nowhere more complicated than on the open sand sheets. Sand deposited in these areas during Pleistocene and post-Pleistocene sea level fluctuations has been "reworked" several times, varying from one area to another. Because of this, buried soils, iron bands, islands of mature forest, and actively eroding older dune strata are common features coexisting within active sand areas.

A. Transverse-ridge Dunes

Low northeast/southwest oriented, nonvegetated sand dune ridges which most commonly migrate in a southeasterly direction.

1. Geomorphology

Transverse-ridge dunes are primarily features of the summer environment. They are undulating, sinuous ridges which are formed essentially perpendicular to the northwest winds of summer and which are greatly modified in shape during winter storms. Their orientation is northeast/southwest; migration takes place in semi-parallel ridges moving in a southeasterly direction (Figure 6).

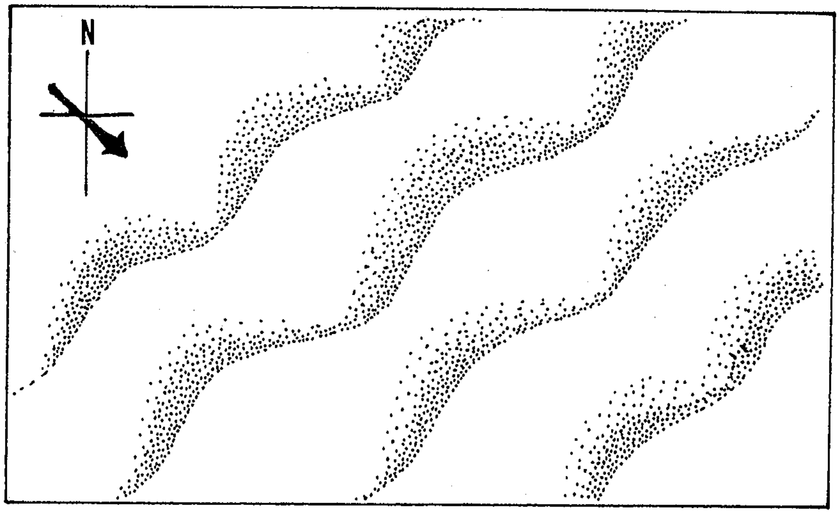


Figure 6. Transverse-ridge dunes form approximately perpendicular to northwest summer winds.

Transverse-ridge dunes are a low relief feature, five to twenty feet high composed of a gentle sloping windward face (five to twenty-five degrees) and a relatively steeper slip face (sixty to seventy degrees). The distance between crests is highly variable, but generally ranges between seventy-five and 150 feet. Where breaches occur, these dunes reveal a highly complex interior cross-bedding. This feature is produced when layers of sand from an advancing dune are deposited obliquely on the dune in its path.

Transverse-ridge dunes occur in groups. They are commonly found on the eastern fringe of the deflation plain. However, Lund (1973) reports that thirty years ago transverse dunes often extended from the beach east into the lower part of the oblique-ridge dunes. This occurred prior to the introduction of European beachgrass (Ammophila arenaria).

A zone of seasonally wet transverse-ridge dunes is often found on the eastern fringe of a deflation plain with a high winter water table. Transverse-ridge dunes commonly extend from the eastern edge of the deflation plain into the zone of the massive oblique-ridge dunes, often "riding" up over the surface of the latter.

Transverse-ridge dunes occur in Lane County on the major open sand strip between the Siuslaw and Siltcoos rivers and on the open sand areas west of north Ten Mile Lake in Coos County.

2. Vegetation

Although transverse-ridge dunes comprise a basically open dune sand unit, isolated areas of vegetation may occur in the depressions between crests. These are primarily associated with the deflation plain and will consist of the various plant types associated with that landform.

3. Attractions and limitations

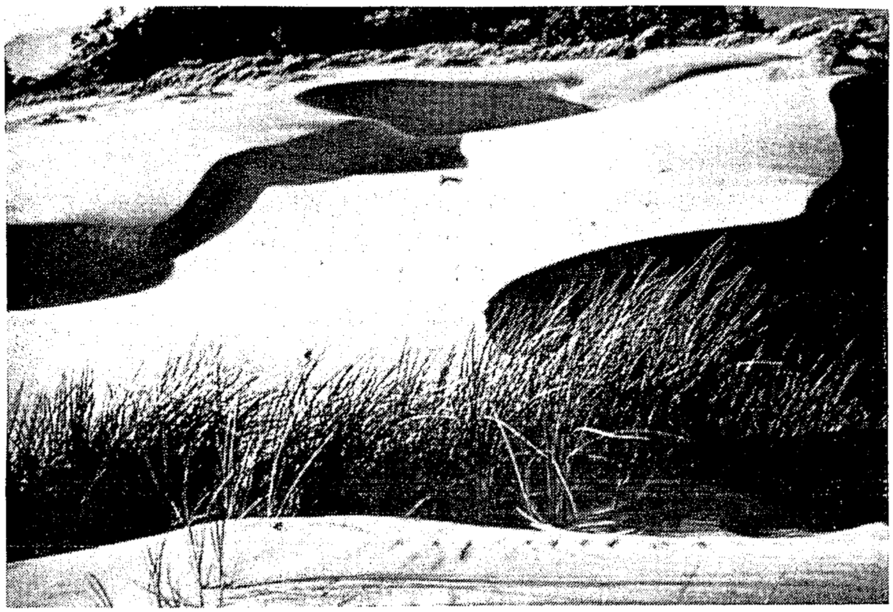
This unit appears to be highly attractive to off-road vehicle users and, to a lesser extent, pedestrian traffic. It has a high tolerance level to most recreational activities, however, facilities such as parking lots and road construction are not suited to this formation. (In some cases stabilization plantings could render such developments feasible; however, these are commonly relatively infertile sand areas (U.S.D.A., 1972, p. 105).

Factors which could create hazards are occasional areas of quicksand in wet depressions between transverse dune ridges, poor visibility in an area used by both off-road vehicle enthusiasts and pedestrians, and inundation or undermining of structures by moving sand.

4. Identification check-list

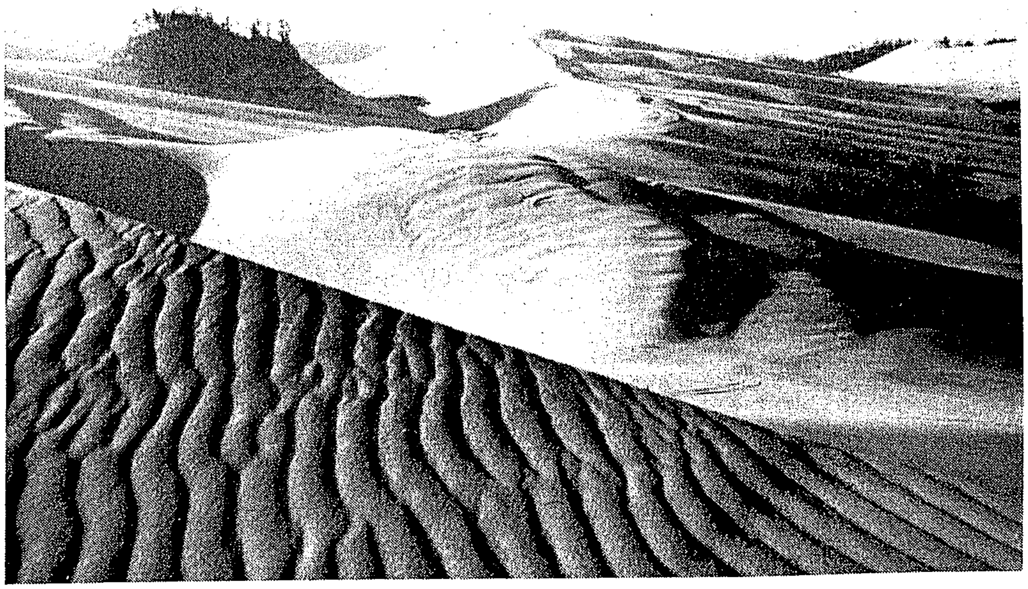
Transverse dunes may be identified by the following features:

1. This dune form occurs as a low (five to twenty-five foot) sinuous ridge with a gently sloping (five to twenty-five degree) windward face and a steeper (sixty to seventy degree) lee face.



2. Transverse-ridge dunes exhibit a northeast/southwest trend and occur in groups on the large, open sand areas along the south central coast.

3. Transverse-ridge dunes often ride up over the western flanks of the massive oblique-ridge dunes.



4. Marsh-type vegetation may occur between ridges where these dunes overlap onto the deflation plain.

B. Oblique-Ridge Dunes

Massive, generally easterly trending and migrating, nonvegetated ridge dunes found on central Oregon coastal sand sheets.

1. Morphology

The most dominant and obvious dune form in the open sand is the oblique-ridge type. Like the transverse-ridge, it is dynamic in nature. However, unlike the transverse-ridge, which is produced by unidirectional wind flow, the oblique dune is formed both by the northwest summer and southwest winter winds, experiencing its most energetic movement during winter storms (Ternyik, 1978). Its somewhat sinuous axis is oriented at an angle (obliquely) to both dominant seasonal wind sources (Figure 7). Primary controlling factors in the development of the oblique-ridge dune

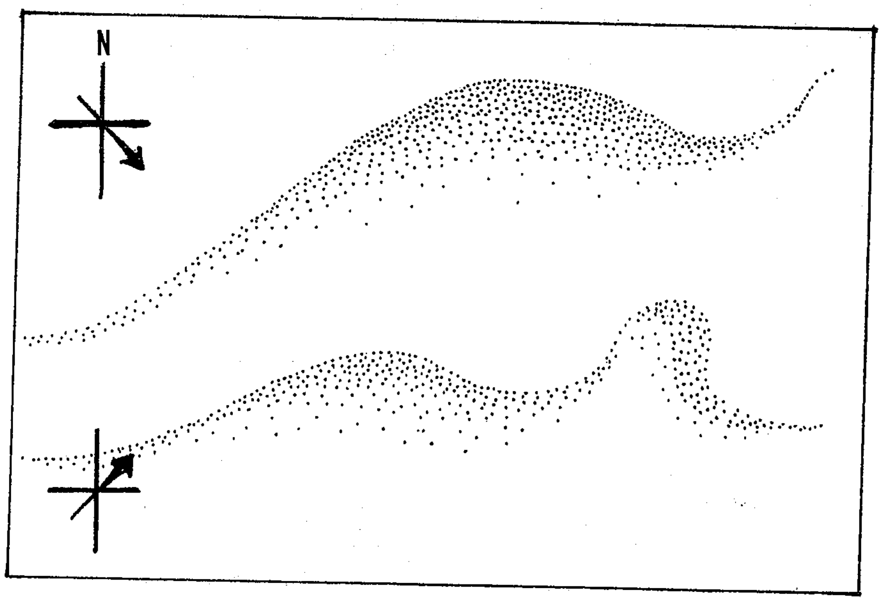


Figure 7. Oblique-ridge dunes form obliquely to both northwest and southwest dominant seasonal winds.

are an abundant sand supply, nearly constant onshore winds and coastal forests which act as wind breaks (Cooper, 1958).

Sands are moved inland by the onshore winds both in the summer (northwest wind) and the winter (southwest wind). Coastal forests which exist on the sand sheets break the flow of the low-level winds, causing them to deposit their sand load at the forest margin. Sand is thereby deposited at a site until the height of the dune thus produced equals or exceeds that of the windbreak. Sand is then precipitated over the eastern face of the dune (of the precipitation ridge) by onshore winds (Figure 8). In this way, the dune moves slowly inland inundating the

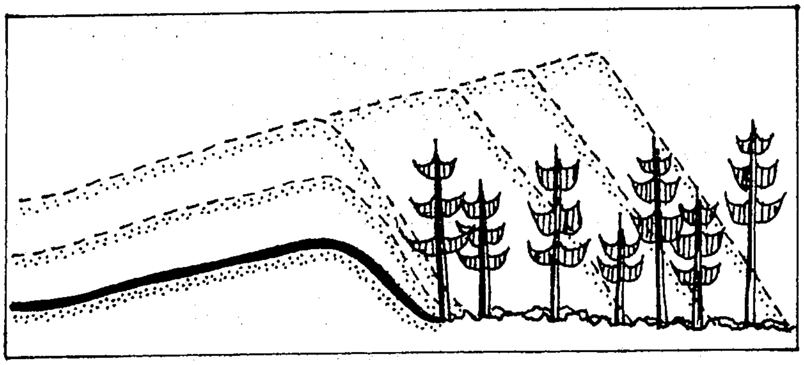


Figure 8. Accumulation and advance of the oblique-ridge dune.

forest as it goes (Cooper, 1958). The ridge does not actually migrate, but the ridge crest operates rather like a stationary transverse dune, the upper lee face of which develops to the south in the summer and to the north in the winter in response to dominant seasonal wind direction (Figure 9). The windward face has a gentle slope (five to thirty degrees)

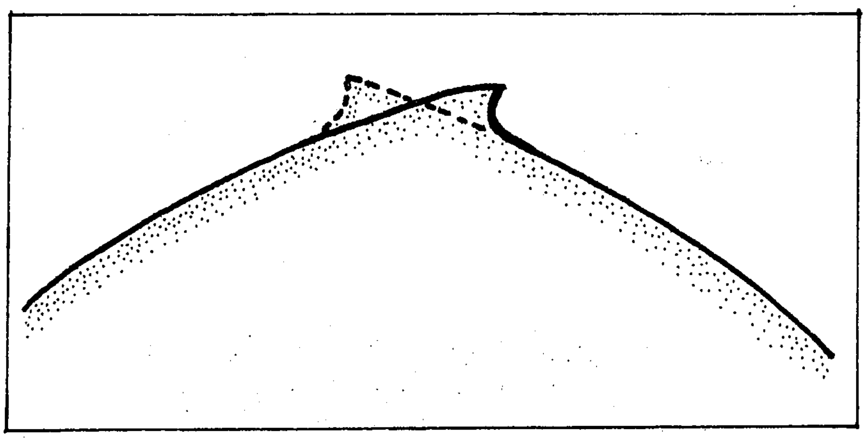


Figure 9. The ridge position of the oblique dune is modified by seasonal winds.

while the lee face is considerably steeper with a gradient of sixty to seventy degrees.

The oblique dunes may reach heights of 180 feet along the eastern edge and may occur in groups with 500 feet or more between ridges. They attain great lengths, averaging over 3,000 feet while some are nearly a mile long (Cooper, 1958). They are commonly bounded on their oceanward side by transverse-ridge dune systems and often terminate at their eastern extremity in a precipitation ridge, actively invading older forested dunes (Figure 10). A system of oblique-ridge dunes may form a

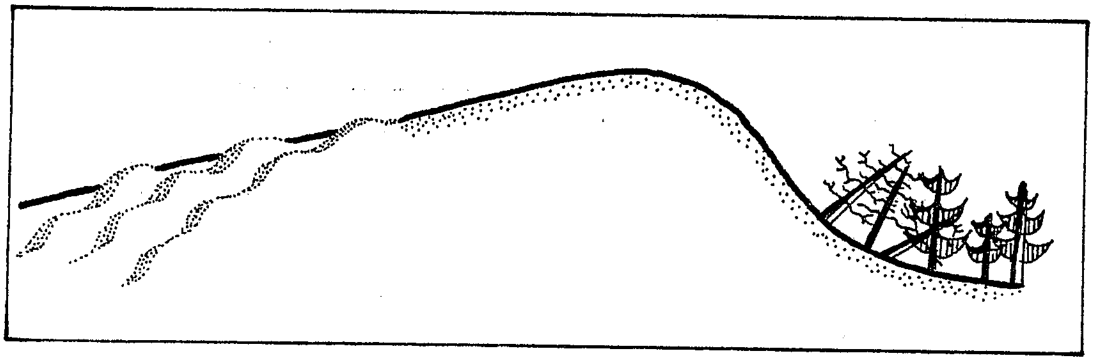


Figure 10. Transverse-ridge dunes riding up over the flanks of an oblique-ridge dune which terminates in a precipitation ridge.

nearly continuous eastward advancing precipitation ridge, often called the active ridge.

The world's distribution of the oblique-ridge dune is limited to the central Oregon coast and occurs on the sand sheets of Lane, Douglas and Coos Counties. Good examples are found between the Siuslaw and Siltcoos Rivers in Lane County and just north and south of the Douglas-Coos Counties boundary.

2. Vegetation

Sparse, marsh-type vegetation may occasionally occur in the depressions between ridges within this landform. These are areas of high water table and are classified as occasionally wet interdune areas. Isolated areas of hummock dunes may also occur on the surface of this landform.

3. Attractions and limitations

Recreationalists use the oblique-ridge dunes on foot, on horseback and in off-road vehicles. These dunes dominate the landscape and capture the imagination of visitors. Impact of recreationalists on this landform is reportedly negligible (U.S.D.A., 1972) although research on Atlantic Coast dunes indicates that considerable sand transport can occur from ORV traffic. This phenonemon would not commonly be considered a serious problem in areas of open windblown sand, however, it could prove to be a contributing factor to such problems as rapid dune advance on interdune lakes, such as at Cleawox Lake in Lane County where ORV traffic is quite heavy.

Oblique-ridge dunes do, however, pose potential hazards for recreationalists from naturally camouflaged tree cast openings in the ground.

Although the oblique-ridge dune is poorly suited to the development of permanent structures (U.S.D.A., 1972), some development has occurred here. Stabilization plantings, if carried out and maintained properly, can alleviate potential development problems. A primary obstacle, however, is that due to the oblique-ridge dunes' mobility and incompatability with legal boundaries, access to key downwind sites for the purpose of stabilization plantings may not be readily available to the developer. Water table limitations mentioned in relation to the surface stabilized and older stable dunes also apply to this dune form.

Recently, concern has been expressed for the survival of these unique dune forms. It has been predicted that these features could disappear within seventy-five years due to sand starvation (U.S.D.A., 1972, p. 110). Those processes, both natural and man-induced which threaten this feature include:

1. The eastward expansion of the deflation plain due to foredune stabilization which cuts off sand supply to the area (Figure 11).

2. Stabilization plantings for developmental and protection purposes.

3. Natural revegetation of the open dune sand areas. The sand sheets of the central Oregon coast, on which these dunes occur have experienced several periods of dune reactivation and subsequent revegetation in the last few thousand years (Cooper, 1958). Sands which were reactivated, probably by fires, experienced restabilization through the natural readvance of indigenous species. This pattern of revegetation could well repeat itself today.

Due to the combination of foredune development and resulting deflation plain advance, stabilization plantings and natural revegetation, the oblique-ridge dunes will almost certainly disappear in the foreseeable future, unless man intervenes.

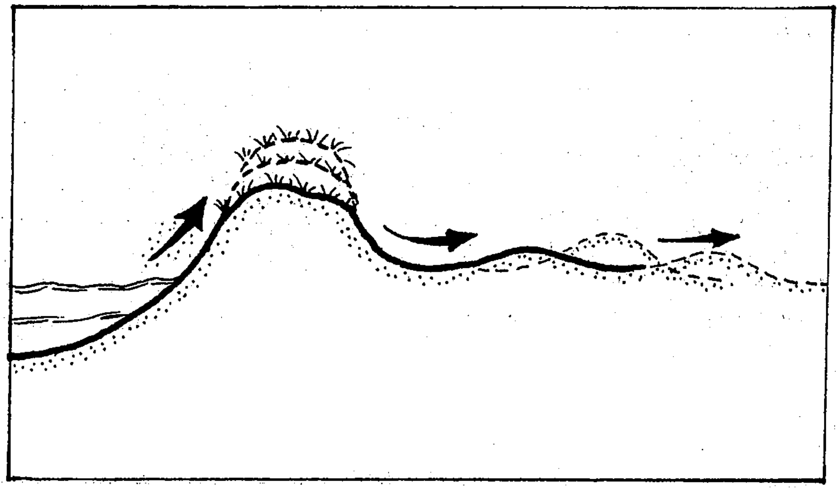
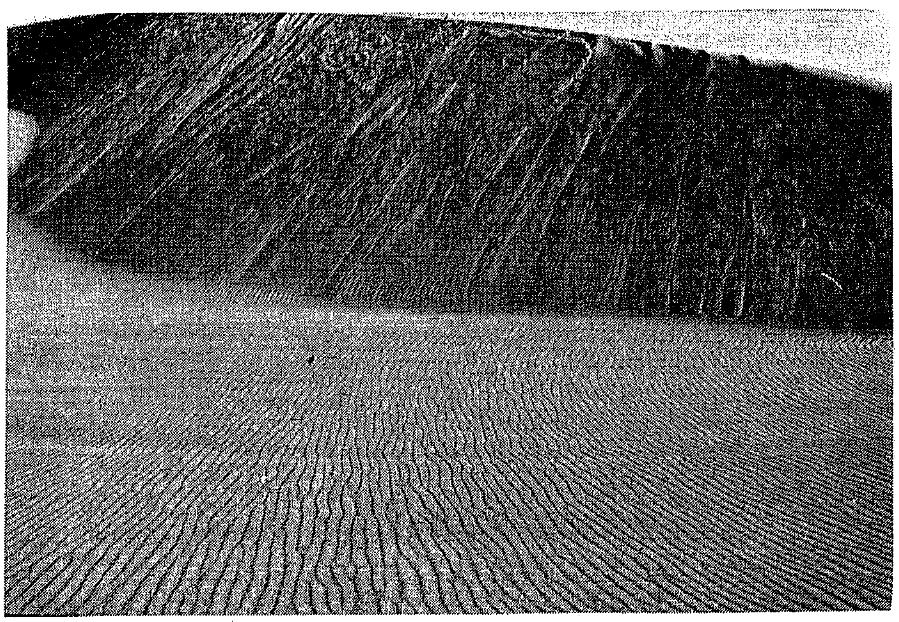


Figure 11. Eastward expansion of deflation plain. Sand supply is interrupted by the growing foredune.

4. Identification check-list

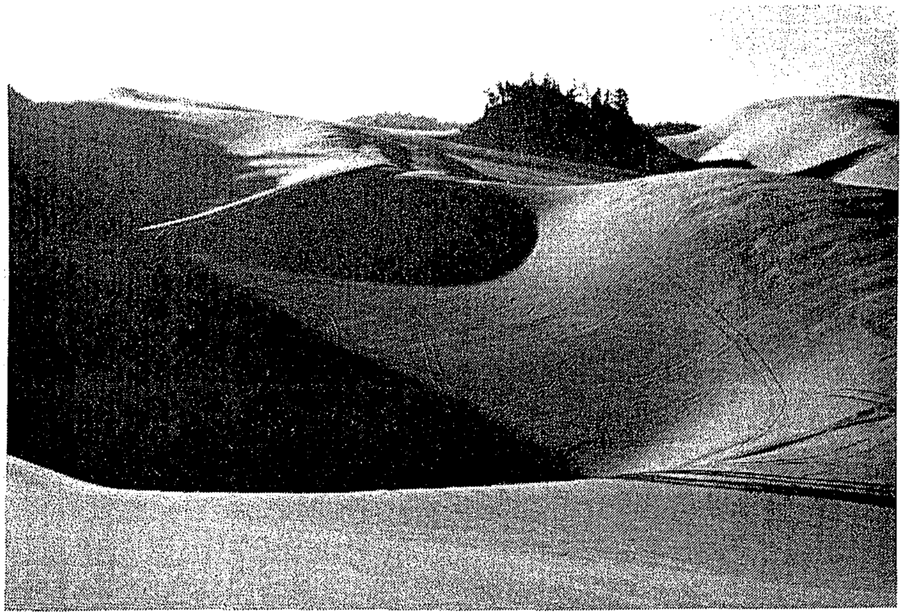
The oblique-ridge dune can be identified by the following characteristics:

1. The massive size of the oblique ridge dune is probably its most distinctive characteristic.



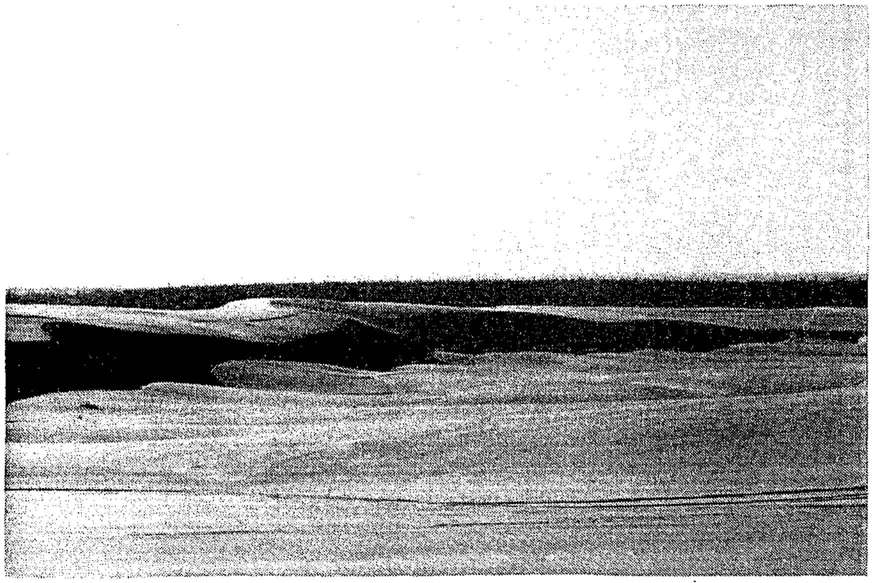
2. It consists of:

   a. a long, sinuous inland moving ridge gently sloping on its windward flanks, and

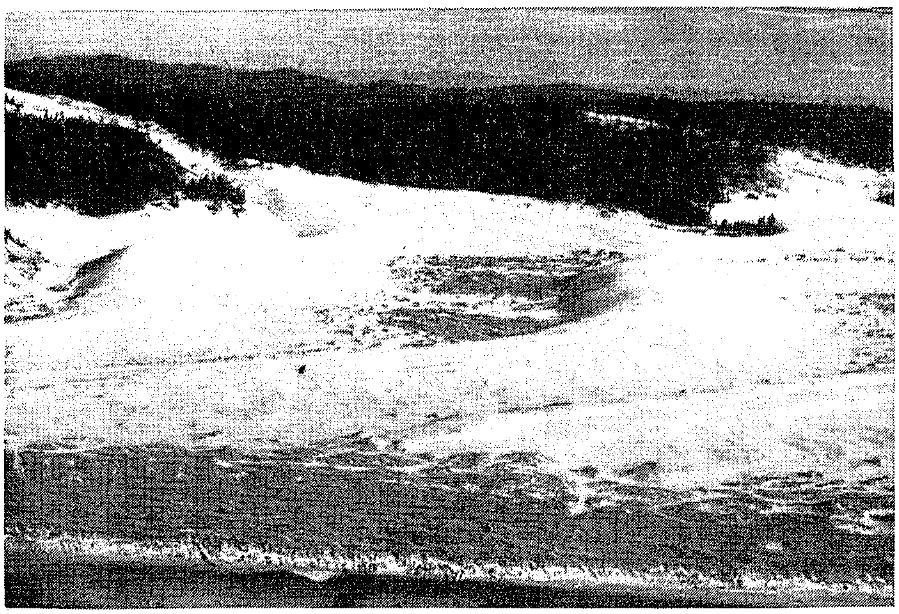


   b. very steeply sloping at its high eastern terminus where it may be encroaching on older forested dunes.

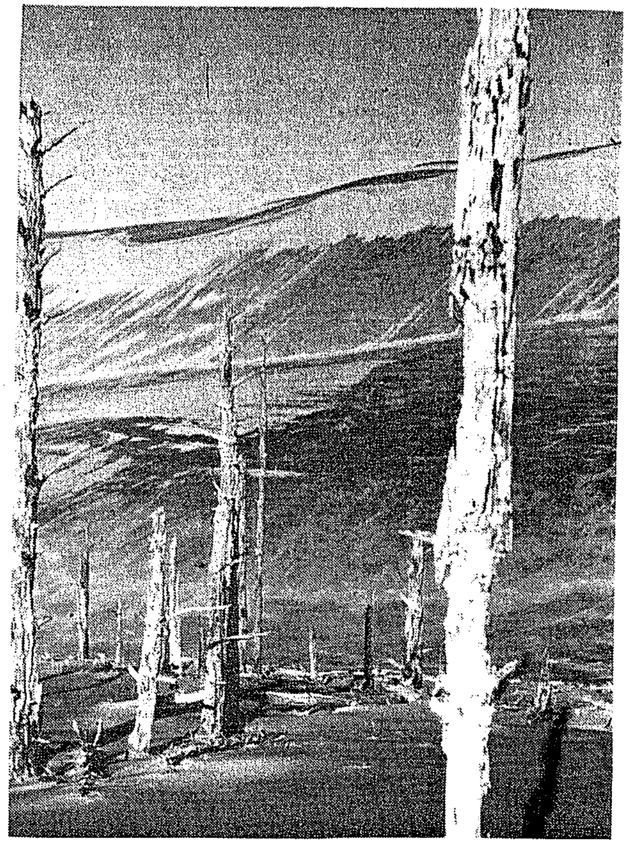
3. The slopes of this dynamic landform are most commonly vegetation-free.



4. The oblique dune landscape appears as a series of undulating waves of sand.



5. Passage of the precipitation ridge may leave exhumed forests in its wake.



6. Islands of surface stable dunes are occasionally found within this open sand landscape.

C. Recently Reactivated Forms

Reactivation of active, conditionally stable and surface stable dunes can occur when binding vegetation and/or the protective soil layer is removed and the site is exposed to erosive winds. The amount of disturbance required for reactivation varies from site to site. Sensitivity to reactivation will depend upon those factors which influence sand cohesiveness, including vegetative cover and cementation such as that which often occurs within the older stabilized dunes. The orientation of the disturbed site to prevailing winds is also of critical importance.

1. Blowout

Localized zone of moving sand within an otherwise vegetated area, which forms a depression from wind erosion on its windward side and an area of accumulation at its terminus.

a. Geomorphology

A blowout is the result of wind scouring within an otherwise conditionally stable or surface stable dune (Figure 12). A blowout

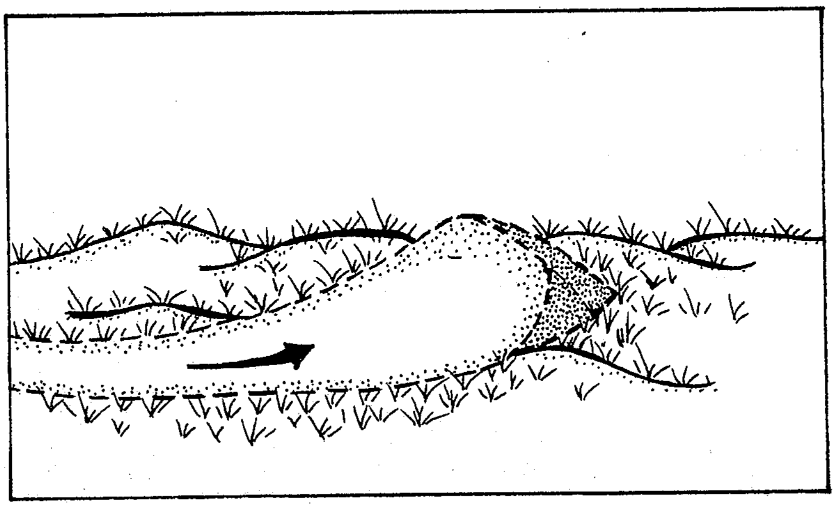


Figure 12. Small blowout within beach grass environment.

may breach the host dune and threaten others in its path. This feature may be only a few feet across and several feet long in the early development stages. However, it can develop into a landform hundreds of feet across and more than a mile long (parabola dune). Smaller blowouts are relatively common features of recently stabilized areas. Once a blowout is begun, especially in the foredune, the trough created tends to funnel the wind, increasing its velocity, and thereby enlarging the blowout.

b. Vegetation

This is a vegetation free landform which is surrounded by vegetated dunes on at least three sides.

c. Attractions and limitations

This feature is probably not suitable for any particular activity or structure.

The potential impacts of a blowout on downwind sites include sand blasting, sand burial and/or heightened storm impact. Areas which may be prone to blowout activity (i.e. recently planted sites or beach grass areas which experience considerable use) should be carefully watched particularly if significant impact inland is probable.

d. Identification check-list

A blowout may be identified by the following features:

1. A blowout is a somewhat elongated, mobile sand landform which occurs within otherwise surface stable or conditionally stable dunes.

2. Parabola Dune

Massive unidirectional trough of deflation terminating in a zone of accumulation within an otherwise vegetated area.

a. Geomorphology

A parabola is essentially a trough blowout of major size which is enclosed on three sides by older vegetated dunes and on the fourth, its source area, by open sand usually of the oblique-ridge type (Figure 13). The initial development of a parabola requires a stable vegetated

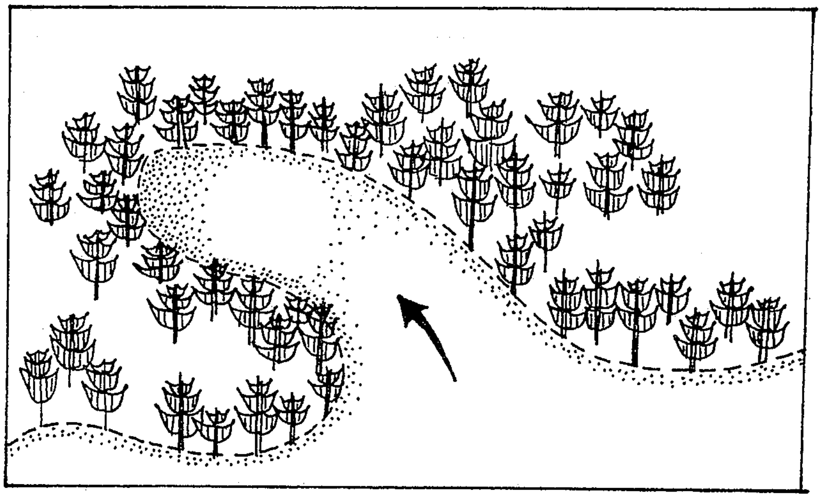


Figure 13. Parabola blowout moving through forested dunes.

site downwind with a point of weakness for the moving sand to break through, considerable volume of source sand, and a unidirectional wind source. Parabolas move inland from their open sand source, through the vegetated area, in a direction parallel to the unidirectional wind source. They can be seen oriented either to the northwest winds of summer or the southwest winds of winter. They may be a hundred feet or more across and extend to nearly a mile in length. Parabolas are named for the similarity that their perimenter bears to the parabolic curve.

b. Vegetation

This is essentially a vegetation free landform although less active forms may exhibit occasional vegetated hummocks.

c. Attractions and limitations

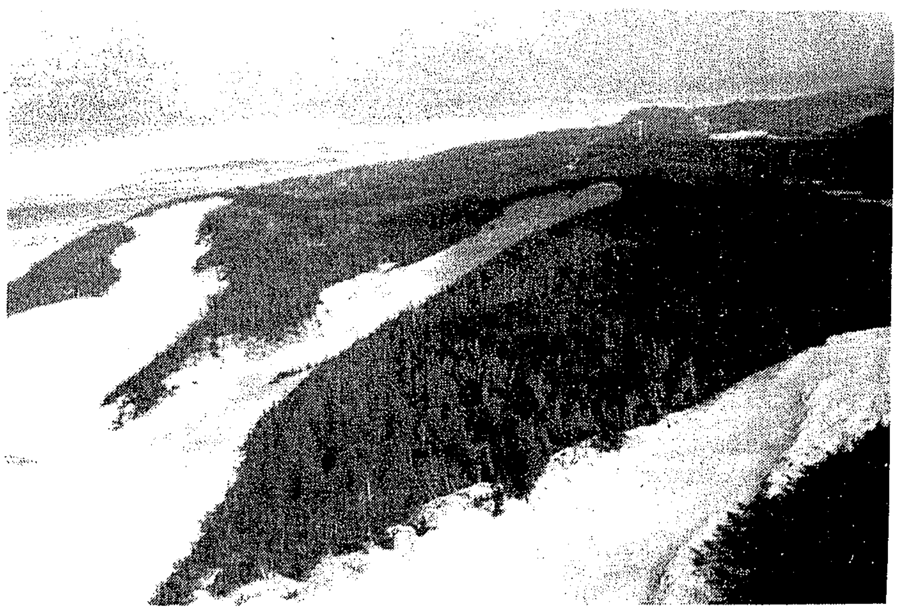
Recreationalists are attracted to this landform for walking, viewing, riding horses, and operating off-road vehicles. The only limitations on these activities are the sensitivity of the fringe-areas' vegetation to trampling and the possible nuisance of sand blasting.

Any development involving permanent structures would be subject to the same limitations as those associated with the oblique-ridge dunes although sand blasting may be a greater problem in this landform.

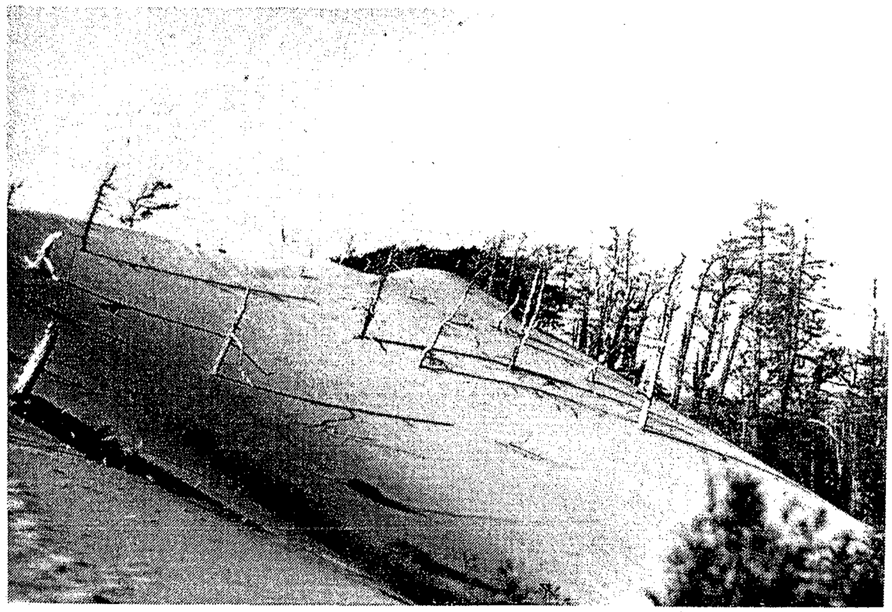
d. Identification check-list

A parabola dune may be identified by the following characteristics:

1. This feature creates an elongate finger of sand cutting through old forested dunes.



2. The terminus (advancing end) of well-developed parabola dunes commonly creates a precipitation ridge advancing on older forested dunes.



VII. GLOSSARY OF TERMS

Accretion: Oceanward advancement of the beach through the ongoing accumulation of sand at its edge.

Active Dunes: Partially vegetated dunes that migrate, grow and diminish according to wind, sand supply and vegetation cover. (May apply to the foredune or hummock dunes.)

Beach Cusps: Embayments of various widths and slopes cut into the beach by the cellular circulation of onshore and offshore currents.

Blowout: Localized zone of deflation within an otherwise vegetated area.

Conditionally Stable Dune: A dune which presently has sufficient vegetation cover to retard wind erosion but which is vulnerable to reactivation upon disturbance of this cover.

Deflation: The erosion of sand or soil by the wind.

Embryo Dune: Low, newly forming dune mounds.

Erosion: To wear away by the action of water, waves or wind.

Lee: The side that is sheltered from the wind.

Older Stable Dune: Dunes of any form which possess both a deep, well-developed soil and semi-cemented underlying sand.

Onshore Winds: Winds which are moving toward or onto the shore from open water.

Precipitation Ridge: High, steeply sloping slip face of large oblique-ridge and parabola dunes.

Rip Current: A strong relatively narrow current flowing outward from a shore which results from the inland flow of waves and wind-driven water.

Sandsheet: Sand deposits of considerable depth and breadth overlying sursurface coastal terraces.

Surface Stabilized Dune: Commonly forested dunes which possess a thinly developed soil and are underlain by loose unconsolidated sands.

Wind Stable Dune: Those dunes which possess sufficient vegetation and/or soil cover to retard wind erosion.

Windward: The side or direction from which the wind is blowing.

REFERENCES CITED

Cooper, William S. 1958. Coastal Sand Dunes of Oregon and Washington. Geological Society of America, Memoir 72. New York, New York. 169 pp.

Leach, Don. Interview. 1978. U.S. Department of Agriculture, Soil Conservation Service, Astoria, Oregon.

Lund, Ernest H. 1973. "Oregon Coastal Dunes," The Ore Bin. State of Oregon Department of Geology and Mineral Industries, Portland. Oregon. 92 pp.

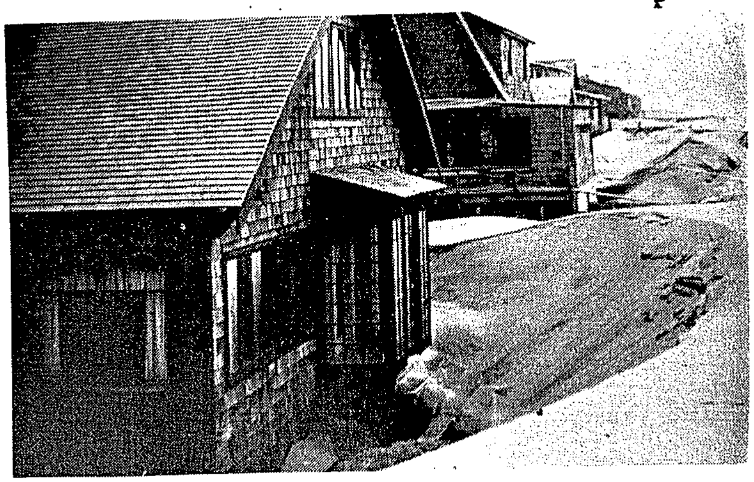
Ternyik, Wilbur. Personal Communication. October, 1978. Owner, Wave Beachgrass Nursery, Florence, Oregon.

U.S. Department of Agriculture, Forest Service. 1972. Resource Inventory Report for the Oregon Dunes National Recreation Area. Siuslaw National Forest, Portland, Oregon. 294 pp.

U.S. Department of Agriculture, Soil Conservation Service and Oregon Coastal Conservation and Development Commission. 1975. Beaches and Dunes of the Oregon Coast. U.S. Department of Agriculture, Soil Conservation Service, Portland, Oregon. 161 pp.

Weideman, Alfred M., LaRea J. Dennis, Frank H. Smith. 1974. Plants of The Oregon Coastal Dunes. Oregon State University Press, Corvallis, Oregon. 117 pp.

Physical Processes & Geologic Hazards On The Oregon Coast



Oregon Coastal Zone Management Association, Inc.

This report was prepared as part of a larger document addressing various beach and dune planning and management considerations and techniques. Other segments of the document and additional materials are:

I. BACKGROUND ON BEACH AND DUNE PLANNING:

Background of the Study

An Introduction to Beach and Dune Physical and Biological Processes

Beach and Dune Planning and Management on the Oregon Coast: A Summary of the State-of-the-Arts

II. BEACH AND DUNE IDENTIFICATION:

A System of Classifying and Identifying Oregon's Coastal Beaches and Dunes

III. PHYSICAL AND BIOLOGICAL CONSIDERATIONS:

Physical Processes and Geologic Hazards on the Oregon Coast

Critical Species and Habitats of Oregon's Coastal Beaches and Dunes

IV. MANAGEMENT CONSIDERATIONS:

Dune Groundwater Planning and Management Considerations for the Oregon Coast

Off-road Vehicle Planning and Management on the Oregon Coast

Sand Removal Planning and Management Considerations for the Oregon Coast

Oregon's Coastal Beaches and Dunes: Uses, Impacts and Management Considerations

Dune Stabilization and Restoration: Methods and Criteria

V. IMPLEMENTATION TECHNIQUES:

Beach and Dune Implementation Techniques: Findings-of-Fact

Beach and Dune Implementation Techniques: Site Investigation Reports

*Beach and Dune Implementation Techniques: Model Ordinances**

VI. ANNOTATED BIBLIOGRAPHY:

Beach and Dune Planning and Management: An Annotated Bibliography

VII. EDUCATIONAL MATERIALS:

Slide show: *Managing Oregon's Beaches and Dunes*

Brochure: *Planning and Managing Oregon's Coastal Beaches and Dunes*

*Prepared under separate contract between Oregon Department of Land Conservation and Development and the Bureau of Governmental Research, Eugene.

Cover design by Arlys Bernard, Newport, Oregon. Photos depict accretion at Clatsop Plains and erosion at Bay Ocean, Oregon.

PREFACE

The following report presents the results of an overview of beach and dune processes and erosion on the Oregon Coast. The study was conducted by Dr. Paul D. Komar, Associate Professor at Oregon State University, Corvallis under contract with the Oregon Coastal Zone Management Association, Inc. and with assistance from OCZMA's Beaches and Dunes Study Team composed of Carl Lindberg, Project Leader, Christianna Crook, Project Associate, Arlys Bernard, Project Secretary, Wilbur Ternyik, Project Coordinator and Kathy Fitzpatrick, Project Administrator. This report constitutes one element of an overall analysis of planning for and managing coastal beaches and dunes as required by Oregon's Beaches and Dunes Goal.

OCZMA extends special appreciation to Dr. Komar for the professional and timely manner in which this report was conducted. Additionally, OCZMA acknowledges the valuable review and comment made by the Beaches and Dunes Steering Committee composed of:

R. A. Corthell, U.S. Soil Conservation Service
Steve Stevens, U.S. Army Corps of Engineers
Sam Allison, Oregon Department of Water Resources
Peter Bond and John Phillips, Oregon Department of Transportation, Parks and Recreation Division
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Oscar Granger, Lincoln County Planning Department
Curt Schneider, Clatsop County Planning Department

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I. INTRODUCTION

The coast of Oregon is made up of stretches of sandy beaches separated by rocky headlands jutting out into the sea (Figure 1). The major headlands such as Cape Blanco, Arago, Perpetua, Foulweather, Cascade Head, Lookout, Meares, Falcon and Tillamook Head are composed of hard basalt, resistant to wave attack. The stretches of beach vary in length from small pocket beaches nestled amongst the rocky headlands to the 50-mile long beach extending from Heceta Head south to Cape Arago near Coos Bay. The beaches are backed in part by sea cliffs cut into lithified sedimentary rocks, sandstones and mudstones, in all cases much less resistant than the basaltic headlands. In some areas the beaches are backed by foredunes consisting of loose sand; such foredune areas show little resistance to wave attack even when well vegetated. Sand spits, such as Coos, Siletz, Nestucca, Netarts, Bayocean and Nehalem, are almost all loose sand and have thus shown the greatest amounts of erosion when attacked by waves. Because sand spits are also particularly attractive building sites with views both of the ocean and bay, the most dramatic examples of erosion destruction have occurred there.

This report will examine particular erosion problems associated with the various sites on the Oregon coast and what can be done from a coastal planning viewpoint to minimize future problems. Sand spits and foredune erosion have presented the greatest erosion problems and therefore have been most extensively studied. The problems associated with dwelling construction in active foredune areas will be considered, followed by an examination of the longer-term erosion of the sedimentary sea cliffs, the erosion of which is important to communities such as Brookings, Bandon, Waldport, Newport, Lincoln City, Cannon Beach and many others.

Erosion of the Oregon coast cannot be understood properly without reference to the physical processes causing that erosion: the ocean waves, tides, nearshore currents, tsunami and winds. For that reason this report will begin with a discussion of these factors and what is known about physical processes on the Oregon coast. At the same time the sources of sand to the beaches and dunes and their general morphology will be examined.

II. COASTAL PROCESSES AND LAND FORMS

A. Beaches

Like most other continental beaches, the beaches of Oregon are composed mainly of quartz and feldspar sand grains derived originally from the weathering of granitic-type rocks. But within the beach sands are lesser amounts of dark heavy minerals such as hornblende, magnetite, augite, garnet and epidote, having shades of green, pink and black.

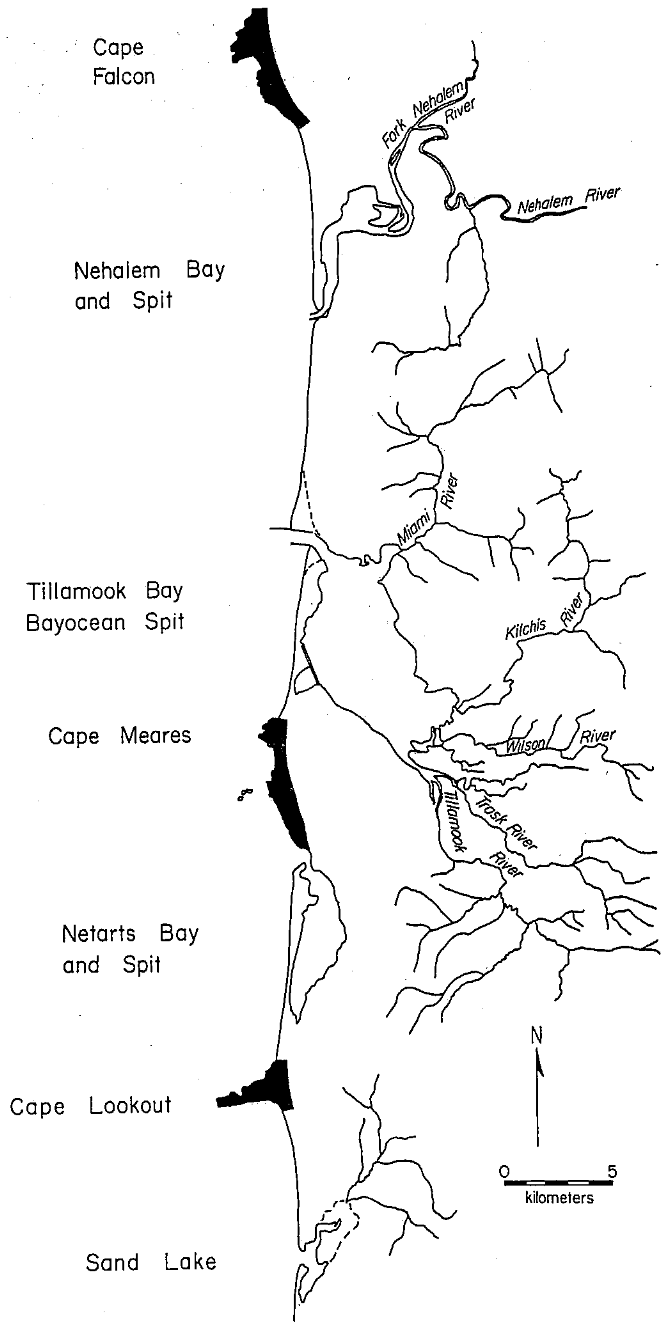


Figure 1. A portion of the north Oregon coast illustrating how it consists of a series of pocket beaches separated by pronounced rocky headlands.

At times these heavy minerals can become locally concentrated so that the beach sand appears greenish-black rather than having the tan color of the quartz and feldspar grains. In certain south Oregon beaches there are 'black sands' containing grains of gold, platinum and chromite, as well as the usual quartz, magnetite, etc. (Twenhofel, 1946). The gold and platinum attracted the attention of prospectors as early as 1852, and little now remains of those minerals in the black sands. The strategic mineral chromite was mined during World War II; although uneconomical to mine now, some chromite remains as a resource.

The beach sands generally have median grain diameters in the range 0.2 to 0.5 mm (fine to medium sand)(Wentworth, 1922), depending upon location. The overall grain size of the beach sand has important effects on the morphology of the beach and its response to erosion. In general, the coarser the beach sand the steeper its offshore slope (Komar, 1976, p. 303-8). Thus the beaches on Siletz Spit and at Gleneden Beach to the south, with a median grain size of about 0.4 mm, are much steeper (average slope - 3.1 degrees) than the more common finer grained beaches (0.2 to 0.3 mm) with average slopes of about 1.7 degrees (Figure 2). As shown by the study of Aquiler and Komar (1978) at two such beaches, a coarse-sand beach also has a higher rate of erosion when attacked by storm waves and a greater amount of total erosion. This in part explains, for example, why Siletz Spit in particular has suffered much erosion.

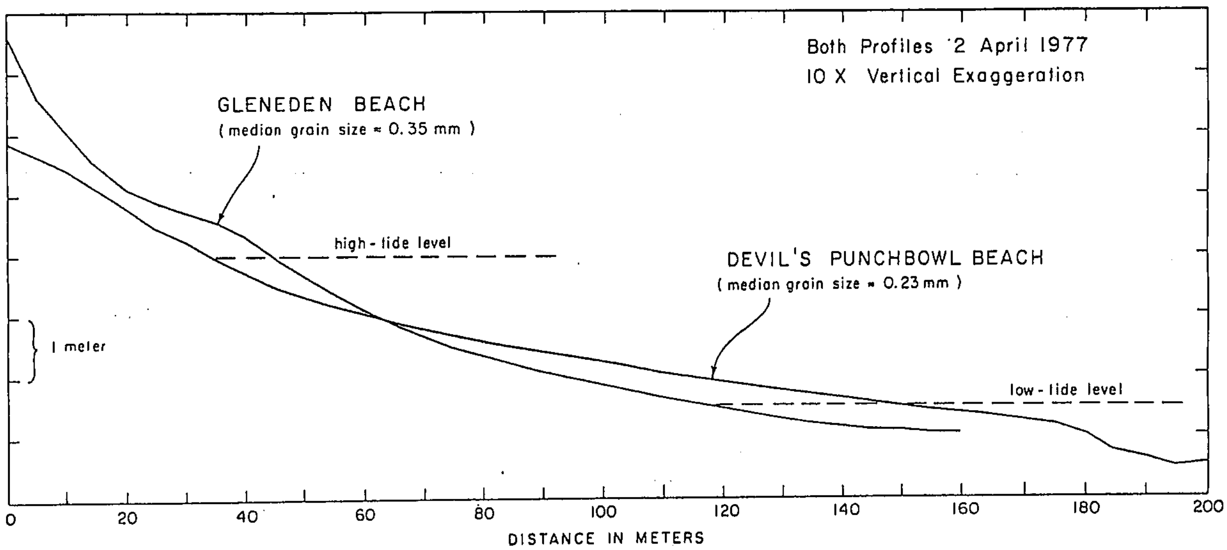


Figure 2. The effects of beach sand grain size on the profile, Gleneden Beach being much coarser and thus having a steeper slope than does the beach to the south of Devil's Punchbowl, Otter Rock.

Small pocket beaches in headland areas usually consist of basalt pebbles and cobbles (4 to 250 mm), the wave energy being too great for sand to remain on the beach. Continuing the trend of increasing beach slope with increasing grain size, these cobble beaches reach slopes of 5 to 25 degrees. Basaltic cobbles and pebbles are also found as a steep storm ridge along the flanks of headlands, backing the otherwise sandy beach (Figure 3). Such cobble ridges form a natural protective barrier from wave attack, important to such areas as Neahkahnie Beach south of Cape Falcon (Figure 3).

Figure 3. The beach at Neakahnie Beach with a steep cobble storm ridge of large rocks derived from the nearby basalt headland, backing an otherwise sandy beach. The cobble ridge offers protection to the coastal property.

B. Sources of Beach Sands

Management of beaches and coasts requires a knowledge of the natural sources and losses of beach sands. For example, if the principal source is sand brought to the coastal zone by rivers, then damming of the rivers would cut off much of that source, resulting in the long-term diminishing of the size of the beach and an increase in coastal erosion.

Such problems are best approached through a consideration of the budget of sediments (Bowen and Inman, 1966; Komar, 1976, Chapter 9). Such a budget involves assessing the sedimentary source contributions (credits) and losses (debits) and equating these to the net gain or loss (balance of sediments) for a given beach. The balance between gains and losses is reflected in local beach erosion or deposition. Table 1 summarizes the usual possible sources and losses of beach sands.

Table 1. The budget of littoral sediments

Credit	Debit	Balance
Longshore transport into area	Longshore transport out of area	Beach deposition or erosion
River transport	Wind transport out	
Sea cliff erosion	Offshore transport	
Onshore transport	Deposition in submarine canyons	
Biogenous deposition	Solution and abrasion	
Hydrogenous deposition	Mining	
Wind transport onto beach		
Beach nourishment		

Unfortunately, the sources and losses of sands to the Oregon beaches are generally only poorly known and usually cannot be quantitatively assessed. On most coasts, rivers are the principal sources, but this does not appear to be true for the majority of Oregon beaches. Many of our rivers pass through sizeable estuaries before reaching the ocean. The river sands are deposited in the estuaries rather than reaching the ocean beaches (Kulm and Byrne, 1966). This can be seen in Figure 4 which shows the areas of sand accumulation in Yaquina Bay and the sources of those sands. In that example the river sands do not reach the ocean beaches, and in fact beach sand is transported into the bay through the inlet so that the estuary represents a loss of beach sands in the budget of sediments. Although more study is needed of other bays and estuaries to determine whether they have similar sand depositional patterns, wide bays such as Coos, Siletz and Tillamook are probably all sinks of river sands so that those rivers do not provide sand to the beaches. Narrow river estuaries such as the Rogue, Umpqua and Siuslaw may be able to transport sand out onto the beaches. However, dredging activities in those estuaries may also remove them as sources of river sands to the beaches. Minor streams (without estuaries) do provide sands to the beaches, but in most cases they are quantitatively minor.

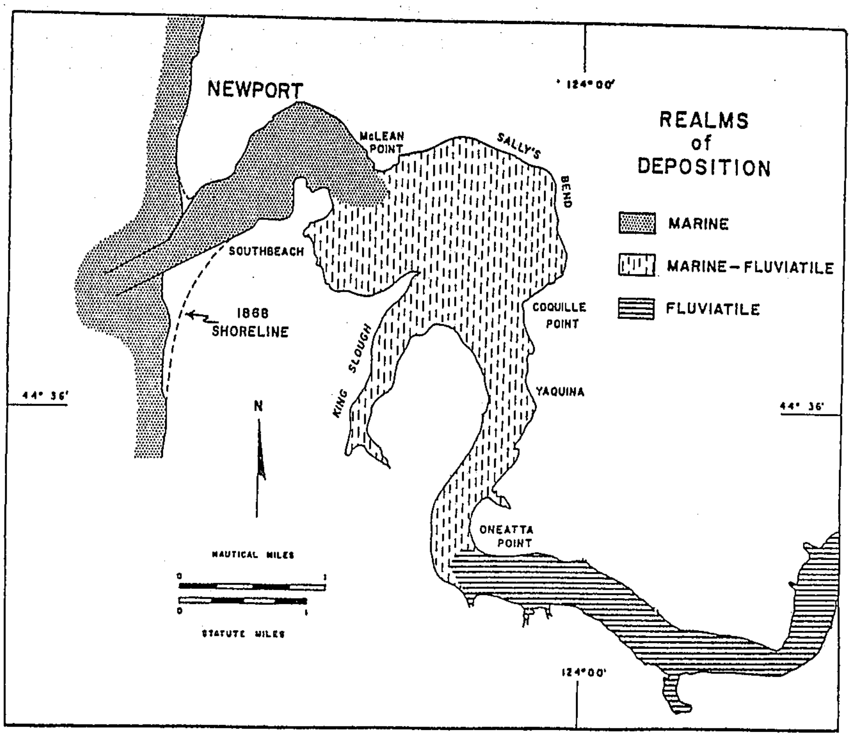


Figure 4. Areas of sand accumulation in Yaquina Bay indicating that the river sands deposit before reaching the ocean and that marine sands are transported through the inlet and also deposited in the bay (from Kulm and Byrne, 1966).

Of major importance to most Oregon beaches is the sand derived from sea cliff erosion. This is especially true where Pleistocene terrace sands form part of the sea cliffs. Removal of this source by the placement of riprap or sea walls (comparable to building a dam on a river) will lead to the long-term decrease in the size of the beach and an increase in coastal erosion.

At present the principal losses of beach sand are by winds blowing the sand inland to form dunes or by losses to the offshore deeper waters. The offshore losses are long-term; as the sand is abraded while on the beach, progressively decreasing in grain size, it may become sufficiently fine to be carried far enough offshore during a storm that it is unable to return to the beach.

Along most of the Oregon coast the sources and natural losses of beach sands are quantitatively small. For this reason, removal of beach sand by sand and gravel companies or others may have a major impact on the beach, this unnatural loss being a major factor in the total budget of sediments. An example of this was the impact of the removal of sand from the beach at Gleneden Beach south of Siletz Spit. An approximate budget of sand for the area is shown schematically in Figure 5. The principal source of sand to this beach has been from sea cliff erosion, estimated to contribute 16,000 cubic meters per year (that volume represents only sand coarse enough to remain on the beach, finer sediments being lost offshore). A study of the mineralogy and grain size of the sands shows that sand brought to the coast by the Siletz River does not contribute to the beach (Rea, 1975). The Salmon River and other small coastal streams contribute a minor amount. Prior to sand mining on the beach (1965 to 1971), the beach appears to have

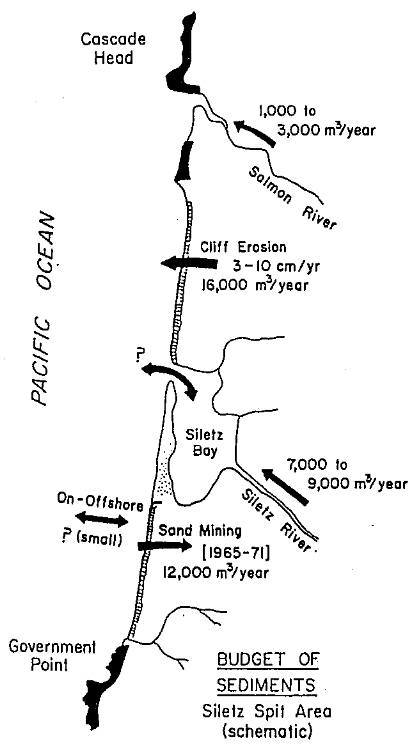


Figure 5. An approximate budget of beach sands for the stretch of coast fronting Lincoln City, south past Siletz Spit to Lincoln Beach. Shown are estimates of the sources and losses of sand from the beach, including that due to sand mining.

neither increased nor decreased in overall width over the years, indicating the natural losses of sand approximately balanced the gains from the sources; these losses must have been to the offshore, to the dunes on Siletz Spit, and some beach sand movement into Siletz Bay. The sand mining during the years 1965-71 removed an average of 12,000 cubic meters per year, an amount nearly the same as that contributed to the beach by sea cliff erosion. Presumably the natural losses remained the same, so that the sand mining represented a net loss of beach sands and a decrease in its total volume. Such a decrease would result in the progressive lessening of the beaches' ability to protect the coastal properties from erosion. As discussed in Section IV, the sand mining at Gleneden Beach was not the primary contributory factor in the recent erosion of Siletz Spit, but most certainly was an aggravating factor in causing increased amounts of erosion.

C. Dunes

Sand dunes, active or vegetated, occupy approximately 140 of Oregon's 310 miles of coast, or about 45 percent (Cooper, 1958; Lund, 1973). The largest area of active dunes with little or no vegetation extends for a distance of 55 miles between Coos Bay on the south to Heceta Head on the north (Figure 6). This strip averages about 2 miles in width, reaching a maximum width of 3 miles at Florence. A major portion of this active dune sheet lies in the Oregon Dunes Recreational Area, a division of the Siuslaw National Forest. A second area of important active dunes is present to the immediate north of Sand Lake on the northern coast.

There are extensive areas of older, well-vegetated dunes, commonly covered with forests of large trees and dense brush. The dune origin of the underlying sands is not always readily apparent; dune sands are best identified by the cross-stratification of sands exposed in roadcuts or other excavations. These vegetated dunes were formed during the Pleistocene Epoch, and are now perched on marine terraces well above sea level. They are common along the Oregon coast with the exception of Curry County south of Cape Blanco.

There are many problems concerning the management of these coastal dune areas. Particularly susceptible to erosion problems are the foredunes which immediately back many beaches. Such foredunes are usually active or only conditionally stabilized by dune grasses. Therefore the sands of the foredunes are often rapidly moved about by the strong coastal winds. In addition, because the foredunes are adjacent to beaches they may be eroded rapidly by waves.

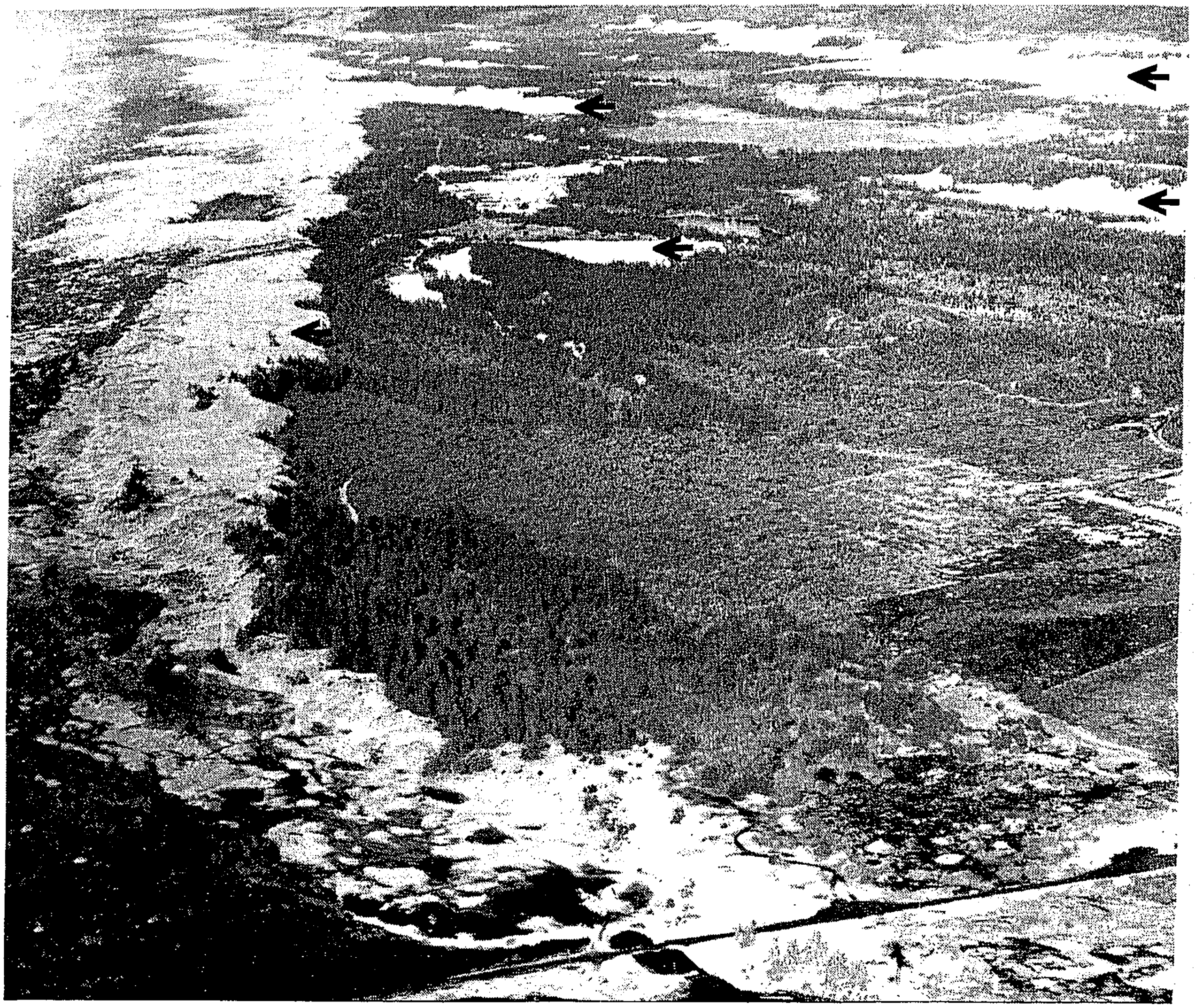


Figure 6. The active dune field of the Coos Bay dune sheet which stretches for some 55 miles along the mid-Oregon coast (photo courtesy of U.S. Army Corps of Engineers, Portland District).

D. Climate

Climate exerts a major influence on Oregon coastal beaches and dunes. In large part, rains govern the surface moisture in the dunes which in turn partly control whether the sands can be moved by winds. The direction and strength of the wind then determines the direction and rate of the resulting sand transport and dune migrations. The coastal winds are also important in wave generation and in the creation of nearshore currents along the beaches.

The climate of the Oregon coast is highly seasonable, more so than most other midlatitude coasts. During the winter months, storm systems move inland from the north Pacific bringing rains and a predominance of strong winds out of the south to southwest. The summer months are dry with milder winds, mainly from the north to northwest (Cooper, 1958).

Water runoffs in the coastal rivers and streams closely follow the seasonal variations in rainfall, discharges in the winter months being 30 to 50 times greater than during the summer (Figure 7). The Columbia River is the one exception to this discharge pattern in that it has two periods of maximum discharges, one during the winter due to the rains, and a second in May and June due to snow melt in the Cascade Mountains.

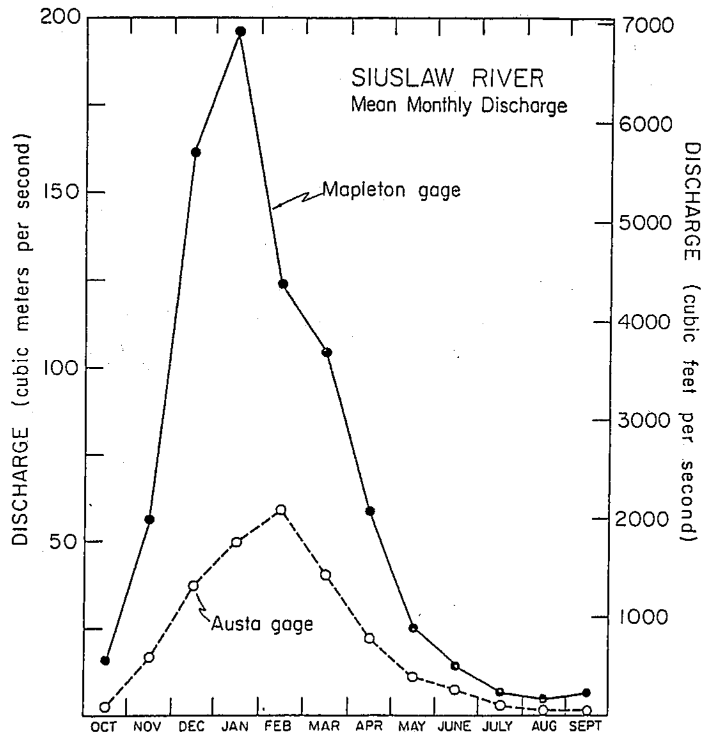


Figure 7. An example of the seasonality of river discharge with large winter discharges and negligible summer discharges, following the seasonality of rainfall.

E. Wave Conditions

Wave conditions along the coast of Oregon also follow a seasonal pattern in response to the parallel changes in weather patterns and wind speeds. This is to be expected as it is the wind that generates the waves; the greater the wind speed the higher the waves produced (Komar, 1976, Chapt. 4). Other factors in wave generation are the duration of the winds and the extent of water area (fetch) over which the winds blow. Not all waves reaching the Oregon coast come from local storm systems adjacent to the coast. An example is shown in Figure 8 from a storm that occurred over the north Pacific during 20-25 December 1972, a storm which generated 23-foot high breaking waves along the coast, resulting in much erosion, especially on Siletz Spit. It is seen that the winds that generated these exceptionally high waves blew across a major portion of the Pacific but were not particularly strong at the Oregon coast itself.

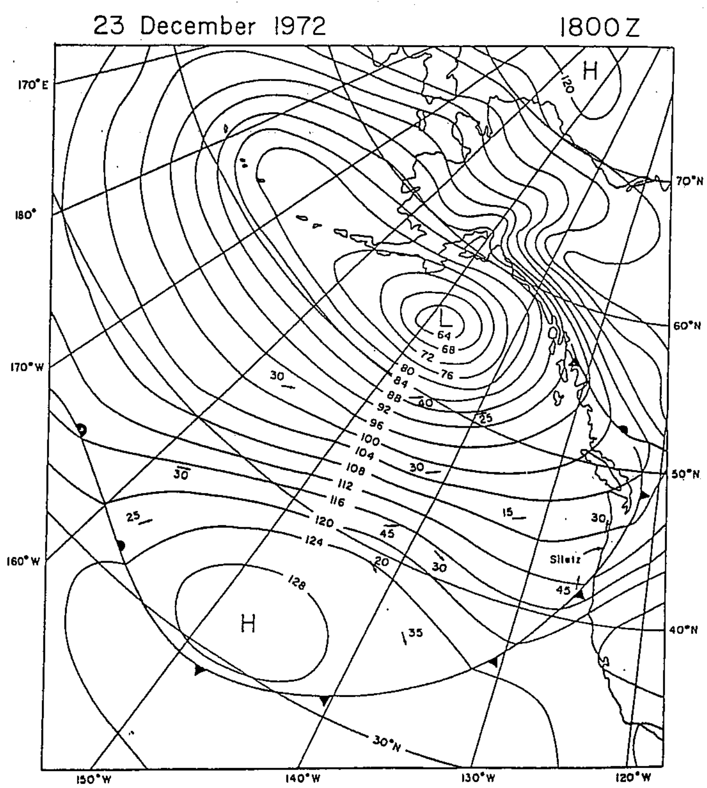


Figure 8. Storm system on December 23, 1972 with winds blowing across most of the Pacific and directed toward Siletz Spit. This storm generated unusually high waves along the Oregon coast which caused major erosion at Siletz Spit and elsewhere.

Waves reach Oregon from storms in the far South Pacific as well, although they are not nearly as large as those generated by storms in the North Pacific. Komar and McKinney (1977) analyzed storms such as that of Figure 8 and their role in generating waves and beach erosion on the Oregon Coast.

Ocean wave conditions have been measured daily at Newport by a seismic recording system that detects microseisms produced by the waves. This yields a measure of the highest one-third of the waves, as well as the periodicity of the wave motions. This system has been in operation since November 1971, measuring waves four times daily. This wave data set is the longest and most complete available for wave conditions on the Oregon coast, and has been summarized by Komar, et al. (1976b) and Creech (1977).

Figure 9 gives an example of the annual changes in wave heights and periods, this example extending from July 1972 through June 1973. The solid lines give the average wave breaker heights and periods for

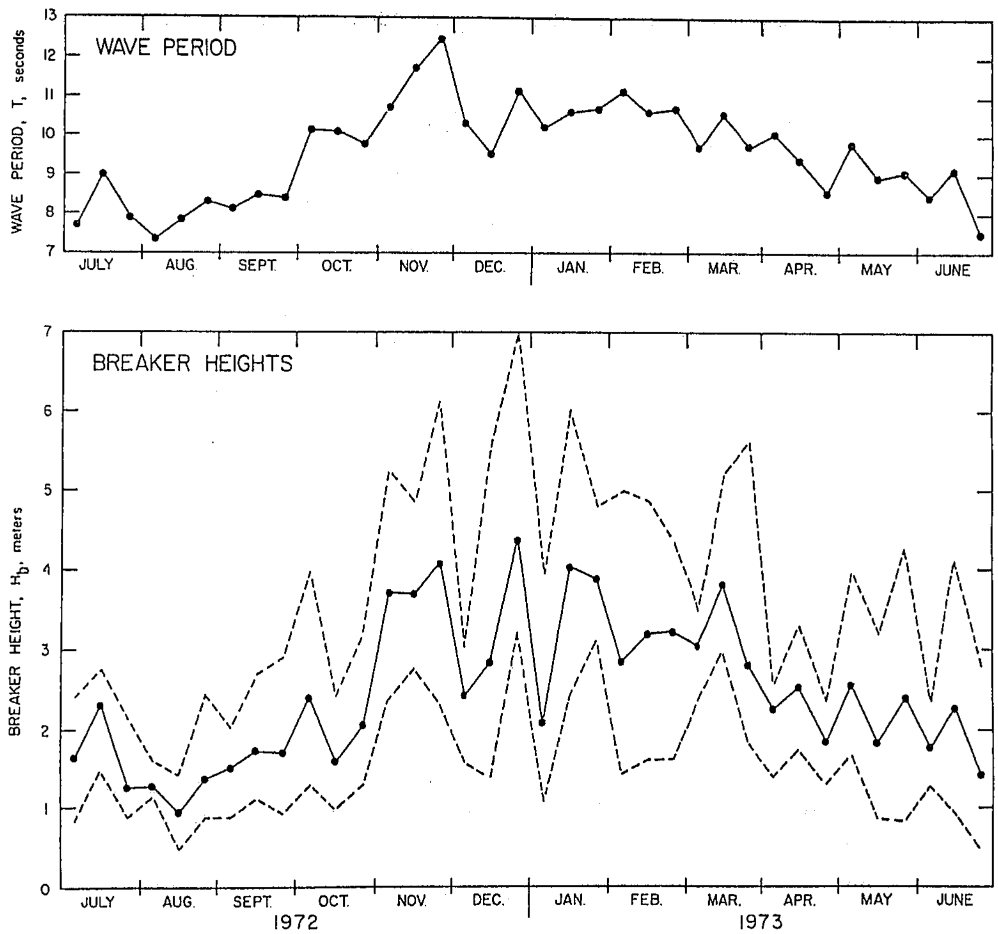


Figure 9. Significant wave breaker heights and periods measured at Newport during July 1972 through June 1973. Each datum point gives the average for one-third month. The dashed lines give the maximum and minimum breaker heights during those one-third month intervals. Note the arrival of large storm waves during the last part of December 1972, caused by the storm of Figure 8.

each one-third month. Also given are the maximum and minimum wave breaker heights that occurred during those one-third month intervals (the dashed lines). It is seen that much larger breaking waves prevail during the winter months, reaching an average of about 15 feet. However, individual storms produce maximum daily waves with significant heights of some 23 feet. Such storm waves occurred in the last one-third of December 1972, (Figure 9), associated with the storm system of Figure 8. Breakers of 23-foot height are truly exceptional. The seismometer system has measured such high waves only three times since its installation in 1971--in December 1972, October 1977 and February 1978. Each instance was marked by severe beach erosion along the coast. Thus, not unexpectedly, unusually high waves are largely responsible for the episodes of coastal erosion.

F. Beach Cycles

Beaches respond to seasonally changing wave conditions as schematically illustrated in Figure 10 and for the beach at Gleneden Beach in Figure 11. During the summer months of low waves, sand moves onshore forming a wide berm--the nearly flat exposed portion of the beach (Figure 10). During the stormy winter months of high waves, sand is eroded from the berm and moves offshore, depositing there in offshore bars. Such seasonal cycles of the beach profiles occur on most beaches, and have been documented by Aguilar and Komar (1978) on two Oregon beaches (Figure 11). Komar (1977) reviews the Oregon beach profiles obtained during 1945-6 by the U.S. Navy using an amphibious DUKW (pronounced "duck"). Only with such an amphibious vehicle have profiles been obtained over the deep outer bars of Oregon beaches.

Although the cycle between the two beach profile types of Figure 10 is approximately seasonal, they are really a response to high storm waves versus low regular swell waves such as occur most commonly during the summer. But if low waves should occur during the winter, sand will move onshore and the berm widen so that the two types of profiles are not always strictly seasonal.

The principal importance of this cycle of beach profiles is that the swell (summer) profile with its berm helps protect the sea cliffs and foredunes from wave attack and erosion. In contrast, the absence of a berm in the storm (winter) profile allows the waves to swash up against the coastal property, producing erosion. This is one of the principal reasons that wave erosion of coastal properties on the Oregon coast is limited mainly to the winter months.

It is seen that an important role of the beach is that it acts as a buffer between the ocean waves and the coastal property, causing the waves to break offshore and dissipate most or all of their energy before reaching the coastal property. With a wide berm the waves are not able to reach the coastal property at all. Removal of sand from the beach by sand mining, as mentioned earlier, will reduce the total volume of beach material and hence the winter waves have less sand to

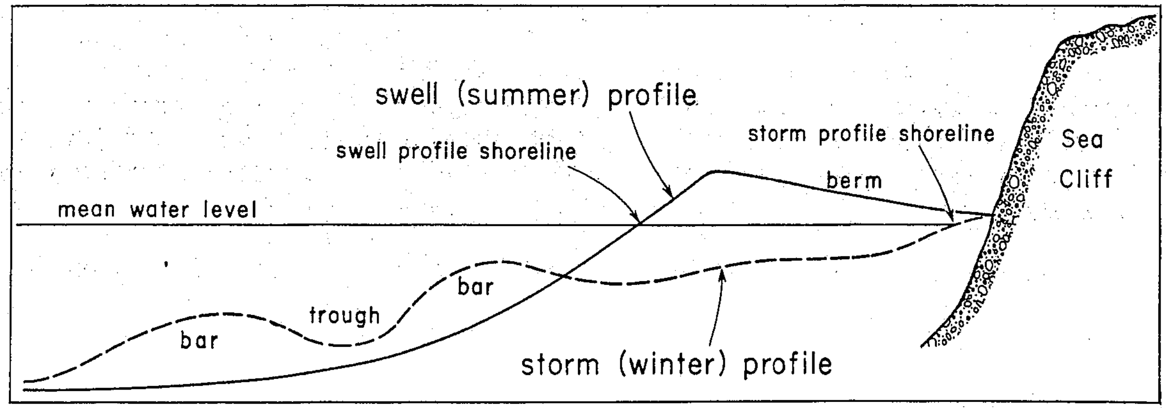


Figure 10. Schematic illustration of the beach profiles produced by storms versus gentle swell waves. On the Oregon coast these profile changes are approximately seasonal due to our storms occurring principally during the winter months.

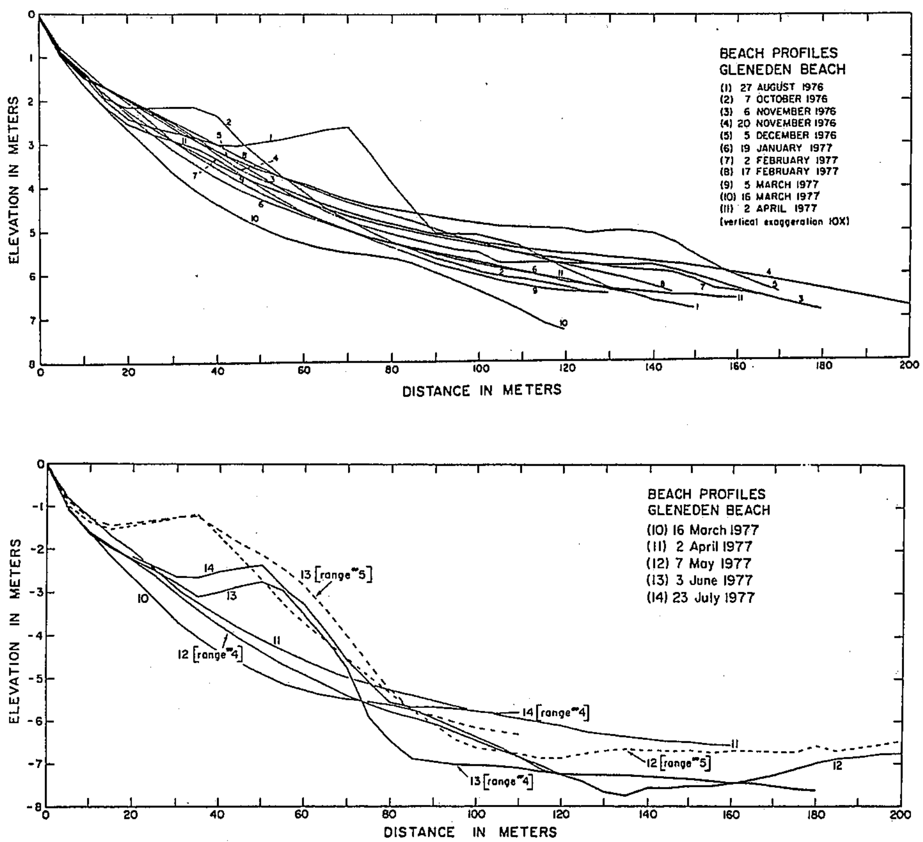


Figure 11. Profile changes measured at Gleneden Beach from August 1976 to July 1977 showing the winter erosion of the exposed portion of the beach followed by deposition as the spring and summer months of lower waves return. The profiles do not extend far enough offshore to show the offshore bars (from Aguilar and Komar, 1978).

shift offshore before attacking coastal property. Sand mining reduces the beach's ability to act as a buffer between the land and the erosive ocean waves.

G. Nearshore Currents and Sand Transport

Waves reaching the coast generate currents in the nearshore zone that are important to sand movements on the beach and to beach erosion. These currents are independent of the normal ocean currents that prevail further offshore, being negligible on the beaches (except for the tidal currents which are important to beach processes in some cases).

When waves break at an angle to the shoreline they generate a current that flows parallel to the shoreline (Komar, 1976, Chapt. 7). This current, together with the waves, produces a transport of sand along the beach known as littoral drift. On Oregon beaches the waves tend to arrive from the southwest during the winter months and from the northwest during the summer (corresponding to the changes in wind directions). As a result, there appears to be a seasonal reversal in the direction of littoral drift; north in the winter, south during the summer. The difference between the two, the net littoral drift, appears to be nearly zero, at least when averaged over a number of years.

That the net littoral drift is essentially zero is demonstrated by the absence of continuous accumulations of sand on one side of jetties or rocky headlands, with erosion on what would be the downdrift side. Instead, sand tends to accumulate and/or erode symmetrically around newly constructed jetties. The major rocky headlands appear to protrude sufficiently far out into the sea that the sands forming the beaches cannot pass around them. Thus, they would also block any net littoral drift if it did exist. Instead, the beaches of Oregon are essentially pocket beaches, isolated from one another by the headlands, with zero net littoral drift prevailing in each pocket. For this reason, when one develops a budget of littoral sand for a particular beach the analysis should include the entire length of the pocket beach between two major headlands (as was done in Figure 5). Only the beach of the Clatsop Plain north of Seaside does not fit into this concept of being a pocket beach, this exception being due to the presence of the Columbia River.

Most of the time the waves approaching the Oregon beaches are nearly parallel to the shoreline trend. Under such circumstances the nearshore currents form a cell circulation, the most prominant part of which are the rip currents (Figure 12), narrow currents flowing offshore away from the beach. The rip currents are fed by longshore currents flowing roughly parallel to shore, but for only a short stretch of beach, unlike the longshore currents which are generated by waves breaking at an angle to the shoreline. The cell circulation pattern illustrated in Figure 12 rearranges the sand on the beach, the feeder longshore currents following troughs in the beach profile shoreward of the offshore bars, and the rip currents bisecting the bars. Of special importance to beach erosion, the rip currents often carry sand offshore, hollowing out embayments into the beach as illustrated in Figure 12. At times these embayments can extend across the entire width of the beach and begin to erode into foredunes or sea cliffs. Such patterns have been important to erosion on Siletz Spit.

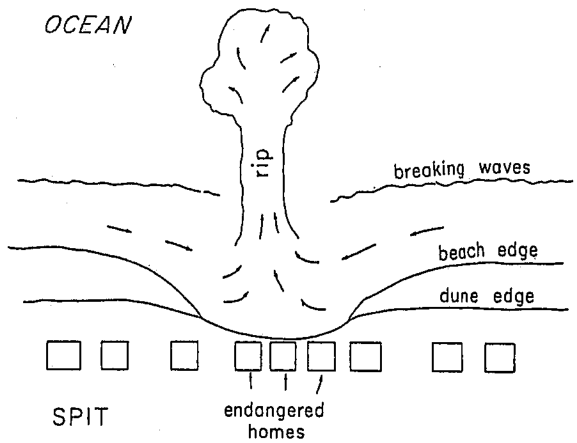


Figure 12. A rip current flowing outward across the beach hollowing out an embayment into the beach and eventually into the foredunes causing property losses.

H. Tides

Tides on the Oregon coast are moderate with a maximum spring tide range of about 13 feet and an average range of about 6 feet. There are two highs and two lows each day, with the two highs and two lows usually of markedly different levels (Figure 13).

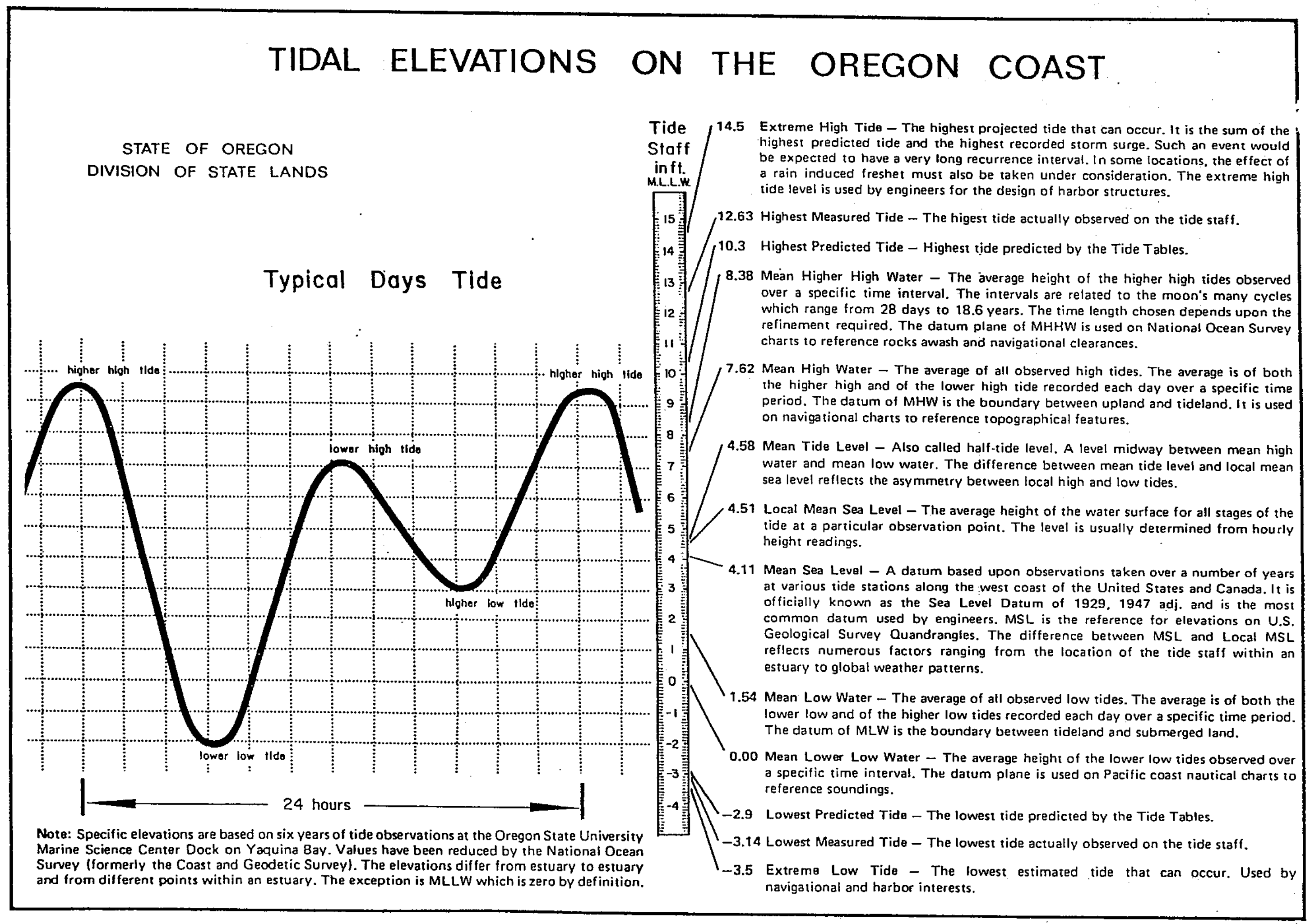


Figure 13. Tidal elevations as measured in Yaquina Bay (from Hamilton, 1973).

Tides are an important factor in coastal erosion in that they govern the hour by hour level of the sea and hence the position of the shoreline and the zone where ocean waves expend their energy. In particular, spring tides may bring water levels high up on sea cliffs and foredunes so that the waves attack the coastal properties directly. Such high spring tides have been shown to aid in the erosion of Siletz Spit and to have had an important part in causing the 1978 breaching of Nestucca Spit. Tides are also significant to the currents which occur in estuaries, especially in the inlets of bays and estuaries.

I. Tsunami

Tsunami are large waves generated on the ocean surface, usually by an earthquake producing a displacement of the sea floor. The most common source of significant tsunami reaching the Oregon coast come from earthquakes in and around Alaska. Two have struck the Oregon coast in recent years--28 March 1964 and 16 May 1968. Their impact on the coast is described in Schatz, et al. (1964), Schatz (1965) and Wilson and Torum (1968).

Figure 14 shows the heights of tsunami waves arriving at various Oregon coast sites during the 1964 episode. It is seen that at each location there is a series of waves, the first wave not always being the largest in the series. In that episode, the maximum wave heights were approximately 10 feet. About the same heights were recorded in the 1968 tsunami.

Maximum destruction from the tsunami occurred along the shorelines of bays and estuaries rather than on the open ocean coastline. This is because at least initially the heights of the tsunami waves increase as they are wedged into the constricting confines of the estuaries. For example, the 1964 tsunami damaged bridges and dwellings along the shores of the Necanicum and Neawanna Rivers (Figure 15), the damage being estimated at $276,000. Other hard hit areas were Cannon Beach ($230,000), the Waldport-Alsea area ($160,000), Florence ($50,000) and Coos Bay ($20,000).

There are few reports of tsunami wave destruction along the ocean shorelines. During the 1964 tsunami four children were drowned as their family slept on the beach at Beverly Beach State Park. This low-lying campground was evacuated twice in 1965 as a result of tsunami warnings (Stembridge, 1975, p. 103). There may be more destruction from future tsunami as many dwellings have been recently constructed in vulnerable areas close to the beach. In addition to low-lying areas that have little or no elevation above the beach, foredune areas can in general also be expected to be vulnerable to tsunami runup. This is because the foredunes commonly have a general oceanward slope that permits the tsunami runup to continue with no direct obstacles. In contrast, areas with sea cliffs should not be endangered as the cliff will reflect most of the energy of the tsunami waves.

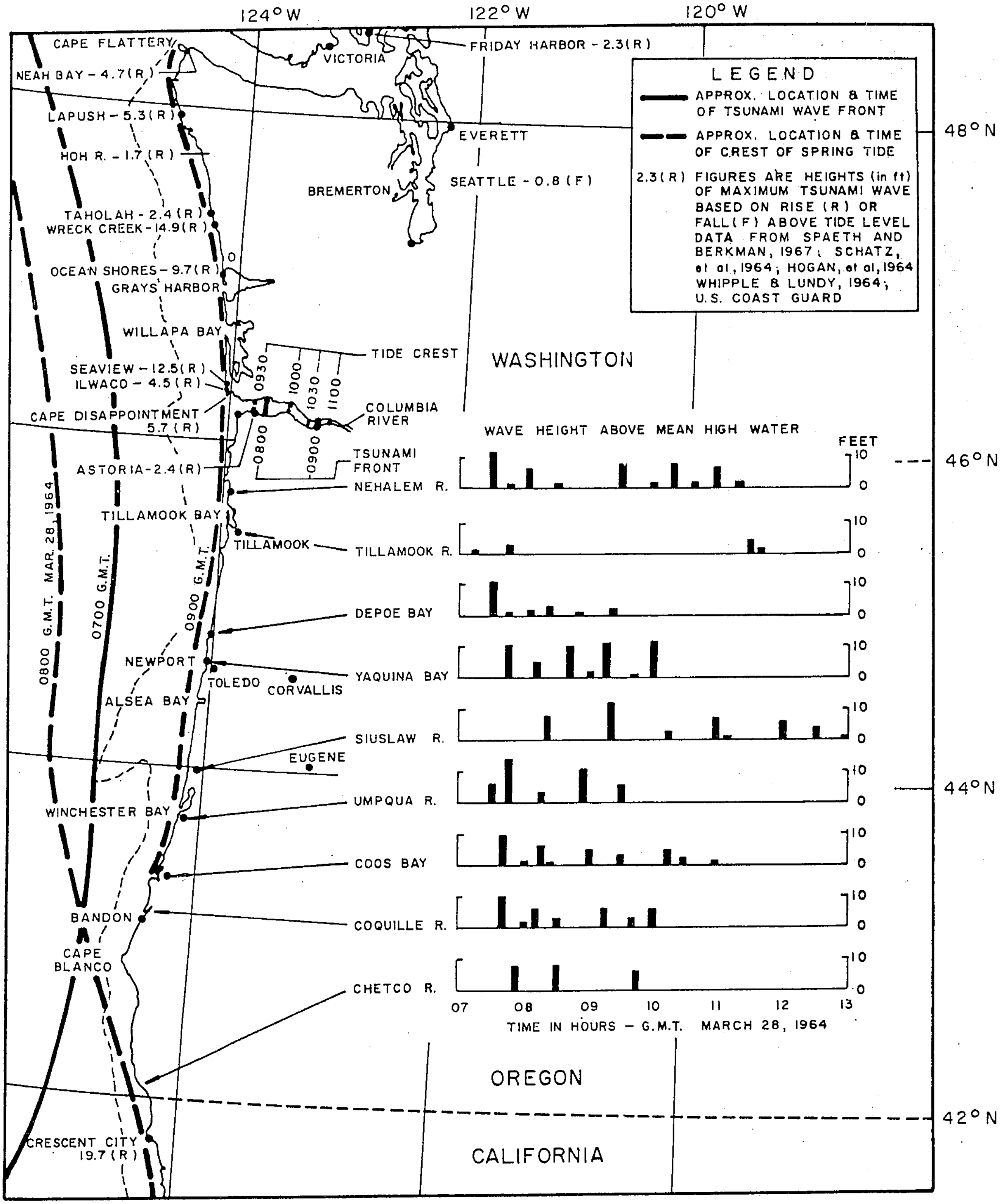


Figure 14. Maximum heights of tsunami waves recorded at tide stations or by observations along the Washington-Oregon coast (from Wilson and Torum, 1968).

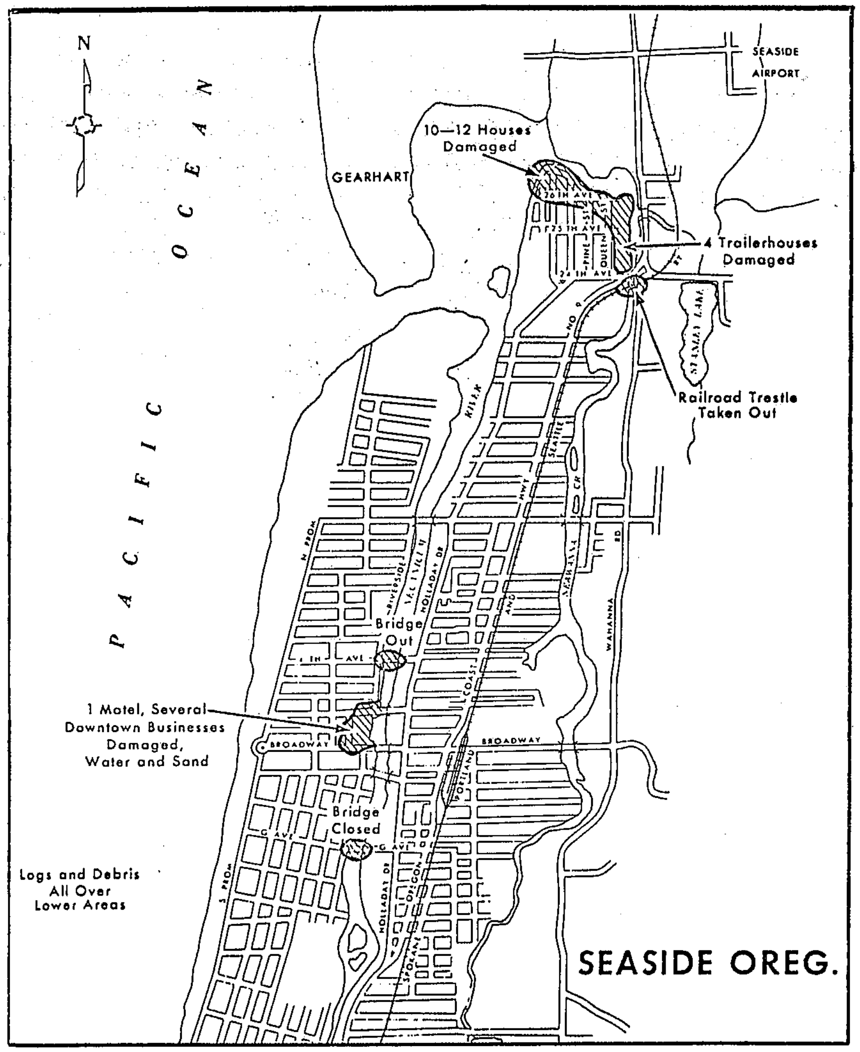


Figure 15. Destruction at Seaside from the March 1964 tsunami (from Wilson and Torum, 1968).

The occurrence of tsunami along the Oregon coast is very sporadic and unpredictable. However, there is a strong probability that another will occur within the next 10 to 20 years. In addition to the estuary areas, almost any foredune or low-lying area can be a potential site for destruction. Unfortunately, with our present understanding of tsunami it is difficult to predict their expected runup for a specific area. Studies following the occurrence of a tsunami show a great deal of variability in the amount of runup along the coastline and the amount of resulting destruction, a variability which at present is poorly understood and cannot be predicted. For this reason, at the present time it is best to be cautious when building on foredunes and in low-lying areas susceptible to tsunami runup.

J. Sea Level Changes

Changes in sea level with respect to the land have important consequences to coastal erosion. With the melting of the Pleistocene ice sheets, which most recently began about 30,000 years ago, water was returned to the oceans causing a rise in sea level. At first this sea level rise was rapid, but about 7,000 years ago it slowed down appreciably (Komar, 1976, p. 154-7). For the past 34 years there appears to be at most a 1.5 mm (0.005 ft.) per year rise in sea level (Hicks, 1972). Hicks determined this rate from long-term tide gauge records obtained on all coasts of the United States. If one averages the recordings of a tide gauge for the entire year, an average water level for that year is obtained. Over the years this level can change, indicating an apparent long-term change in the sea level. The result obtained at a particular coastal site will depend on whether the land there is stable, rising or lowering, as well as on any actual sea level change. For example, on the east coast of the United States the land is sinking so that the apparent sea level rise is still larger than the 1.5 mm/year value (Figure 16). As a consequence, in the long term (tens of years to centuries) the shoreline there tends to migrate landward, resulting in shoreline erosion and endangering dwellings constructed too close to the beach. In contrast, much of Alaska is rising at a geologically rapid rate, much greater than 1.5 mm/year. This results in the land emerging from the sea with the shorelines receeding (Figure 16). If sea level is presently rising at the rate of

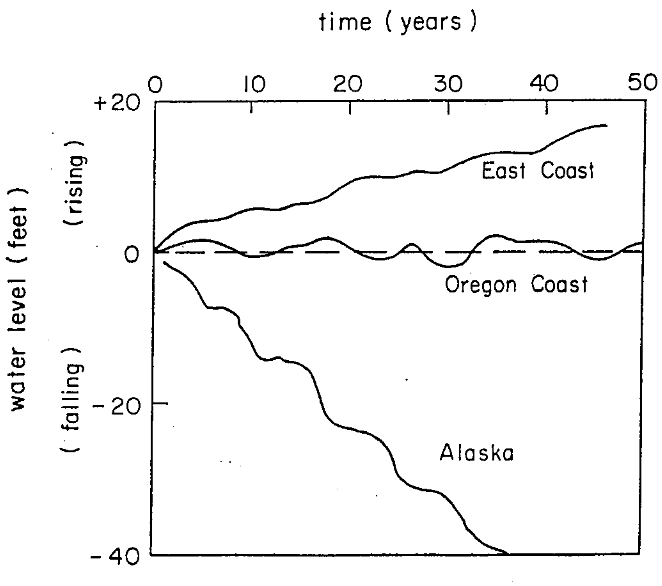


Figure 16. Schematic of water level changes on the Oregon coast as compared to the East coast and the coast of Alaska, based on the data of Hicks (1972).

1.5 mm/year, then the Oregon coast must be rising at about the same rate as the tide-gauge records at Astoria, Crescent City (California), and Friday Harbor (Washington), analyzed by Hicks (1972), all show no apparent sea-level changes over the years (Figure 16). Excepting the yearly fluctuations which have many causes, the long-term trends show a nearly unchanging sea level. In contrast to the east coast, the apparent lack of a rising water level with respect to the land along the Oregon coast should act as a deterrent to coastal erosion. However, as recently as 7,000 years ago the sea was probably transgressing rapidly over the Oregon coastal zone, producing erosion. Insufficient time has passed since then for the coast to come to equilibrium with the present sea level, so that the general erosion of the rocky headlands and terraces is more a response to that past rise in sea level than due to any present-day rise.

III. EROSION DUE TO JETTY CONSTRUCTION

The earliest erosion problems on the Oregon coast were associated with the construction of jetties at the entrances to bays and estuaries. Most of these were installed early in the century, but subsequently have been repaired and in some cases lengthened. Of interest are the causes of the erosion resulting from jetty construction or extension. An examination of these problems also provides information about the littoral drift of sand along Oregon's coastal beaches.

The most dramatic and famous case of erosion due to jetty construction on the Oregon coast is that which occurred on Bayocean Spit opposite Tillamook Bay. Following the installation of a single north jetty, sand accumulated to the north side of that jetty, resulting in sand deposition to the north (Figure 17). At the same time, erosion occurred along most of the length of Bayocean Spit and south past the community of Cape Meares. Somewhat earlier the resort community of Bayocean Park had been developed on the spit; its homes and buildings were progressively undermined by the erosion and lost (Figure 18), so that eventually the entire town disappeared. Erosion to the spit culminated in November 1952 when storm waves combined with high tides to break through the spit at its narrow mid-section, the northern half of the spit becoming an island. The newly breached area became the main inlet to the bay; the former inlet with the jetty began to close. For this reason, in 1956 the U.S. Army Corps of Engineers built a dike across the new inlet, closing it, and the inlet with the jetty opened once again. The story of the development of Bayocean Spit and its subsequent erosion is documented at length in Terich (1973) and in Terich and Komar (1974).

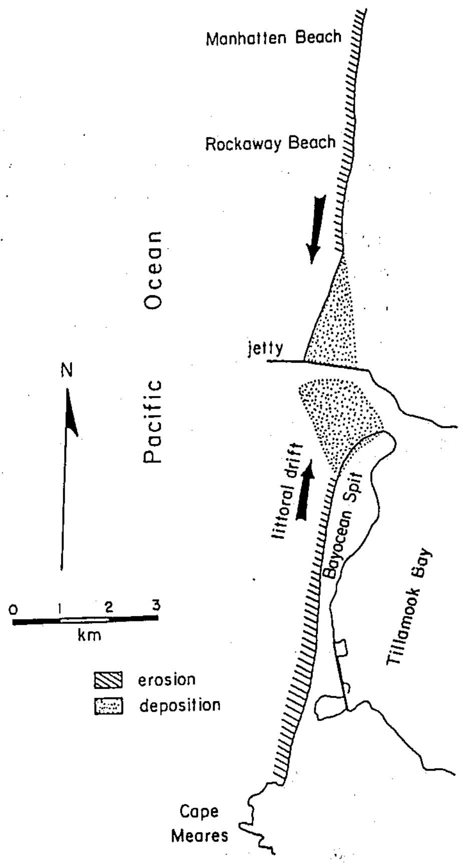


Figure 17. Patterns of beach deposition and erosion resulting from construction of the north jetty at the entrance to Tillamook Bay (from Terich and Komar, 1974).

The sand accumulation to the north of the Tillamook jetty together with erosion along the spit to the south (Figure 17) led early studies to conclude that the jetty construction had blocked a large net littoral drift of sand toward the south. Such patterns of erosion and deposition (beach sand accumulation) are typical of the blockage of a net littoral drift, diagramed schematically in Figure 19A, such as has commonly occurred on the east coast of the United States and in southern California. As previously mentioned it is now believed that this and other beach areas of the Oregon coast have essentially zero net littoral drifts (Figure 19). If a very large net littoral drift did occur in the Bayocean Spit area, then Cape Meares to the south (Figure 17) should have acted similar to a jetty, blocking the drift with a large accumulation of sand on its north side; there is none.

The erosion of Bayocean Spit has to be understood in terms of having occurred under conditions of a zero net littoral drift. Even with a zero net drift there can be local rearrangements of beach sand produced by the jetty construction. Such changes are best seen where two jetties are constructed rather than a single jetty as at the Tillamook Bay entrance.

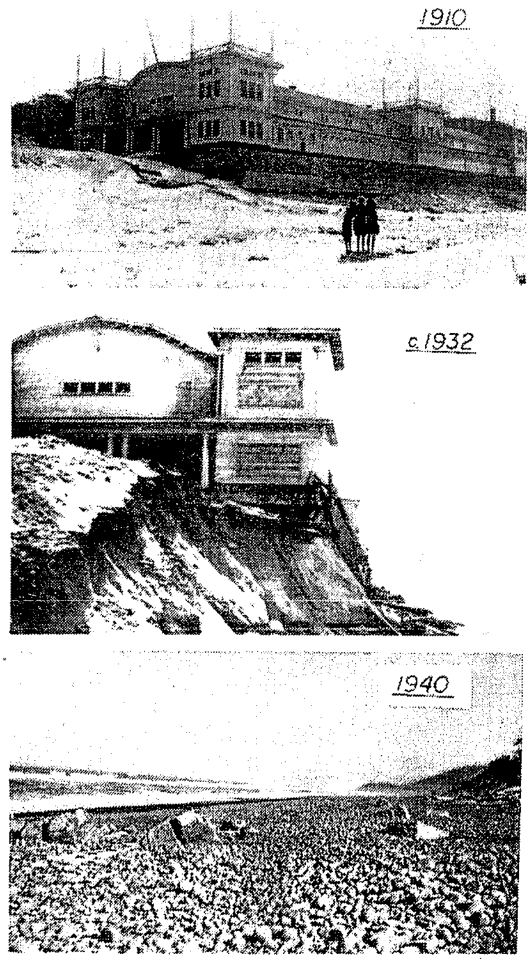


Figure 18. Erosion on Bayocean Spit leading to the loss of the natatorium with an indoor swimming pool (from Terich and Komar, 1974).

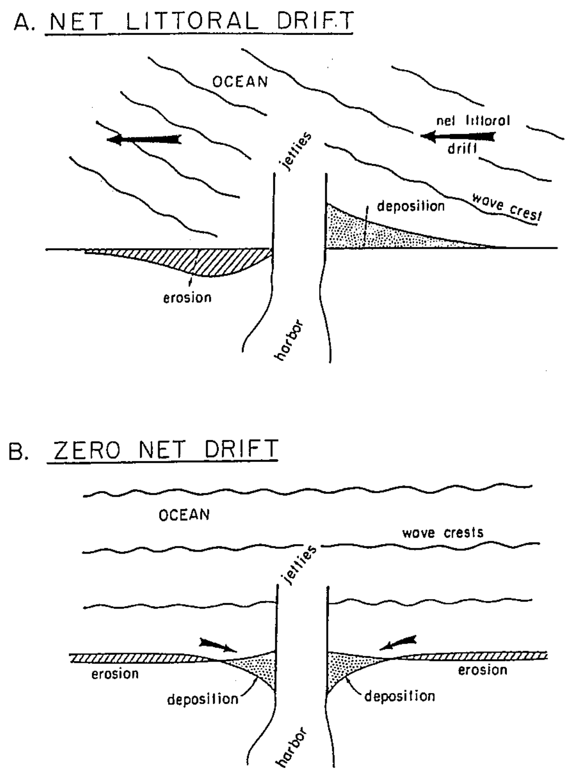


Figure 19. Schematic of shoreline changes (deposition and erosion) produced by jetty construction in areas experiencing a net littoral drift versus an area such as the Oregon coast where there is a zero net littoral drift.

Large shoreline changes also occurred following construction of a pair of jetties at the entrance to the Siuslaw River near Florence (Figure 20). It is seen that where two jetties are constructed, there is beach sand accumulation both to the north and south, immediately adjacent to the jetties. This deposition and shoreline advance occurs because an embayment is formed between the newly constructed jetty and the pre-jetty shoreline. Before jetty construction, the shoreline curved inward toward the inlet and was in equilibrium with both the ocean waves and with the currents coming in and out of the inlet. Jetty construction eliminated the inlet currents acting on that curved portion of shoreline, leaving only the waves. The waves broke at angles to the curved shoreline and so moved sand into the embayment until it completely filled with sand (Figure 21). Once the embayment filled and there was a smooth and nearly straight shoreline parallel to the dominant waves, then a zero net littoral drift once again prevailed. After that stage is reached there are no additional large-scale adjustments of the shoreline due to the presence of the jetties. Therefore a new equilibrium is achieved, and shoreline changes do not continue indefinitely. In the case of the blockage of a net littoral drift (Figure 19A), the only equilibrium that could occur following jetty construction is if the sand accumulated on the updrift side of the jetties until it is able to pass around the jetties to the downdrift side.

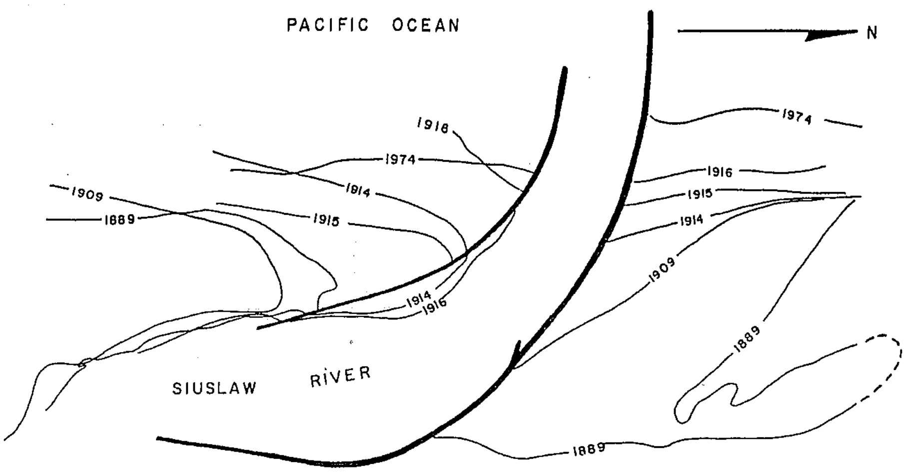


Figure 20. Compilation of shoreline changes resulting from jetty construction at the mouth of the Siuslaw River, based on old ground surveys and aerial photographs. The 1889 shoreline predates jetty construction (from Komar, et al., 1976a).

The sand that fills the shoreline embayments produced by jetty construction must come from somewhere, and most of it comes from shoreline erosion at greater distances from the jetties (Figure 19B). Thus a symmetrical pattern of erosion and deposition results with beach sand accumulation immediately adjacent to the jetties, both to the north and south, and with erosion at greater distances from the jetties (Figure 19B). This contrasts with the asymmetrical pattern where the jetties block a net littoral drift, the shoreline advancing seaward on the updrift side and erosion occurring on the downdrift side (Figure 19A). As in the case for jetty construction on the Siuslaw River (Figure 20), the patterns of erosion and deposition may not be perfectly symmetrical due to the different sizes of embayments created on the two sides of the

jetty construction was filled and the shoreline straightened. There was probably some erosion further to the north, but the length of beach there is long so that there was only a small amount of erosion per unit shoreline length. Sand also accumulated at the northern tip of Bayocean Spit even though a true embayment was not formed by jetty construction. This accumulation was in the form of a large shoal which developed seaward of the south side of the inlet (Figure 17). That sand apparently came from the erosion of Bayocean Spit, so there was something of a symmetrical pattern of deposition and erosion (Figure 17), similar to that of the Siuslaw jetties. The erosion of Bayocean Spit was large because the eroded sand came from a short length of beach, Cape Meares being to the immediate south. In 1976 a south jetty was constructed at the inlet, forming a true embayment with the pre-jetty shoreline. As at the Siuslaw inlet and other Oregon-coast inlets, the embayment filled until the shoreline was straight with the shoreline along the remaining length of Bayocean Spit. That filling required some additional sand, again derived from further erosion of the spit. However, since that time, erosion of the spit and the Cape Meares area has been small since a new equilibrium exists in which no further sand is required for deposition next to the south jetty.

On the Oregon coast and other areas of zero net littoral drift, once jetties are constructed and sand has filled the embayments to either side, the jetties can subsequently be extended without producing additional major shoreline readjustments and erosion. This is especially true if the jetties are perpendicular to the coastline trend, extending straight out to sea. For example, the jetties on the Siuslaw River inlet (Figure 20) could be extended without causing renewed erosion problems, and the proposed extension of the south jetty at Tillamook Bay will not cause significant additional erosion on Bayocean Spit. However, where jetties are oblique to the shoreline trend, as at the Yaquina Bay entrance (Figure 22), jetty extension produces some additional sheltering from the waves to the enclosed side and results in further sand accumulation next to the jetty and some further erosion at greater distances from the jetty; this was the case with the extension of the Yaquina Bay jetties in 1971.

The filled embayment areas to either side of inlet jetties are dependent upon the presence of the jetties. If the jetties are allowed to degrade then there may be some erosion to these filled areas. A possible example of this may be the recent erosion at Nedonna to the immediate south of the jetties on the Nehalem River. As at the other inlets, following the construction on the Nehalem in 1917, the embayments to either side filled and the shoreline there advanced seaward. No further work has been done on these jetties, however, and they have deteriorated to the point that they are covered with water at high tide. The shoreline again curves back inward into the inlet, but not as much as prior to jetty construction so that further erosion might be expected. The community of Nedonna Beach was developed on the south embayment fill, in an area that was underwater before jetty construction.

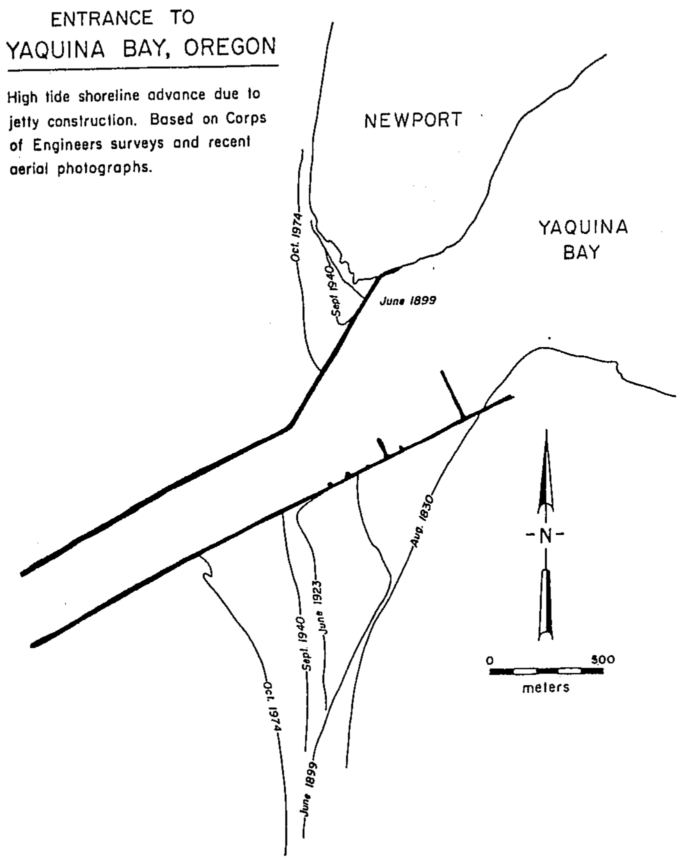


Figure 22. Compilation of shoreline changes resulting from jetty construction and then later extension at Yaquina Bay. The 1830 shoreline predates the jetty construction. The south jetty extension occurred between 1940 and 1974 and is seen to have produced some shoreline advance due to the additional protection caused by the jetty extension (from Komar, et al., 1976a).

All of the jetty systems on the Oregon coast, with the exception of the Columbia River jetties, were studied by Komar, et al. (1976a) to determine patterns of erosion and deposition. All were shown to conform to the pattern of deposition adjacent to the jetties with erosion at greater distances. This provides strong evidence that there is indeed a zero net littoral drift prevailing along the coast of Oregon as discussed earlier.

IV. SAND SPIT AND FOREDUNE EROSION (SILETZ SPIT)

Bayocean Spit eroded due to jetty construction. But other spits, such as Siletz and Nestucca Spits, have also suffered episodes of erosion without the presence of jetties. Their storm wave erosion problems are therefore attributable mainly to natural causes, man playing a minor role in the processes. This section will deal with such natural erosion to the fragile sand spits, especially that which has occurred on Siletz Spit as the problems there have been extensively studied (Rea, 1975; Rea and Komar, 1975; Komar and Rea, 1976b; McKinney, 1977; Komar and McKinney, 1977).

Prior to 1960, Siletz Spit appeared much as it had for hundreds of years; over most of its length there were low hummocky dunes, active or sparsely covered with dune grasses. Development of the spit began in the early 1960's. A road was cut along its length and artificial lagoons were carved into the bay-side of the spit. A scatter of houses appeared.

Following spit development, beach erosion first appeared during January 1971 when a series of storms cut into the foredunes upon which homes had been built. Several homes were in the path of the erosion, but riprap placement halted the erosion advance before they were seriously threatened.

Erosion returned in the winter of 1972-73. A major storm occurred over the North Pacific in late December 1972 (Figure 8), generating wave breakers up to 23 feet in height (Figure 9). The waves cut into the foredunes, quickly threatening several homes. A house still under construction was left unprotected and so was undermined by the retreating dune bluff and collapsed onto the beach (Figure 23). Riprapping began on Christmas Eve to protect the other homes. However, these houses were initially defended only on their seaward sides, empty lots to either side being left unprotected. Foredune erosion and retreat continued in these empty lots, flanking the riprap fronting the homes, necessitating the placement of rocks along their sides as well as fronts (Figure 24). The result was groups of homes situated on promentories extending out onto the beach, supported by riprap on three sides.

Erosion has returned in varying degrees in subsequent winters. It was particularly severe during the winter of 1975-76 and again in 1977-78 when a storm generated breaking waves about 23 feet high, and at a time of high Spring tides. The combination of large waves plus high tides nearly breached the spit (Figure 25). This same storm did breach Nestucca Spit, (see Section V).

In each instance foredune erosion did not occur over the entire length of the spit. Instead, it was limited to two or three zones, each some 200 feet of spit length. This localization of dune erosion was governed by the positions of rip currents as previously discussed (Section II). The seaward flowing rip currents transport sand offshore, hollowing out embayments into the beach berm. At times these embayments reach across the entire beach and begin to cut into the foredunes on Siletz Spit, setting the stage for severe erosion. The major erosion itself occurs during a severe winter storm which produces high wave conditions along the coast. The large waves are able to move ashore over the deep water of the embayments with little loss of energy, swashing directly against the base of the foredunes, cutting them back. Such embayments are seen in Figure 26 at the time of the December 1972 erosion; major foredune erosion occurred shoreward of the most pronounced embayment.

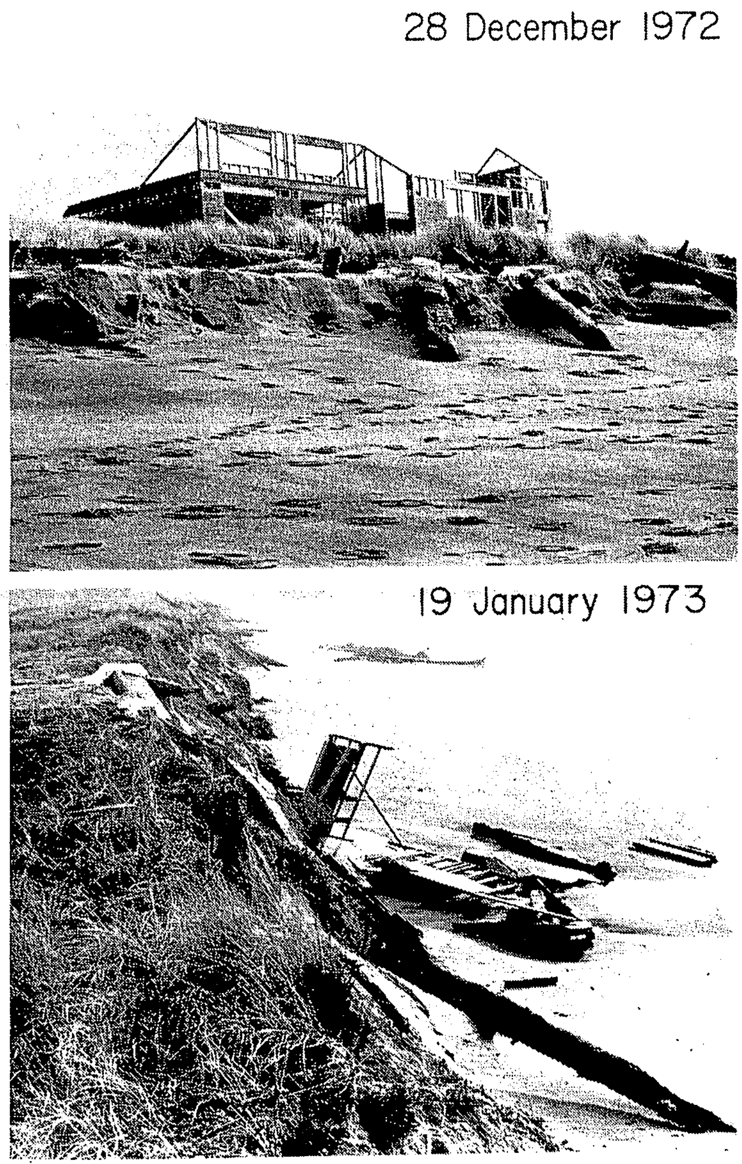


Figure 23. Destruction of house under construction on Siletz Spit due to the rapid wave erosion of the foredunes upon which the house was being built (from Komar and Rea, 1976).

Figure 24. House left on a promentory of riprap on Siletz Spit as adjacent unprotected empty lots continued to erode (Photo by P. D. Komar, 23 January 1973).

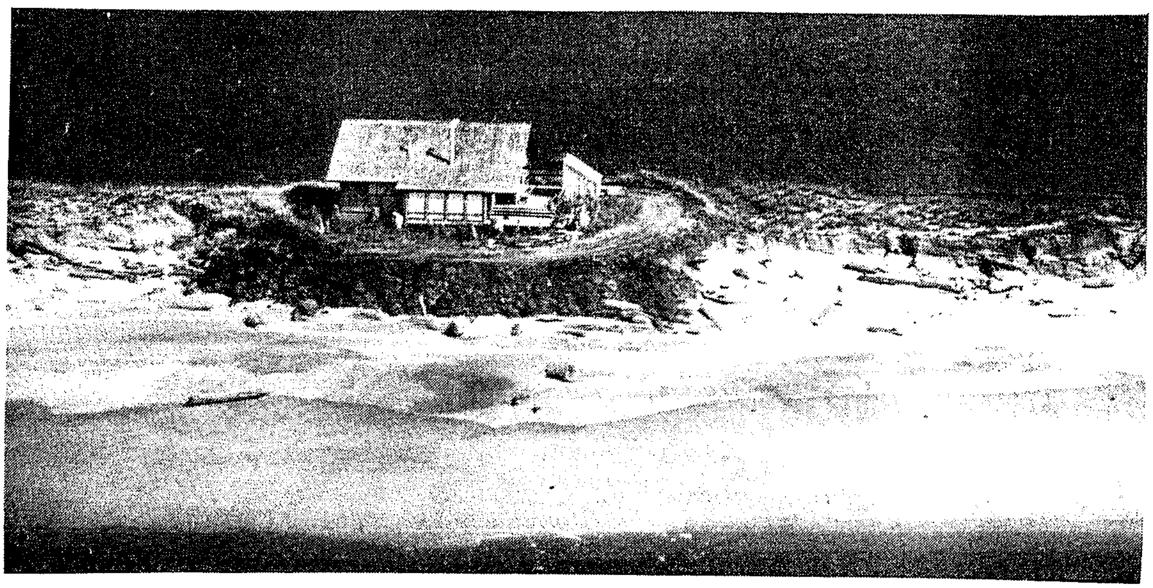


Figure 25. Erosion during the winter of 1977-78 along the narrowest portion of Siletz Spit, nearly leading to its breaching (Photo by P. D. Komar).

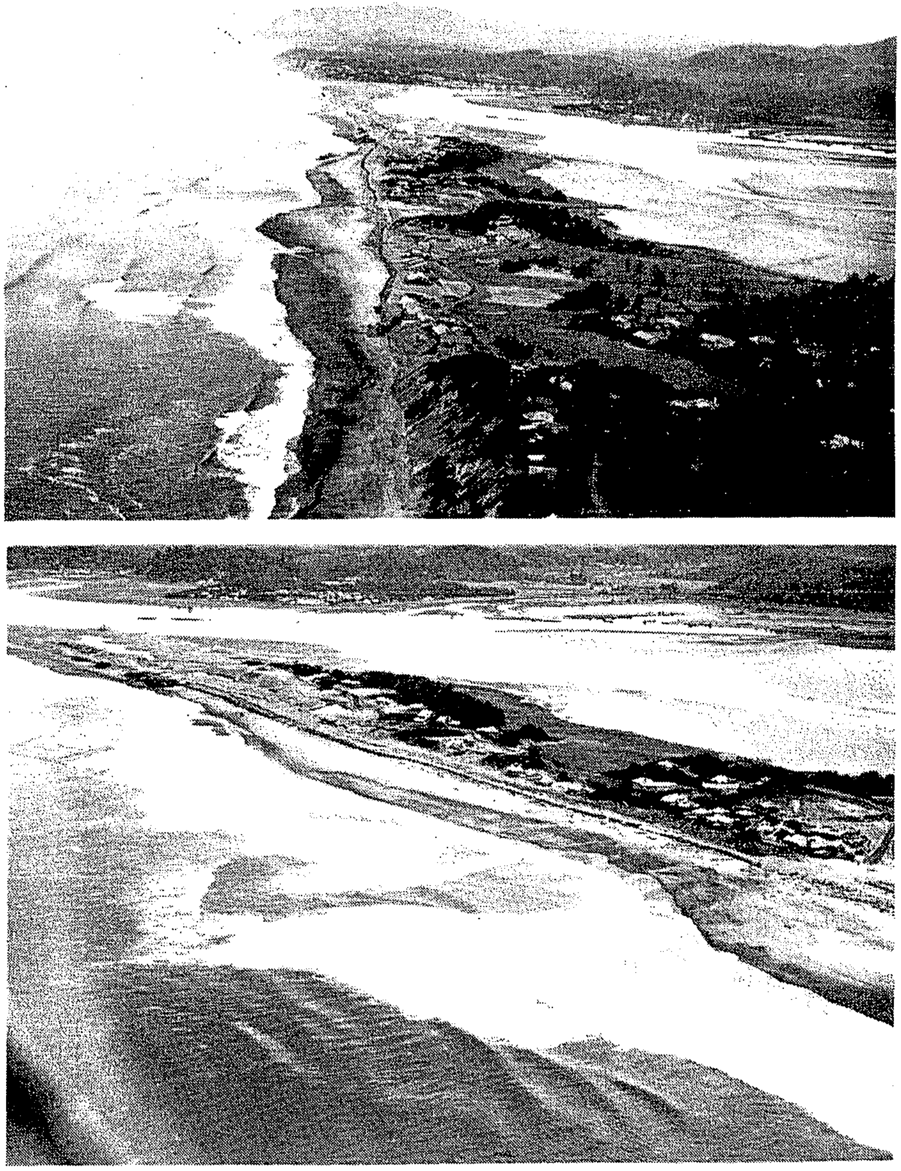


Figure 26. Embayments cut out of the beach and into the foredunes on Siletz Spit leading to property losses during December 1972 and January 1973, produced by seaward flowing rip currents (from Komar and Rea, 1976).

Thus the positioning of the rip currents during the winter governs the locations of maximum beach and foredune erosion. This usually changes from one winter to the next so the areas of erosion are not always the same. At present we are unable to predict where the rip currents will form. But once it is seen where they are positioned we can anticipate that these could be potential erosion sites. During some winters they remain relatively fixed in position and so are able to hollow out large embayments; such conditions are most conducive to major erosion. During other winters the rip currents migrate somewhat north-south, probably when waves arrive obliquely to the coastline, and do not form as large embayments; consequently the potential for erosion is smaller.

During severe episodes of erosion on Siletz Spit, the foredunes were cut back some 100 feet around the lengths of ocean-facing lots. Studies of aerial photographs dating as early as 1939 show that such erosion has occurred repeatedly in the past, but that following the erosion, beach sand is washed and blown into the eroded zone eventually rebuilding the foredunes (Rea, 1975; Rea and Komar, 1975; Komar and Rea, 1976b). The following sequence of events is revealed by aerial photographs and is typical of many cycles of erosion and accretion of the foredunes: (1) high storm waves erode an embayment or vertical scarp into the foredunes; (2) subsequent high tides deposit drift logs in the eroded embayment; (3) lower energy waves during the summer build a wide beach; (4) the logs behind the beach trap sand that is either blown off the beach or washed there by the waves at high tides; (5) wind-blown sand continues to accumulate around the logs, sometimes aided by dune grasses, until the foredunes are re-established; (6) erosion again occurs to repeat the cycle. If uninterrupted, one complete cycle can take from ten to fifteen years. Figure 27 illustrates the process of dune reformation (steps 4 and 5) in a small embayment cut into the foredunes. The criss-crossing matrix of logs is seen to be effective in trapping sand to re-establish the foredunes. Drift logs can therefore be an important agent in the reformation of foredunes.

Such cycles of erosion and foredune accretion have occurred repeatedly in the past, shown by the sequence of aerial photos of the Siletz Spit. It is also indicated by the presence of sawed drift logs buried within the foredunes, revealed by the erosion. Many homes built on Siletz Spit were constructed on foredune areas that had previously been eroded away and then reformed as described above--erosion which occurred as recently as the 1950's and early 1960's, just before spit development.

In summary, erosion of foredune areas can be very rapid, removing some 100 feet of property in two or three weeks. The erosion is mainly centered in the lee of rip currents which hollow out embayments into the beach. Maximum erosion occurs under large storm waves, and is also aided by the high water levels of Spring tides. Following erosion the foredunes may be re-established by beach sand washing and blowing into the eroded zone; drift logs aid in dune reformation by trapping the wind-blown sands.

Figure 27. Drift logs washed into an embayment cut by a rip current on Siletz Spit, now actively trapping wind-blown sands and beginning to reform the foredunes (from Rea and Komar, 1975).

It would have been preferable if development on Siletz Spit had been prohibited in the approximately 100 feet zone where foredunes are susceptible to rapid wave undercutting and erosion. Then the natural cycle of erosion followed by dune rebuilding could have continued. Instead, the presence of the homes necessitated the placement of huge quantities of riprap to the detriment of the spit's appearance (Figure 28). Much of this riprap was placed on an emergency basis, without the benefit of correct engineering procedures. As a result this riprap is being progressively washed away (Figure 29) and will have to be replaced at additional cost to the homeowners.

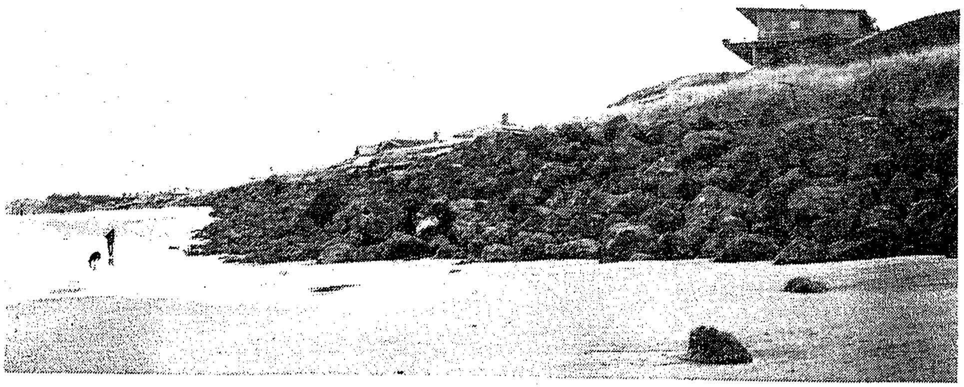


Figure 28. Large piles of riprap employed on Siletz Spit to protect the homes built on the foredunes.

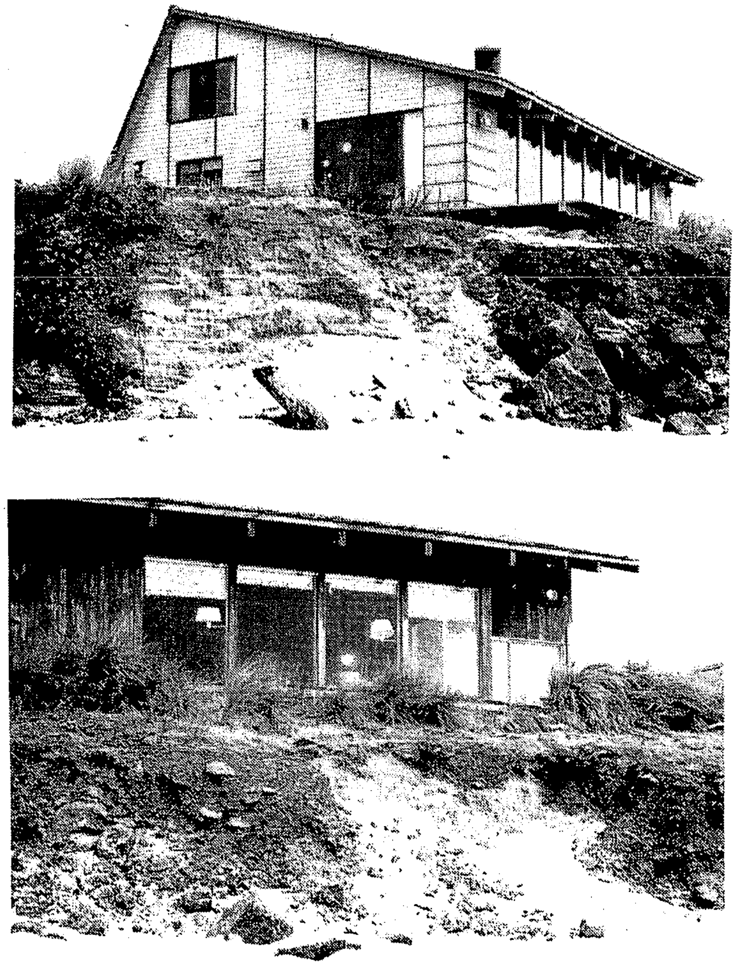


Figure 29. Erosion of riprap on Siletz Spit by a series of storms, exposing the dune sands to wave attack (from Rea and Komar, 1975).

V. OTHER AREAS OF FOREDUNE EROSION OR POTENTIAL EROSION

Other sand spits and foredune areas have suffered erosion on the Oregon coast in addition to that which has occurred on Siletz Spit. Even though erosion may not have been noted in the recent past, all foredune areas have the potential for rapid wave erosion due to their negligible resistance to wave attack. This section will discuss other sand spit and foredune areas that have eroded or have the potential for future erosion.

A. Nestucca Spit Erosion

The erosion of Nestucca Spit, Figure 30, is comparable in extent and in processes to the erosion on Siletz Spit, already discussed (Komar, 1978). The erosion has threatened a number of homes at the Kiwanda Shores development to the south of Cape Kiwanda, necessitating the placement of large quantities of riprap even before house construction was complete (Figure 31). Maximum erosion occurred during the winter of 1977-78; under the onslaught of 23-foot high breakers at a

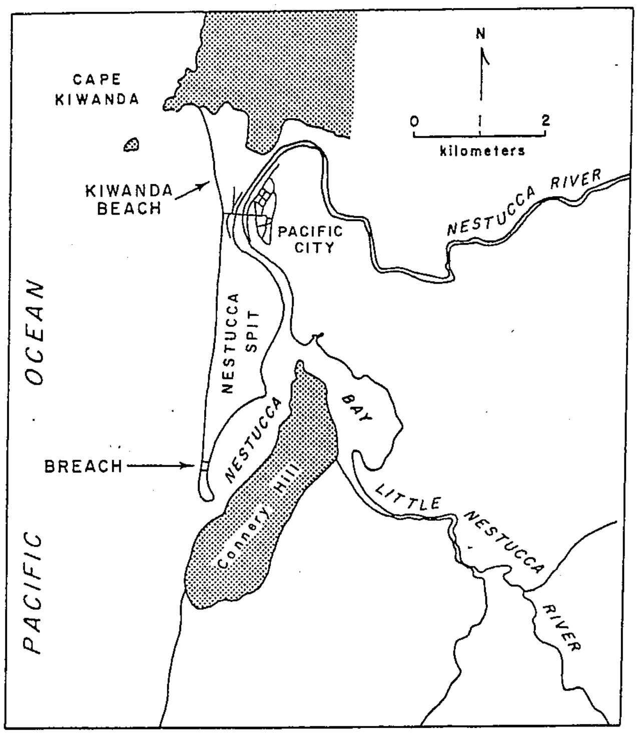
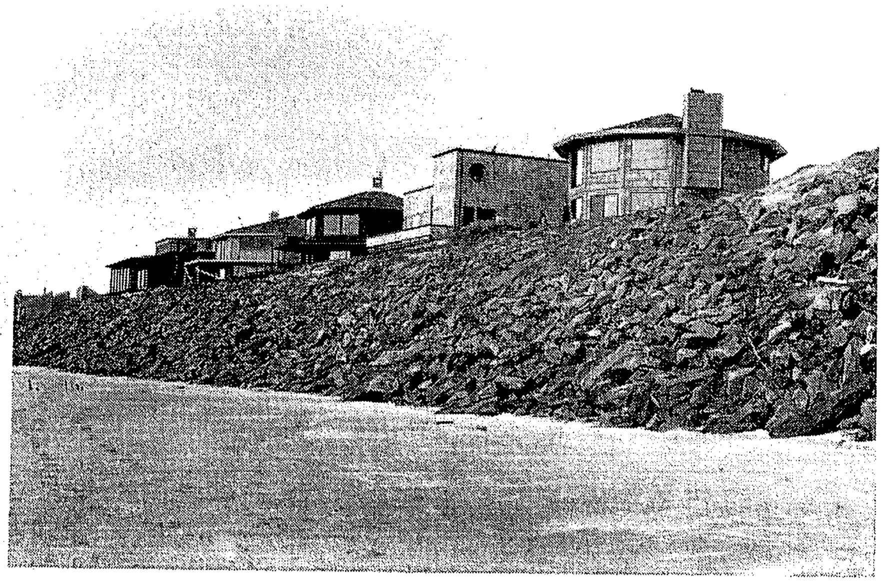


Figure 30. Nestucca Spit, showing the areas of foredune erosion and breaching during February 1978 (from Komar, 1978).



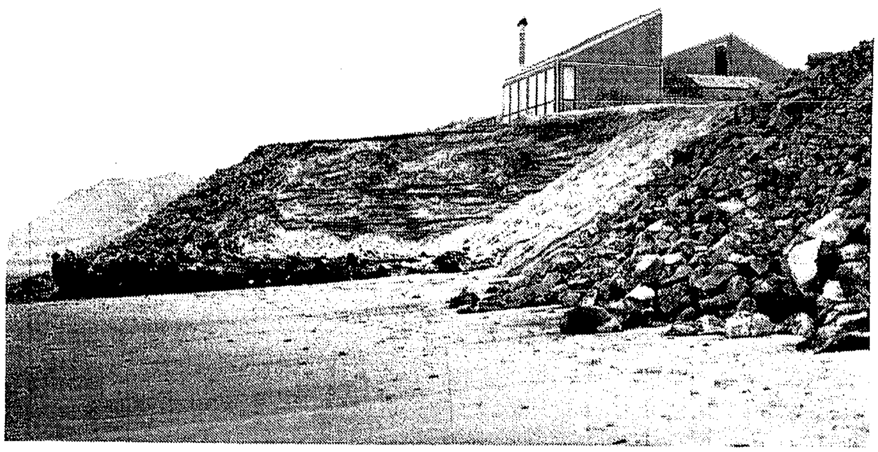


Figure 31. Homes to the south of Cape Kiwanda protected by riprap placed due to the erosion of the foredunes upon which they were being constructed (from Komar, 1978).

time of high Spring tides on 5 February 1978, the resulting erosion broke through the spit near its southern end (Figure 32). This is the only known occurrence of the natural breaching of a sand spit on the west coast of the United States (the breaching of Bayocean Spit, discussed above, was not natural in that the ultimate cause was the construction of jetties). Fortunately, the breached site at Nestucca Spit was well away from any developments and so threatened no dwellings. However, it did demonstrate the fragile nature of sand spits and their general unsuitability for development.

Figure 32. The breach in Nestucca Spit produced by a combination of unusually high storm waves and high Spring tides in early February 1978 (State of Oregon, Highway Department photo).

The erosion processes on Nestucca Spit are very similar to those on Siletz Spit. Rip current embayments again played a role in determining the centers of maximum erosion. However, the beach sand on Nestucca Spit is finer than on Siletz and therefore the beach slope is somewhat less (see Section II). This causes the rip current embayments on Nestucca Spit to be wide and shallower than on Siletz, and they do not cut as far back into the foredunes. The result is that foredune erosion on Nestucca Spit tends to cover a longer length of coastline, but does not reach as far inland. During the time of maximum erosion and breaching, sawed drift logs were observed within the eroding foredune scarp. As at Siletz, this indicates that these foredune areas have eroded before, since logging began in the coastal watersheds about the turn of the century.

B. Netarts Spit

Netarts Spit has a total length of about 5 miles, and is wide to the north but very narrow in its middle section. The spit is covered with dunes, the highest reaching nearly 50 feet high. To the south the dunes are apparently old as they are covered with Sitka spruce. Elsewhere the dunes are vegetated only with low pines or sparse dune grasses.

Erosion of Netarts Spit by wave attack was apparently a threat to the southern portion prior to 1940. Dicken (1961, p. 57) suggests that there is evidence that the spit may have broken through early in the century in its narrow portion. In 1940 the State of Oregon developed Cape Lookout State Park at the spit's southern end. The State constructed a wood piling bulkhead backed by riprap along 600 feet of the park where erosion had apparently been occurring (Figure 33). On the basis of aerial photographs, Stembridge (1975, p. 80) estimates that erosion has amounted to only 10 to 15 feet since 1939.

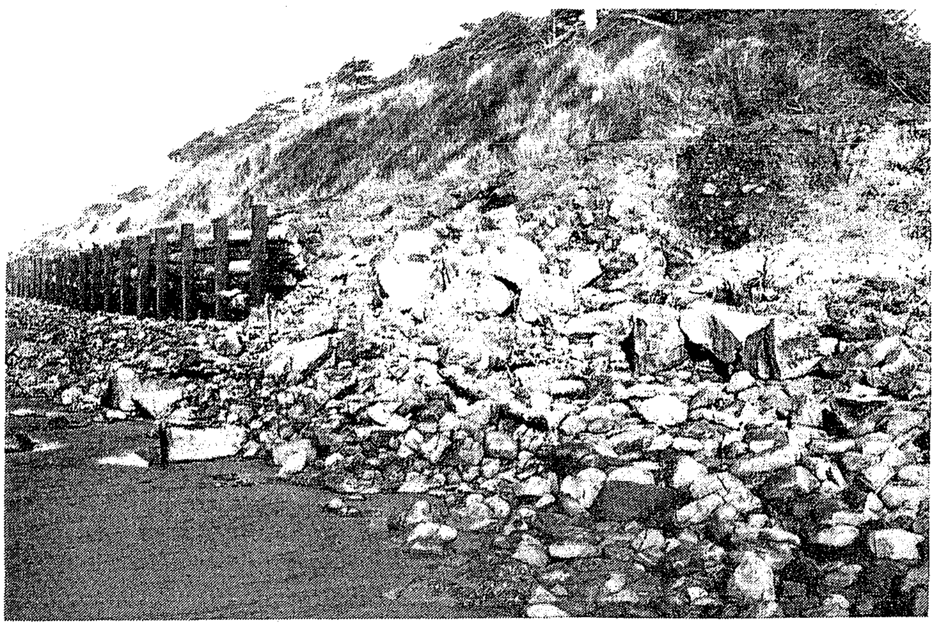


Figure 33. The wood piling bulkhead built on Netarts Spit to stop wave attack of the dunes.

The dune bluff facing the ocean is vegetated and also testifies to the fact that little or no erosion has occurred in recent years. At times the waves do reach the base of the slope, making a slight notch into the dunes, but this has been minor. It would probably take a very unusual combination of storm waves, high tides and a storm surge to cause appreciable erosion on the spit. At present, the chief problem is due to visitors cutting paths through the dune vegetation (Figure 34) which may lead to wind erosion of the dunes.

Figure 34. Degradation of the dunes on Netarts Spit due to visitors cutting a path from the beach to the state park.

The sand on Netarts Spit is fine and the beach slope very low. As a result, the rip current embayments are extremely broad and shallow, so much so that they do not appear to play any significant role in beach erosion as was the case on Siletz and Nestucca Spits. This may be a major factor in the general lack of erosion problems on Netarts Spit.

C. Nehalem Spit

Nehalem Spit is an area of low dunes that have been conditionally stabilized by European beach grass, there having been a dramatic growth of the grass in the area since 1939 (Stembridge, 1975, Figure 31). On the basis of aerial photographs, Dicken (1961, p. 66) estimated that the spit has eroded 5 to 10 feet over a 21 year period (0.25 to 0.5 feet per year). As discussed earlier (Section III), there was shoreline progradation adjacent to the Nehalem inlet jetties following their construction in 1910-19. But subsequently that area has also been eroding due to the progressive deterioration of the jetties.

The bluff in the Manzanita area cut by this long-term erosion is now nearing many homes (Figure 35) built a number of years ago. The erosion is progressive, rather than periodic and rapid as at Siletz Spit, so these homes are probably not in any immediate danger. Further south, on Nehalem Spit itself, a number of new homes have been recently constructed on the foredunes close to the beach (Figure 36). There are signs of wave erosion of the foredunes in this area so there may be some potential danger to these houses. Sands are also being actively moved by the winds, which may also lead to problems. Unfortunately, no one has made a detailed study of this area.

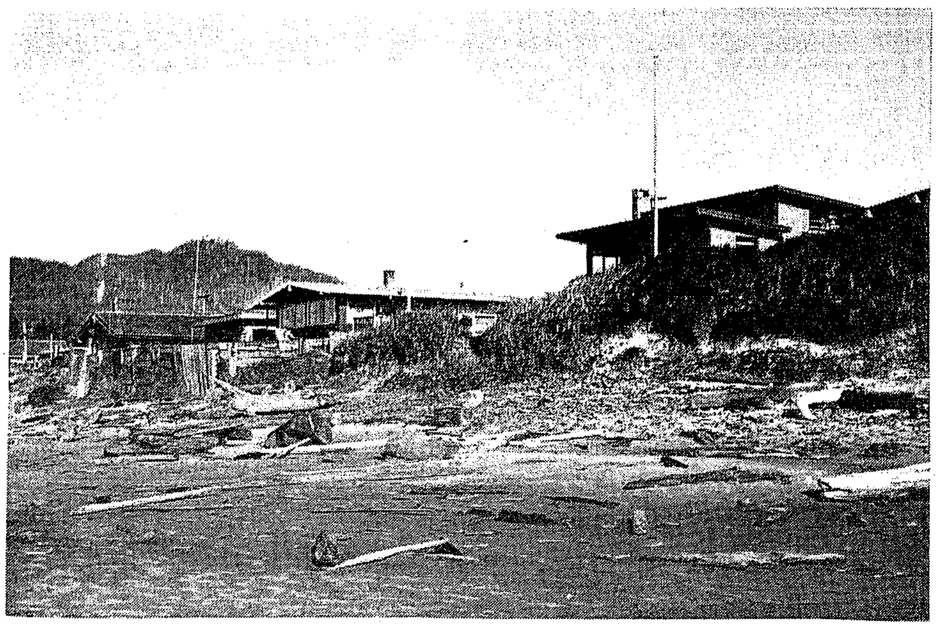


Figure 35. Long-term progressive erosion in Manzanita, now nearing some of the homes.

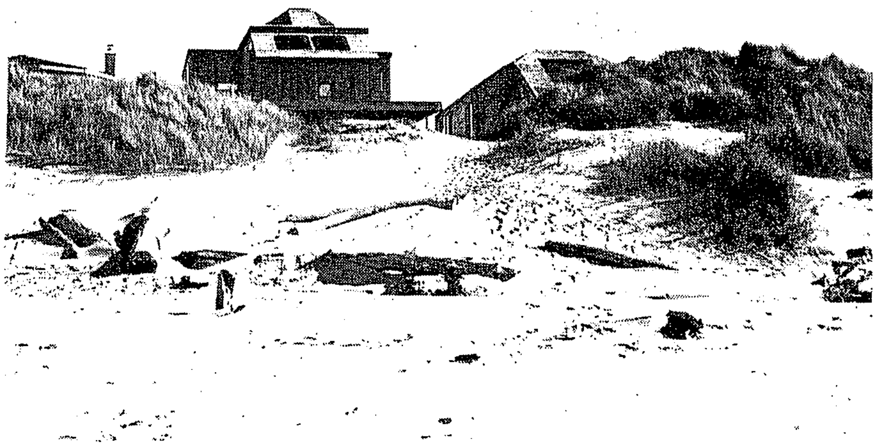


Figure 36. Homes built on Nehalem Spit in an area of active foredunes susceptible both to ocean wave attack and wind erosion.

D. Alsea Spit

Alsea Spit may be the one spit on the Oregon coast that is accreting rather than undergoing long-term erosion. This is to be hoped for as the spit is presently undergoing intensive development over its entire area.

Stembridge (1975, p. 115-120) compared aerial photographs of 1939 and 1974 of the area and found that the south tip of the spit has shown maximum accretion, an average of 10 feet per year. The accretion progressively decreases in amount northward along the length of the spit, until at about 1.6 miles north of the inlet it becomes zero with erosion occurring still further to the north. Erosion rates of up to 2 feet per year have been occurring along the bay side of the spit.

This accretion of Alsea Spit may be related to high sediment yields from the Alsea River as suggested by Stembridge (1975, p. 120). Because the accretion is maximum at the south tip of the spit, it may instead have resulted from a southward migration of the inlet itself, such migrations being common for inlets without jetties. If this is the case, then at some future date the inlet migration could reverse and move back to the north. This would cause erosion on the spit, especially at its south tip, so it would be best not to develop that area.

E. Seaside - The Necanicum River Inlet

An example where foredunes have been eroded by inlet migrations is provided by the Necanicum River inlet at the north edge of Seaside. In past decades the position of this inlet has alternately migrated north and south over a distance of about 4,000 feet. In 1948, for example, it moved well to the south to the very edge of the Seaside community, endangering the sewage treatment plant there. It then moved back to the north causing erosion of the foredunes south of Gearhart.

Seaside and the Necanicum inlet area are at the southern portion of the Clatsop Plains and thus have an abundance of sand. Because of this, whenever the Necanicum inlet migrates away from an area, sand rapidly accumulates to form a foredune. At present, such an active foredune is found north of the inlet at the south edge of Gearhart. However, such foredunes adjacent to the inlet are very susceptible to erosion by renewed inlet migration.

In 1967 the inlet migrated to the north and a spit of foredunes began to develop to the south as a continuation of Seaside. A developer quickly placed riprap over that foredune area so the inlet would not migrate back and reclaim the area. The intention was to construct dwellings on the newly accreted area, but the riprap was placed without a permit and so has been under litigation ever since. The inlet has periodically been attempting to migrate back to the south and has been progressively eroding and undermining the riprap at its northern tip. In the meantime, foredunes have accumulated in the area on top of the riprap. In 1978 these active dunes were bulldozed flat, covered with sludge from the sewage treatment plant and seeded with grass.

Due to their natural migrations, such inlet areas without jetties are particularly dangerous to develop. The strong currents in the inlets can undermine the riprap unless done with jetty-scale material. The deep-water of the inlet also allows ocean waves to reach the shoreline with little loss of energy so that inlet areas can also suffer from wave attack. They are also particularly susceptible to overwash by tsunami waves (Section II). In the particular case of the Necanicum inlet, there will be continuing problems with wind-blown sands due to the particular abundance of sand there.

The Necanicum inlet also provides an example of foredunes and bay-shore properties being eroded by currents within the estuary itself. The Neawanna Creek enters the Necanicum estuary on its north side to the east of Gearhart. In the past few years, the flow of the Neawanna has been eroding the bay-side of Gearhart, necessitating the placement of riprap to protect homes there. It strikes the bay side of the foredunes south of Gearhart and is actively eroding them (Figure 37).

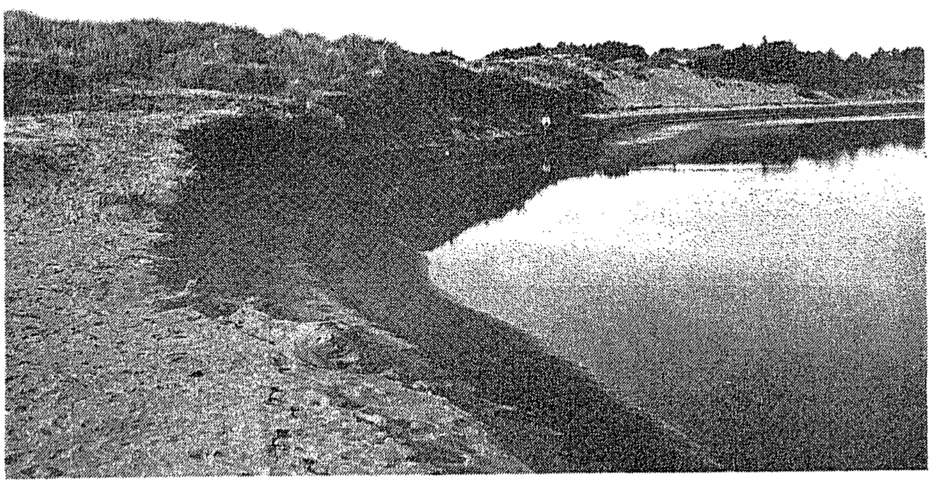


Figure 37. Bay-shore erosion at Gearhart, caused by the flow of the Neawanna Creek against the property.

Such bay-side erosion could also pose a threat to any dwellings placed in the area. Bay-side erosion has similarly occurred on Siletz Spit where the flow of the Siletz River impinges on the spit after flowing across the bay (Figure 38). The erosion there has been aggravated by the placement of the Siletz Keys landfill. Prior to the landfill, river flood waters were able to spill into the south part of the bay (open arrows of Figure 38), but after the landfill blocked these channels

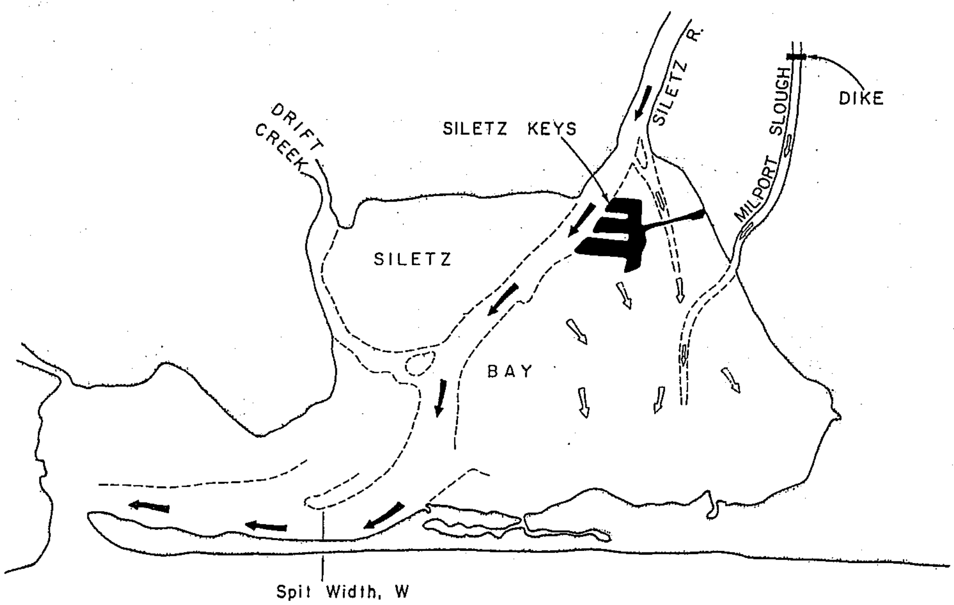


Figure 38. Bay-shore erosion on Siletz Spit where the Siletz River strikes the backside of the spit. The erosion has been aggravated by the placement of landfills such as Siletz Keys which prevents flood-waters from spilling into the south portion of the bay (from Rea and Komar, 1975).

all of the flood waters were jetted against the spit (Rea, 1975; Komar and Rea, 1976b). This bay-side erosion has progressively narrowed the spit, and together with the ocean-side erosion (Section IV), may cause a breaching of the spit (see Figure 25). Old, well-vegetated dunes may also be eroded by bay or estuary currents; an example is the north shore of the Siuslaw River.

F. Cannon Beach (Breakers Point)

Not all foredune areas are located on sand spits are associated with inlets. There are examples where foredunes have formed fronting sea cliffs or older well-vegetated dunes. One example is found in the Cannon Beach area to the north of Elk Creek (Figure 39), a portion of which is presently undergoing development. There are clear signs that the formation of this foredune is quite recent, probably less than 100 years old. At times storm waves cut into the foredunes, much as on Siletz Spit, removing as much as 30 feet during a single storm (Rosenfeld, 1979). This erosion has exposed sawed drift logs, again much as observed on Siletz Spit (Section IV), indicating dune accumulation since logging began in the area. Backing the northern portions of this foredune are higher, older dunes covered with trees. A clear erosion scarp, now covered with grass, has been cut into the seaward-facing side of these older dunes (Figure 39). This indicates that not too long ago erosion proceeded all the way up to the older dunes, entirely removing the foredunes. That erosion must have been an unusual combination of extreme storm waves, high Spring tides and a storm surge, producing an event analogous to the 100 to 200 year flood in a river. Since that event the foredune sands have been accumulating with the exception of the 30 feet or so that is periodically eroded by more common winter storms. Like the river floodplain which is covered by the 100-year flood, this foredune area and others like it are not desirable locations for permanent dwellings.

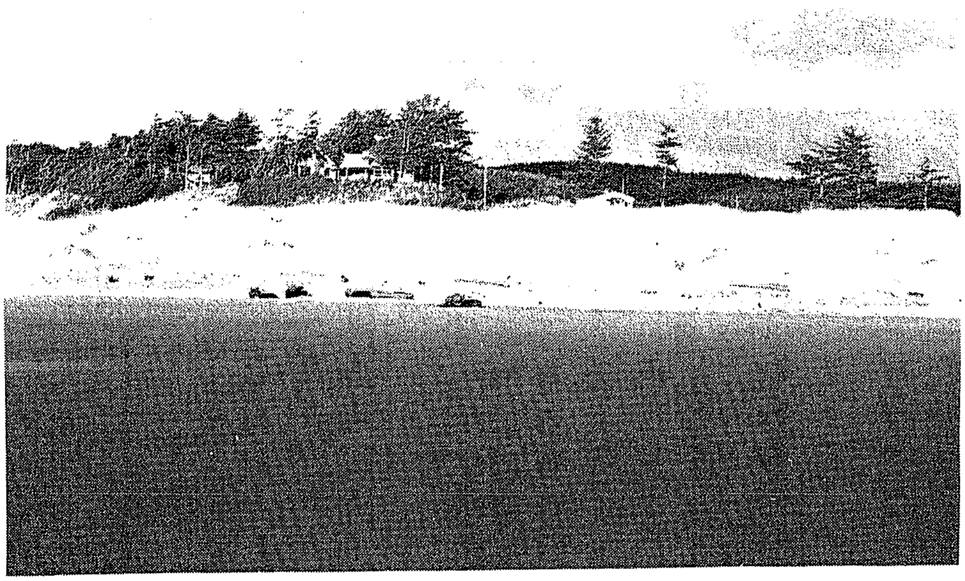


Figure 39. Foredunes at Breakers Point, Cannon Beach, backed by older, well-vegetated dunes into which waves at some time cut a near-vertical scarp.

VI. SEA CLIFF EROSION

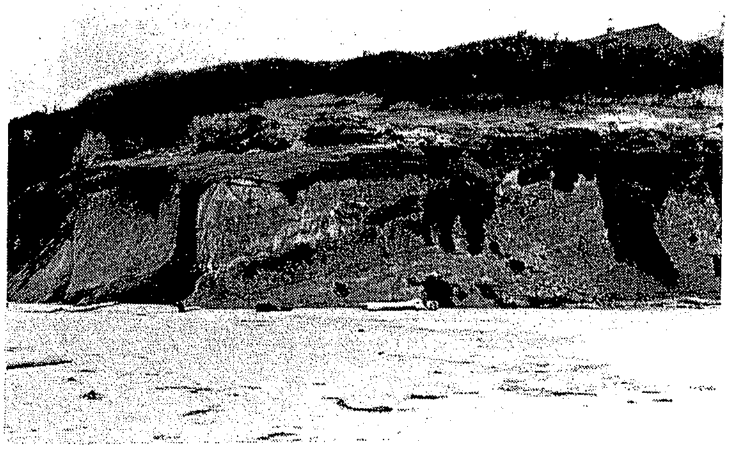
Although not as dramatic as the rapid erosion of foredunes, the long-term, progressive erosion of sedimentary sea cliffs along the Oregon coast remains an important problem for the coastal planner and resident. Certainly on a coast-wide basis, more homes are threatened by sea cliff erosion than by eroding foredunes. This is because many of our coastal communities (Cannon Beach, Lincoln City, Newport, Waldport, Bandon, Brookings, and numerous others) are located in areas of eroding sea cliffs. Most of these are built on the flat areas of marine terraces, consisting of Pleistocene marine sandstones overlying mudstones of older ages. These rocks are susceptible to wave attack to form the familiar sea cliffs (Figure 40) seen along much of the Oregon coast.

This section will examine the processes of sea cliff erosion (including landslides), what is known about their recession rates, and what attempts have been made to protect them from wave attack and the success or lack of success of such attempts. Examples of problems with eroding sea cliffs on the Oregon coast are cited.

A. Processes of Erosion

Erosion of sea cliffs is often viewed as a process of wave attack undermining the cliff followed by landsliding. This view is somewhat oversimplified as other processes are also involved including groundwater sapping and direct erosion by rainwash (especially important in Oregon). The Pleistocene terrace sandstones that form a primary component of the Oregon sea cliffs are only weakly cemented and so are easily eroded away by rainwash and groundwater. The sand so washed away, or that which has dropped from the cliff as a minor landslide, tends to accumulate at the base of the cliff as a tallus pile, sloping toward the sea (Figure 40). Most often the waves are more important in periodically removing this tallus accumulation than in directly attacking the sea cliff itself. The amount of tallus found at the cliff base can give some idea as to the frequency of wave attack in a particular area (Figure 41). A large accumulation, especially one with vegetation growing upon it, indicates that a long period has elapsed since storm waves were able to reach the sea cliffs. This was the case at Taft until the winter of 1977-78 at which time unusually severe winter storms removed the extensive tallus accumulations (Figure 42). A large quantity of drift logs had been removed from the beach fronting Taft, and this too may have played a role in the renewed erosion of the sea cliff.

The absence of any tallus accumulation at the base of the sea cliff indicates a very recent episode of water erosion. Where the fronting beach is narrow, such erosion may occur nearly every winter so only minor tallus accumulations may be found during the summer months. Such areas are generally those that show the maximum rates of overall sea cliff recession. At other areas, Taft being an example, wave attack occurs infrequently and the tallus may accumulate over several years before again being eroded away; such areas generally show smaller rates of cliff recession.



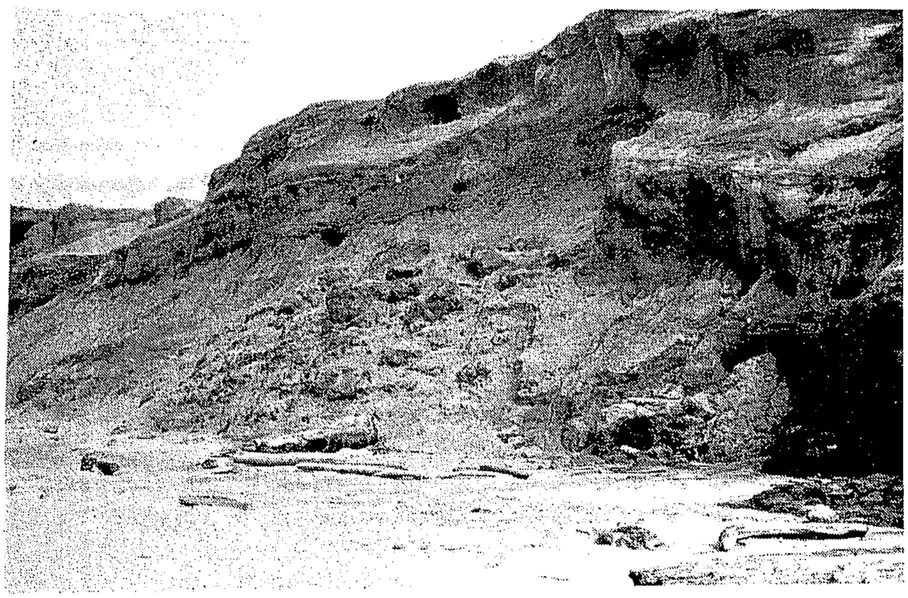


Figure 40. Typical sea cliffs of the Oregon coast formed by erosion of marine terraces. The upper photo shows a thin layer of Pleistocene terrace sands overlying older Tertiary mudstones with an apparent dip to the left. The lower photo, from the Lincoln City area, is a sea cliff composed entirely of terrace sandstones, and is seen to be more susceptible to erosion processes.

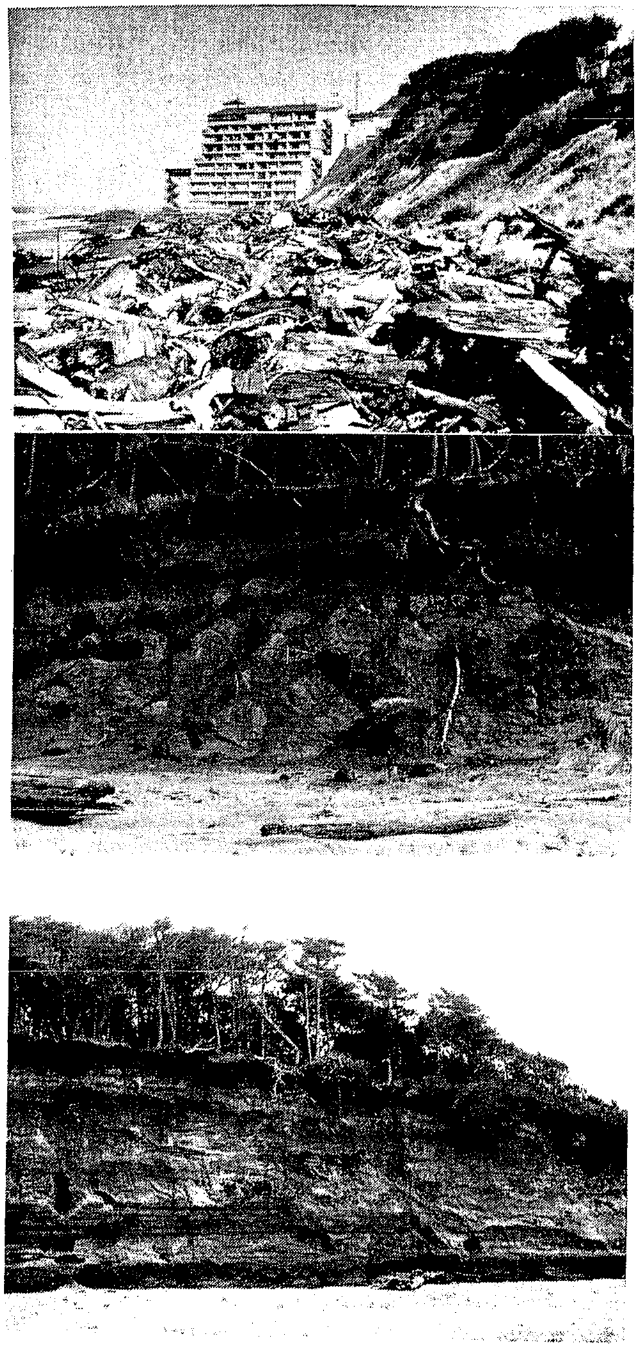


Figure 41. The extent of tallus accumulation at the base of the sea cliff can give some indication of the frequency or recency of wave attack. The upper photo from Taft shows a considerable accumulation with the development of vegetation, indicating an extended period of time since wave erosion, in this case the logs possibly offering some protection (compare with Figure 42 of the same area after erosion during the winter of 1977-78). The middle photo from Gleneden Beach shows a sea cliff with a large tallus accumulation but no vegetation, indicating no wave attack for perhaps 5 to 10 years. The lower photo is from the same area, the severe storms of the winter of 1977-78 having washed away all of the tallus accumulation.

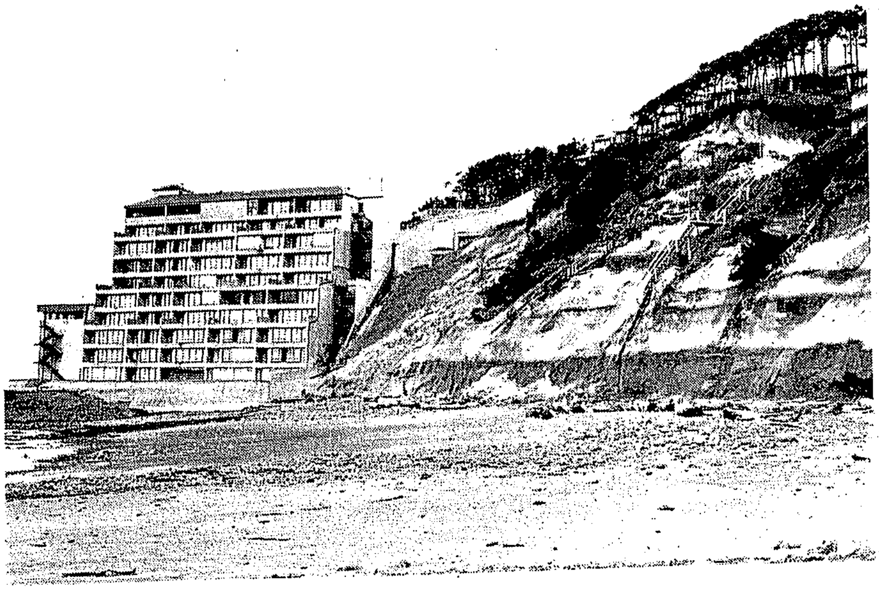
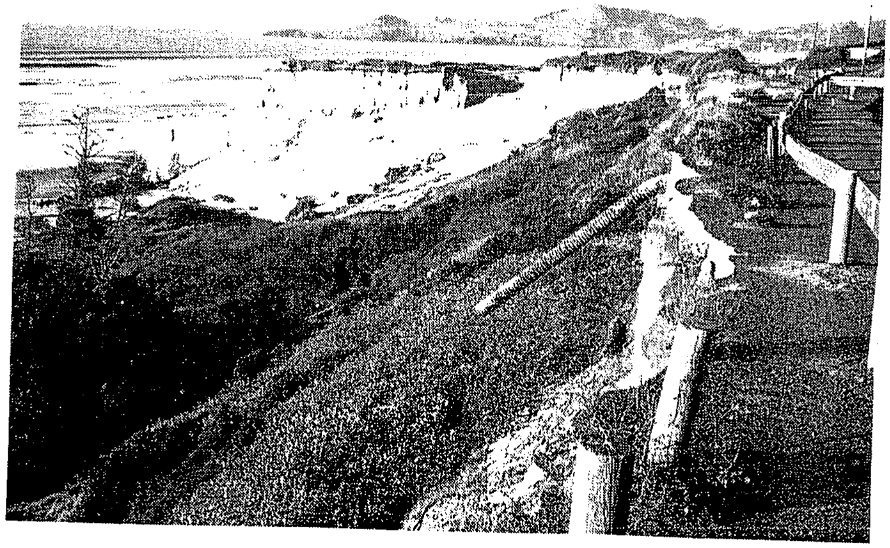


Figure 42. Sea cliff erosion at Taft during the winter of 1977-78. Compare with the first photo of Figure 41 of the same area, noting the loss of logs on the beach and the loss of the vegetated tallus slope.

The presence of the tallus slope offers some support to the sea cliff. Once it is removed landsliding usually quickly follows, responding more to this loss of support than from actual wave undercutting of the cliff. In most areas the landsliding consists of only small sections of the cliff dropping down onto the beach (Figure 43). This minor slumping, together with rainwash and groundwater sapping, produces a slow to moderate progressive retreat of the sea cliff and loss of property.

Figure 43. Small landslides are an important process to sea cliff erosion, especially where the cliff is composed of terrace sandstones.

At times, however, large landslides can occur that suddenly remove several acres of land. Important to their generation is the geometry of the sea cliff, including its height and the orientation of the geologic strata forming the cliff. Large landslides are likely to occur in areas where the older rocks underlying the Pleistocene terrace sands slope in the seaward direction as the sliding of the rock mass can occur along this bedding. Byrne (1964) has estimated that such stratigraphically seaward-dipping terrace deposits are present along more than half of the coastline north of Waldport. One such area is Newport where in 1943 an area of about six acres progressively slid seaward, dropping down 20 feet in the process (Figure 44). More than a dozen homes and other structures were lost, some of which originally had been well back from the cliff edge (North and Byrne, 1965; Stembridge, 1975). Figure 45 summarizes the sea cliff retreat over the years in the Newport area, a retreat brought about mainly by landsliding.



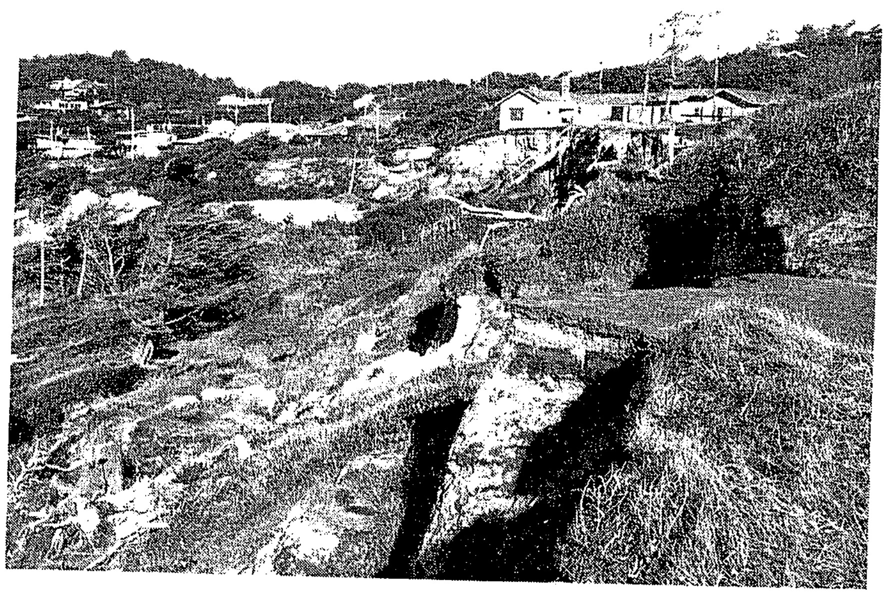


Figure 44. Large landslides in the Jumpoff Joe area of Newport.

Another factor important to the generation of large landslides is the presence of groundwater which lubricates the slide, increases the weight of the material, and may also produce a pore-water pressure. Compiling the occurrences of major landslides as reported in coastal

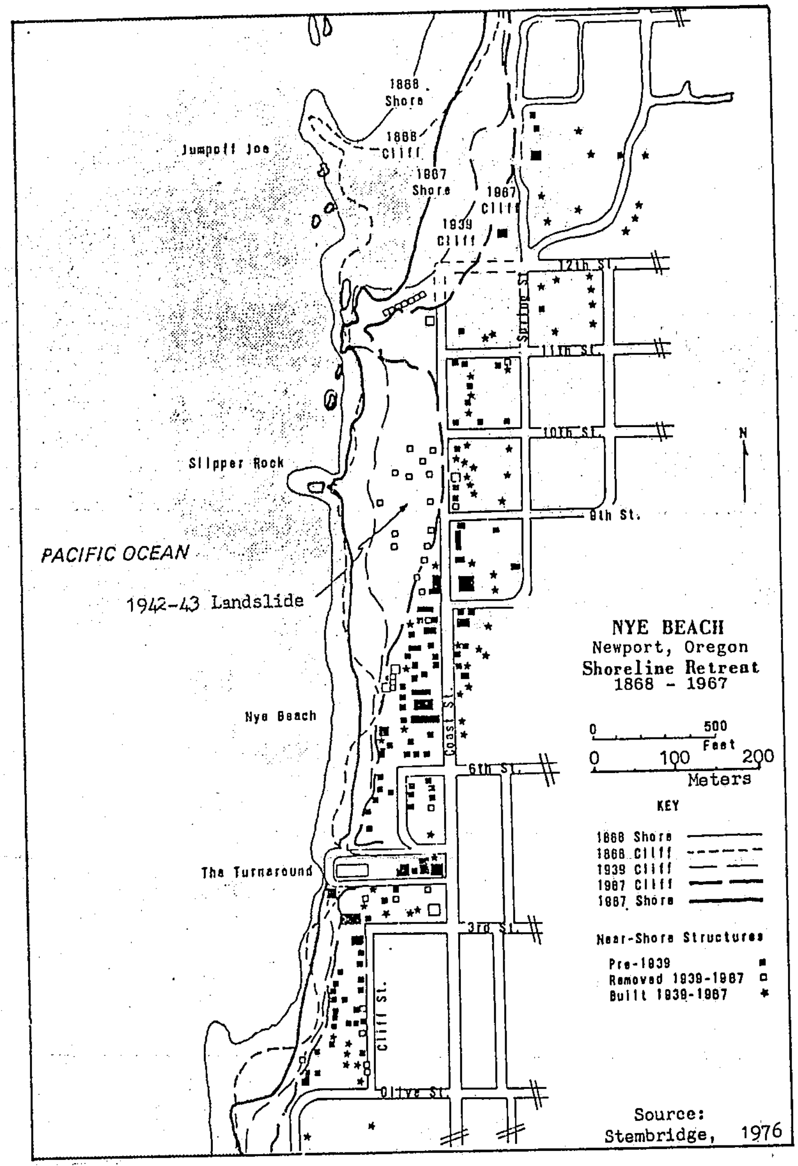


Figure 45. The sea cliff retreat in the Jumpoff Joe area of Newport as documented by Stembridge (1975) from aerial photographs. The property losses here are due almost entirely to large landslides.

newspapers, Byrne (1963) showed that they occur almost exclusively during the months of October through April (Figure 46). Although wave attack may play some role in the winter increase in landsliding, the increased precipitation appears to be more important in that most of the newspaper accounts indicated that sliding occurred during or immediately after extended periods of torrential rains. In more recent years, large landslides appear to have increased in frequency during the summer months rather than being restricted to the winter, probably due to the increased usage of septic tanks which contribute to the ground water at all times of the year.

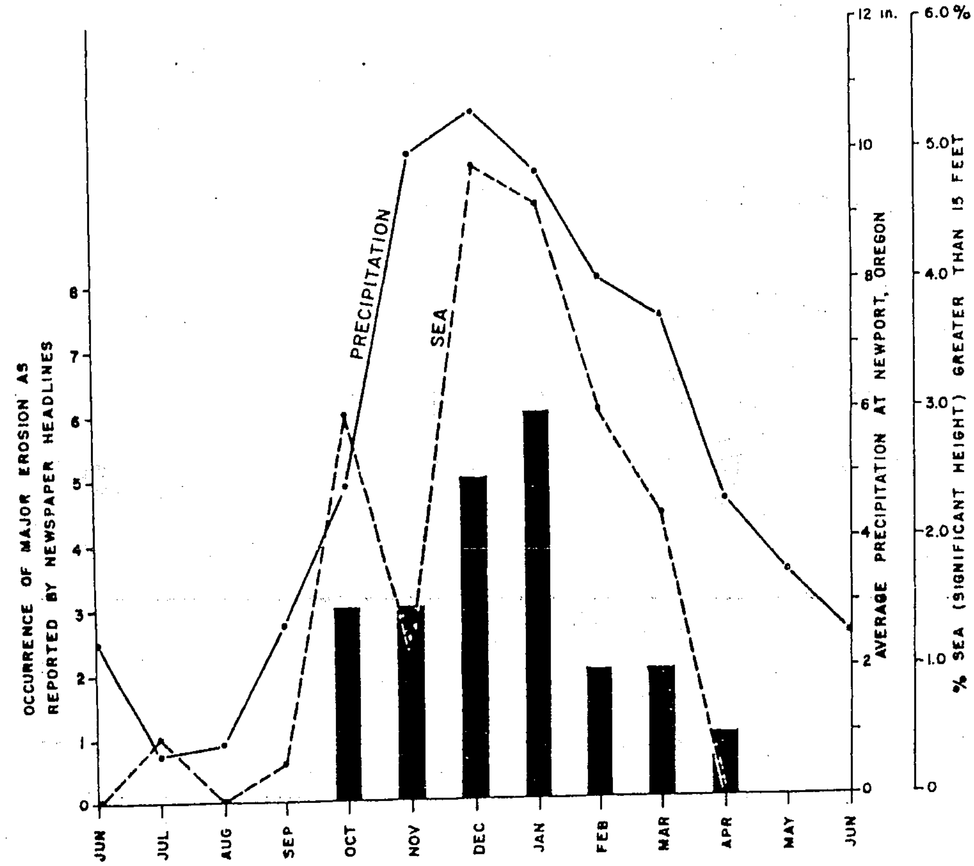


Figure 46. The compilation of landslide occurrences on the Oregon coast from newspaper reports, showing their development during the winter months at times of high precipitation and wave action (from Byrne, 1963).

Large landslides are also important in the headland areas due to the high slopes. The landslides occurring in Ecola State Park are good examples (Schlicker, et al., 1961). Large landslides are particularly common on the flanks of the headlands due to the combination of steep slopes and the presence of loose rock and soil derived from the headland. These areas pose a special problem in that they are often prime sites for housing developments.

Landslides on the Oregon coast have received considerable attention. Byrne (1963), North (1964) and North and Byrne (1965) document landsliding on the northern coast from Florence to the Columbia River. The various reports of the Oregon Department of Geology and Mineral Industries, discuss the hazards from coastal landsliding (for example, Schlicker, et al., 1973). Schlicker (1956) reviews landsliding in general, and Prestedge (1977) discusses the mechanics of landsliding with specific reference to the Oregon coast and the engineering techniques of stabilization.

One additional factor is important to sea cliff erosion--the human factor. Figure 47 illustrates how people can have an impact on the erosion rate by carving graffiti and in some cases even cutting tunnels into the sea cliffs. Considering that natural sea cliff recession rates often amount to only a few inches per year, this human factor cannot be viewed as negligible.

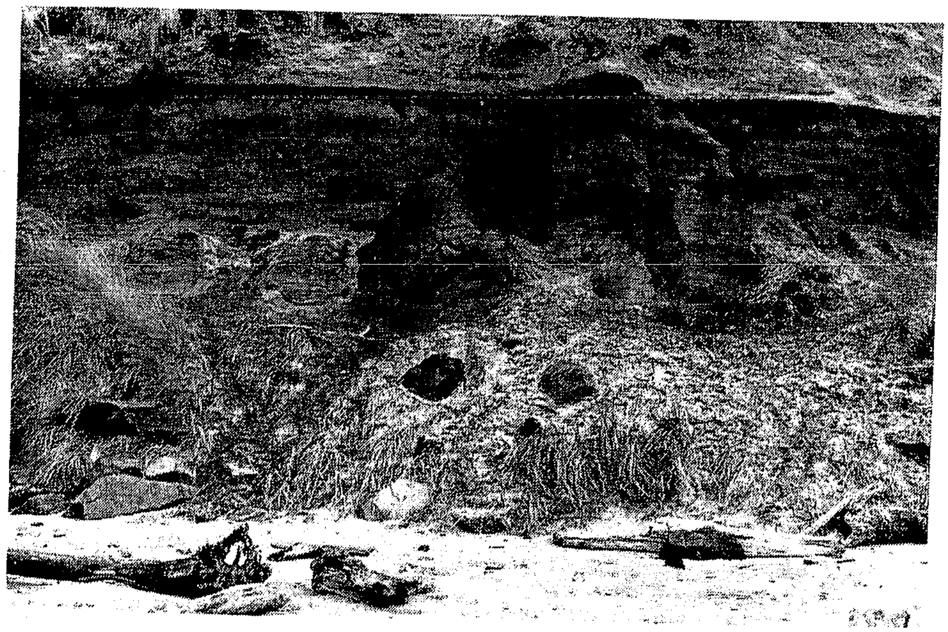


Figure 47. Graffitti carved into a sea cliff at Lincoln City, having a significant effect on the long-term cliff retreat rate.

B. Rates of Sea Cliff Erosion

Of relevance to planning is the long-term recession rate of sea cliffs and the potential for landslides removing large blocks of property in a short time. Landslides have already been discussed, and in most cases their presence or potential is reasonably clear. The progressive recession of sea cliffs is important for determining what distances homes or other structures should be set back from the eroding sea cliff so that they are not destroyed before their anticipated life time of use.

A standard procedure for determining long-term cliff recession rates is through the use of sequences of aerial photographs. There are many difficulties and inherent uncertainties in this procedure so that the amount of erosion measured has to be large if the measured rates are to exceed the uncertainties. This means that the procedure gives best results in areas that have high rates of cliff recession or if there is a very long period of time represented by the available aerial photographs so that even though the rate may be small the total amount of erosion over that period of time is large enough to measure.

The earliest aerial photogaph coverage of substantial stretches of the Oregon coast dates back to 1939. The areas covered by those 1939 photos are diagramed by Stembridge (1975, p. 193). Coverage in the 1940's is scarce, but in the 1950's to the present many more flights were carried out. This forty years of coverage is adequate so long as the cliff recession rates are moderate to high, but if low (less than 2 to 4 inches per year) then the total amount of erosion that has occurred can barely be measured with any certainty by aerial photo techniques.

Stembridge (1975) gives a coast-long summary of the cliff recession rates, based upon the 1939 and 1967 aerial photos and upon field inspections. Table 2 summarizes his estimated erosion rates for backshores of various compositions. The terrace deposits are seen to have a wide range of recession rates, from less than 1 foot per year to greater than 20 feet per year. The large recession rates are found in areas susceptible to landsliding, such as the Jumpoff Joe area of Newport, already discussed. The largest recession rates are for areas of recent sand deposits, the rapid erosion of Bayocean Spit being the primary example (see Section III). Stembridge (1975) does discuss the erosion rates he found for a number of areas along the Oregon coast, as well as presenting the overall summary of Table 2.

Smith (1978) has determined coastal changes for Lincoln County, again using aerial photographs (1939, 1959 and 1973). Erosion rates for that 34-year period range from amounts too low to measure to a maximum of about 240 feet in the Jumpoff Joe area of Newport. The mean amount of erosion was about 20 feet, giving a mean rate of 7.1 inches per year for that 34-year period. Included in that average are some basalt headlands with very low rates of erosion. Excluding those areas from the county-wide average leaves an average of 9.2 inches per year, an average for the coast consisting of sedimentary terraces or unconsolidated materials (the sand spits). Smith found a great deal of variability in recession rates along the Lincoln County coast, so that these averages should not be applied to estimate the recession rate of sea cliffs in some particular area. It would be wise for each county to conduct a study similar to that of Smith (1975) in Lincoln County.

Table 2. Ranges of maximum backshore erosion rates (after Stembridge, 1975)

Backshore Composition	Range of Maximum Erosion (in feet per year)			Examples
Igneous (basalt)	<0.1	to	>0.3	Cape Foulweather, Heceta Head
Metamorphic	<0.1	to	>1.0	
Sedimentary	<0.5	to	>2.0	Cape Kiwanda, Cape Arago
Terrace Deposits	<1.0	to	>20.0	Lincoln City, Jumpoff Joe
Recent Sand Deposits	<10.0	to	>100.0	Bayocean Spit

C. Methods of Sea Cliff Protection

Several methods have been employed on the Oregon coast in attempt to prevent or slow the erosion of sea cliffs. Those most commonly used are riprap and a variety of sea walls. The sea walls may be constructed of concrete or logs; drift logs taken from the adjacent beach are sometimes employed. Groins that project out across the beach to trap part of the littoral sand drift have not been used on Oregon beaches, and probably would not be effective due to the lack of a littoral drift.

All of the protective devices must act to defend the sea cliff from wave attack. In many cases this defense is against only the wave swash rather than the full force of breaking waves. In such cases, a low wall of logs fixed in place at the base of the sea cliff or just in front of the tallus slope is adequate. Great masses of riprap are really needed only where there is severe and direct wave attack. The weight of the riprap does have the added advantage of helping to prevent landsliding as it weights the toe of the cliff. Solid concrete walls have the same effect, but have the disadvantage that they can reflect the wave energy which induces erosion of the beach adjacent to them. This can lead to the undermining of the sea wall and its failure and collapse onto the beach. Log walls and riprap may be partially destroyed by wave attack, but seldom completely fail like a concrete wall.

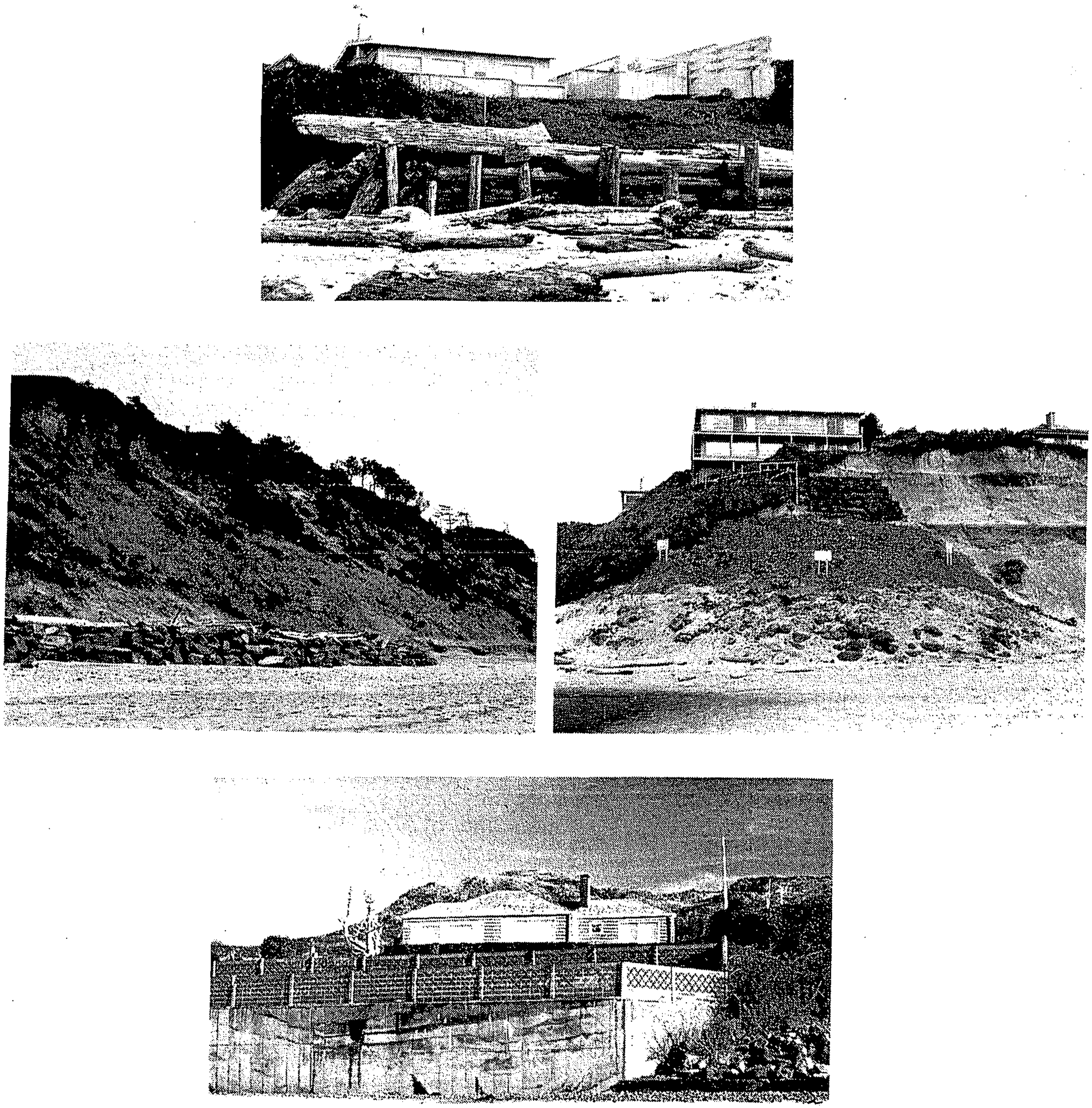


Figure 48. A variety of sea cliff protection approaches have been employed on the Oregon coast, mainly involving log sea walls, concrete sea walls and riprap.

None of these protective schemes completely halt the sea cliff recession unless they extend to the full height of the cliff. If they cover only the base of the cliff, the bare upper portion will continue to suffer some erosion by rain wash and groundwater sapping. This retreat of the top of the cliff will continue until the overall slope of the cliff is decreased, at which time it may become vegetated. But before that stage is reached, the top of the cliff could retreat by several feet, but at a lower rate than before protection was provided to the lower portion of the cliff.

There are arguments against any form of sea cliff protection. First, they can be expensive and would be unnecessary if dwellings were set back an adequate distance from the cliff edge. As discussed in Section II, the erosion of sea cliffs in most cases provides the principal source of sand to the Oregon beaches; cutting off this source by extensive protection will lead to the long-term diminishment of our beaches. And finally, the huge piles of riprap or concrete sea walls can be unsightly, destroying the aesthetic value of the coast that originally attracted people there.

VII. THE COASTAL DUNE SHEETS

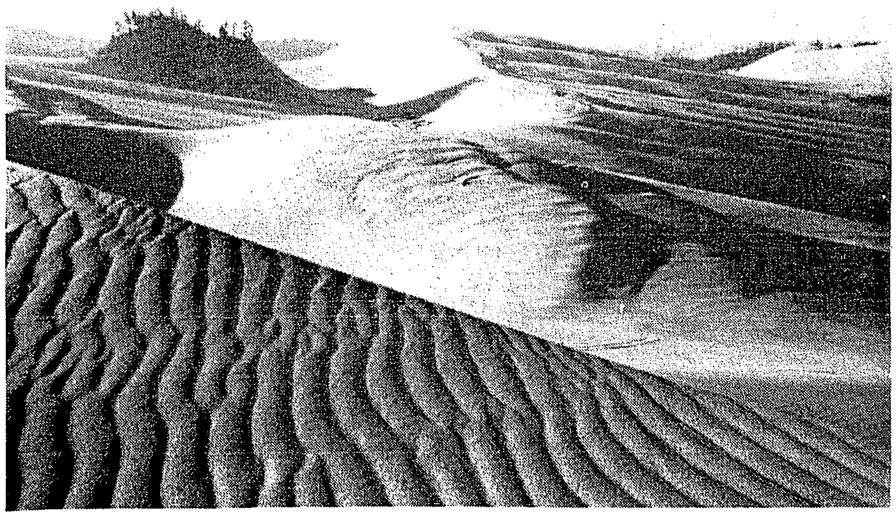
Sections IV and V of this report dealt largely with foredune erosion, whether the foredunes are located on sand spits such as Siletz and Nestucca, or fronting sea cliffs and older dunes as at Cannon Beach (Breakers Point). This section will concentrate instead on the older dunes generally found more inland. It was pointed out in Section II that such dunes, active or vegetated, cover about 45 percent of Oregon's 310 miles of coastline. The best known and most intensely studied is the sheet of active dunes extending for a distance of 55 miles between Coos Bay on the south to Heceta Head near Florence. These dunes and others on the Oregon and Washington coasts were investigated by Cooper (1958), and most of our information on Oregon dunes comes from that source. Later contributions have been made especially by Lund (1973) and various chapters in Dicken (1961). This section will summarize what is known about the physical processes important to dune sand movements on the Oregon coast, the effects of vegetation, and the problems relevant to the management of these areas.

A. Active Dune Types

In his study of the active dunes of the Oregon coast, Cooper (1958) identified two principal types, the transverse-ridge pattern and oblique-ridge pattern (Figure 49). These dune types are somewhat different from those commonly found in deserts and other coastal dune areas.

The transverse-ridge pattern of dunes originally occurred in nearly all the major dune localities on the Oregon coast, but since the introduction of European beachgrass its form has been restricted to the Coos

Bay dune sheet. They are asymmetric in cross-section with windward slopes of 3 to 12 degrees and lee slip faces averaging about 33 degrees, the steepest possible slope for sliding sand. They vary greatly in length; a single ridge may be more than half a mile long. They are not uniform in height, the ridge crest forming a succession of highs and lows.



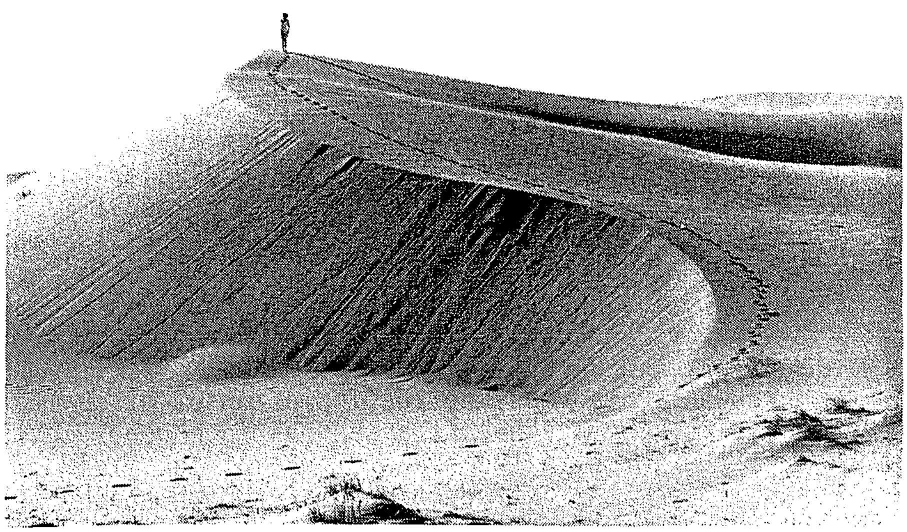


Figure 49. The two active dune types found on the Oregon coast, the transverse-ridge pattern and the oblique-ridge pattern, both now largely confined to the Coos Bay dune sheet. (Lower photo courtesy of Oregon Department of Transportation.)

Cooper has shown (1958, p. 31-33) that the Oregon transverse-ridge dunes are not precisely perpendicular to the controlling northwest summer winds, although they are nearly so. Instead, he found that the transverse-ridges form angles of 11 to 23 degrees to what should be the perpendicular to the wind, facing more to the landward (Figure 50). Presumably the dunes also migrate by this same 11-23 degrees to the left of the wind direction, although Cooper did not demonstrate this to be the case.

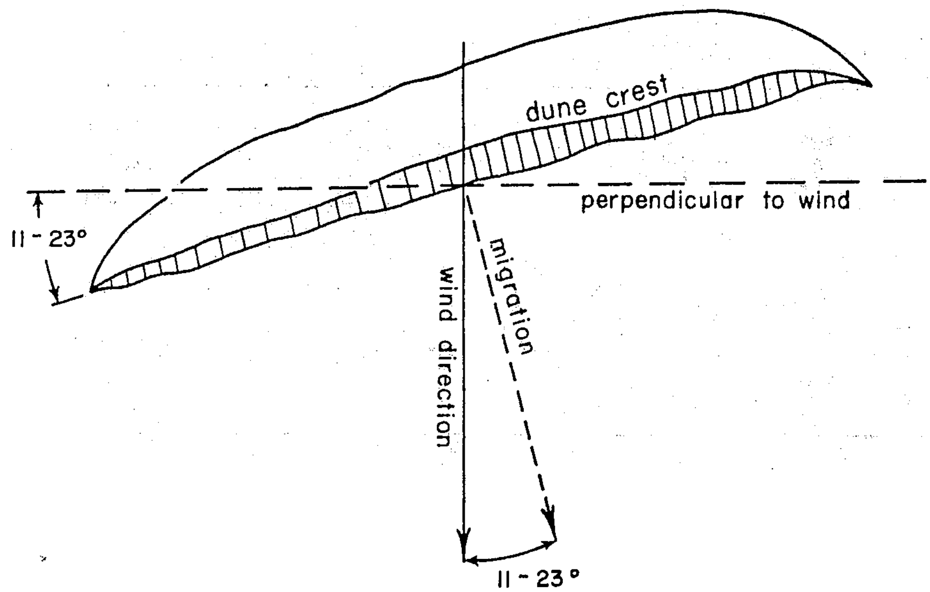


Figure 50. Cooper (1958) has shown that the transverse-ridge dunes do not align exactly perpendicular to the wind direction, instead forming an angle of about 11 to 23 degrees, the dune facing (and migrating) more landward.

Transverse-ridge dunes occupy a strip adjoining the beach or separated from it by foredunes parallel to the shore. Prior to the introduction of European beachgrass and the formation of grass-covered foredunes backing the beaches, transverse-ridge dunes covered the entire area from the beach to the seaward edge of the field of oblique-ridge dunes. Since the introduction of European beachgrass their area has been greatly reduced and continues to shrink. On their inland edge they merge with the field of larger oblique-ridge dunes, the transverse-ridges sometimes climbing up and over the seaward ends of the oblique-ridges. They tend to be smallest near the shore and largest at their inland edge. Average crest to crest distances in fields of transverse-ridge dunes range from 60 to 160 feet.

Cooper (1958) made a few measurements of migration rates of transverse-ridge dunes on the Coos Bay sheet. Measurements were obtained for four dunes with slipfaces over a period of six years. The average rate of advance was 5.2 feet per year, varying from 2.3 to 9.2 feet per year. As expected, most of this advance takes place during the dry summer months of April through August. Also for this reason, the migrations tend to be toward the south to southeast under the north to northwest winds prevailing during those months. Cooper also found that the closer the dunes are to the shore the higher their rates of advance, resulting from the greater wind speeds closer to shore than further inland. He found no correlation between dune height and its rate of advance.

A knowledge of dune migration rates is important in planning measures of dune control or in keeping structures out of the path of an advancing dune. As pointed out by Cooper, his few measurements over a period of six years have to be viewed as the maximum for long-term over-all advance as there may be periods of temporary stabilization with no advancement. Additional study needs to be made of migration rates of these transverse-ridge dunes on the Oregon coast.

The oblique-ridge pattern of dune formation identified by Cooper (1958) occurs only on the Coos Bay dune sheet. They are much larger than the transverse-ridge pattern, forming a series of ridges 4,000 to 5,500 feet in length, aligned with their lengths roughly in an east-west (onshore-offshore) direction (Figure 49). They are highest at a point somewhat shoreward of their landward ends, both in absolute altitude and in height above the immediate base. Cooper measured an average height of 185 feet for ten major dunes. The ridges are spaced rather evenly, particularly at their seaward parts, where the average inter-crest distance ranges between 500 to 650 feet.

On their landward ends the oblique-ridges blend with a ridge of sand that connects them together, the resulting pattern being described by Cooper as a rake, the oblique-ridges forming the teeth of the rake. The connecting ridge is part of the precipitation ridge that has a landward-facing slipface, slowly moving inland and progressively burying the forests that usually lie in the path (Figure 51). This inland advance always appears to be slow (Cooper gives no measurements, however), tending to be somewhat more rapid where the ridge is low.

The oblique-ridge dunes are oriented such that their crests are oblique to both the summer north-northwest winds and to the southwest winds of winter. Most important, they do not migrate, but instead remain fixed in position except for minor shifts with no consistent trend. In cross section the steepest side is usually on the north. During the summer the eroding northern slope is smooth-faced and the south side has a prominant slipface below which is a gentler slope leading to the floor of the adjacent corridor. In most places the windward slope is almost as steep as the slipface. During the summer the oblique-ridge behaves much as a giant transverse-ridge and sand is moved to the southeast. During the winter a slipface of sorts forms on the north side, which is subject to frequent mass slumping, so that even during the winter there is a northward sand transport in the midst of the rain.

Figure 51. A precipitation ridge of the Coos Bay dune sheet migrating slowly landward, burying trees in its path. (Photo courtesy of Oregon Department of Geology and Mineral Industries.)

B. Vegetation Effects

The native flora of the Oregon coast did not provide species capable of building substantial foredunes. Thus prior to the 1940's extensive active dune fields existed, sands blowing inland from the beaches to provide a plentiful supply of sand. In about 1910 European beachgrass (Ammophilia arenaria (L.)) was first brought into the Coos Bay region. European beachgrass took a firm hold and has subsequently spread along the coast producing in many places a prominant foredune where none existed before. These developing foredunes have largely cut off the sand supply from the inland dunes.

The most noticeable effect has been the shrinking of areas covered by transverse-ridge dunes. With the sand supply cut off, the winds erode the dune sands down to the summer groundwater level so that vegetation can quickly take hold. Areas formerly covered by active transverse-ridge dunes have been converted into deflation plains since the 1940's. Comparisons of aerial photos of that period with more recent photos reveal dramatic changes (Figure 52). In places, the areas of open active sand have narrowed by nearly half in 30 years (Lund, 1973).

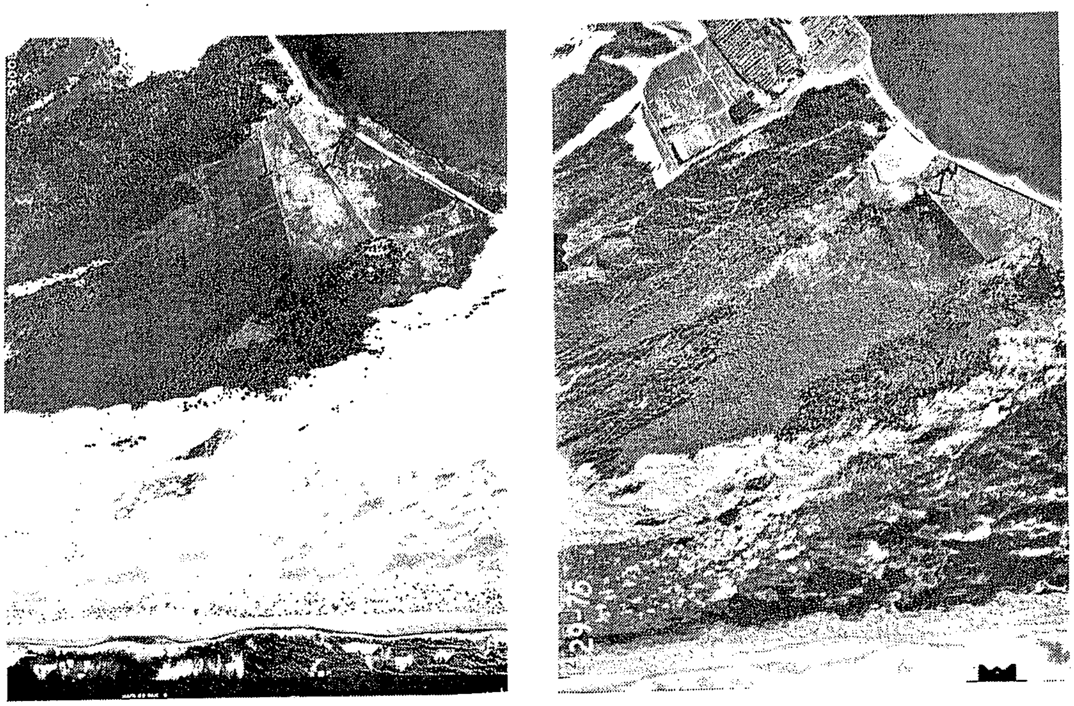


Figure 52. An example of the effects of the introduction of European beachgrass to the Oregon coast at Coos Bay, diminishing the extent of active dune sands and encouraging the formation of foredunes and deflation plains (left - 1939, right - 1975). (Photos courtesy of U.S. Army Corps of Engineers, Portland District.)

C. Older Vegetated Dunes

The active dune fields found on the Oregon coast achieved their present development during the last few thousands of years as the sea rose to its present level. Cooper (1958) discusses the abundant evidence that a similar history of dune development occurred earlier during the Pleistocene, also at times of submergence (times of glacial melting). There appears to have been at least two such episodes of dune formation on the Oregon coast. The dune fields formed during these earlier episodes are now generally well vegetated with forests of pine and spruce and with at least some soil development. They vary considerably in the amount of cementation of the old dune sands beneath the soil cover. Although vegetated forms of transverse-ridge and oblique-ridge dunes cannot be recognized, vegetated precipitation ridges provide good evidence for the landward extent of the old dune fields.

Most of these older dune fields are adjacent to important bodies of modern dunes, indicating that in the earlier cycles, dune development followed processes similar to those of the present fields. Particularly large areas exist to the east of the active Coos Bay dune sheet, especially to the north of Florence and to the immediate north of Coos Bay. Portions of these old forested dunes are also found on sand spits such as Bayocean and Netarts, and in terrace areas such as around Newport. Cooper (1958) provides a series of maps showing the aerial extent of the old vegetated dune fields.

Where these old dune sands are uncemented, removal of the vegetation cover can result in their rejuvenation. Natural examples of this are commonly found adjacent to the beaches where wave erosion cleared some of the dunes of vegetation. This leads to a blowout, removing dune sands from the exposed portion. If the effective wind is unidirectional, then the blowout can develop into a parabola dune, a trough blowout of major size with large terminal and lateral walls. Parabola dunes grow progressively in length in the direction of effective wind, and more slowly in width. According to Cooper (1958, p. 75), most have developed in areas protected from the summer winds and are hence mainly under the influence of the winter's southwest winds. For this reason, most develop northward to northeast. In addition to originating near the beach, a number of parabola dunes have also formed along the margin of the Coos Bay dune sheet. The extensive field of active dune sands to the north of Sand Lake is basically a large parabola dune, the largest on the Oregon coast (Cooper, 1958, p. 75). Although these examples of parabola dunes were formed naturally, man's removal of the vegetation covering the older dunes can similarly bring about rejuvenation and the development of a blowout or parabola dune.

The Clatsop Plain extends from the Columbia River south to Tillamook Head, and is largely covered by a series of vegetated dune ridges. These dune ridges are long linear features extending approximately north-south, roughly parallel to the modern-day beach. Long linear lakes, marshes and creeks occupy the lows between the dune ridges. The vegetation cover of the Clatsop Plain has undergone extensive changes in the last 100-150 years; these changes are documented by Hanneson (1961, p. 85).

Although vegetated, the dunes of the Clatsop Plain are not as old as the other vegetated dunes discussed in this section. They were formed during the last several thousand years as the sea neared its present level. Following sea level rise, the beach built out and the dune ridges developed on the accreting land, formed by the abundant sand supplied by the Columbia River. Cooper (1958, p. 123-6) recognizes three stages of progradation on the basis of three groups of ridges. Shoreline advance appears to be continuing, although the picture has been somewhat complicated by the construction of the jetties at the mouth of the Columbia. Dicken (1961, p. 73) calculated, for example, that the maximum growth of the beach between 1944 and 1960 was about 500 feet, some 30 feet per year. As discussed in Section V, the excess of sand at Seaside has resulted in problems with blowing sand, and several hundred thousand cubic yards of sand have been removed from the Seaside beach since 1960 (Stembridge, 1975, p. 45).

Beneath their vegetative cover, the dune sands of the Clatsop Plain are loose. As already discussed for the older dunes of the Oregon coast, removal of the vegetation cover can lead to blowouts and dune rejuvenation.

REFERENCES CITED

Aguilar-Tunon, N. A., and P. D. Komar. 1978. "The Annual Cycle of Profile Changes of Two Oregon Beaches." The Ore Bin. Department of Geology and Mineral Industries, Portland, Oregon. 40(2):25-39. 14 pp.

Bowen, A. J., and D. L. Inman. 1966. Budget of Littoral Sands in the Vicinity of Point Arguello, California. U.S. Army Coastal Engineering Research Center Technical Memo No. 19. Fort Belvoir, Virginia. 56 pp.

Byrne, J. V. 1963. "Coastal Erosion, Northern Oregon." Essays in Marine Geology in Honor of K. O. Emery. University of Southern California Press, Los Angeles, California. (11-33). 24 pp.

Byrne, J. V. 1964. "An Erosional Classification for the Northern Oregon Coast." Association of American Geographers Annals. Chicago, Illinois. 54:329-335. 7 pp.

Cooper, W. S. 1958. Coastal Sand Dunes of Oregon and Washington. Geological Society of America, Memoir 72. Waverly Press, Inc., Baltimore, Maryland. 169 pp.

Creech, H. C. 1977. "Five Year Climatology (1972-1976) of Nearshore Ocean Waves Off Yaquina Bay, Oregon." Oregon State University Sea Grant Program Ref. ORESU-T-27-011, Corvallis, Oregon. 17 pp.

Dicken, S. N. 1961. Some Recent Physical Changes of the Oregon Coast. Office of Naval Research Contract Nonr-2771(04), Department of Geography, University of Oregon, Eugene, Oregon. 151 pp.

Hamilton, Stanley F. 1973. "Oregon Estuaries." Oregon Division of State Lands, Salem, Oregon. 49 pp.

Hanneson, Bill. 1961. "Vegetation Changes of the Oregon Coastal Dunes." Some Recent Physical Changes of the Oregon Coast. Office of Naval Research Contract Nonr-2771(04), Department of Geography, University of Oregon, Eugene, Oregon. (77-99) 23 pp.

Hicks, S. D. 1972. "On the Classification and Trends of Long Period Sea Level Series." Shore and Beach. American Shore and Beach Preservation Association, Miami, Florida. 40(1):20-23. 4 pp.

Komar, P. D. 1976. Beach Processes and Sedimentation. Prentice-Hall, Inc. Englewood Cliffs, New Jersey. 429 pp.

Komar, P. D. 1977. "Beach Profiles Obtained with an Amphibious DUKW on the Oregon and Washington Coasts." The Ore Bin. Department of Geology and Mineral Industries, Portland, Oregon. 29(11):169-180. 12 pp.

Komar, P. D. 1978. "Wave Conditions on the Oregon Coast During the Winter of 1977-78 and the Resulting Erosion of Nestucca Spit." Shore and Beach. American Shore and Beach Preservation Association, Miami, Florida. 46(4):3-8. 6 pp.

Komar, P. D. and C. C. Rea. 1976. "Erosion of Siletz Spit, Oregon." Shore and Beach. American Shore and Beach Preservation Association, Miami, Florida. 44(1):9-15. 7 pp.

Komar, P. D., J. R. Lizarraga, and T. A. Terich. 1976a. "Oregon Coast Shoreline Changes Due to Jetties." Journal of Waterways, Harbors and Coastal Engineering Division. American Society of Civil Engineers, New York, New York. 102(WW1) Paper 11933:13-30, 18 pp.

Komar, P. D., W. Quinn, H. C. Creech, C. C. Rea, and J. R. Lizarraga-Arciniega. 1976b. "Wave Conditions and Beach Erosion on the Oregon Coast." The Ore Bin. Department of Geology and Mineral Industries, Portland, Oregon. 38(7):103-112. 10 pp.

Komar, P. D. and B. A. McKinney. 1977. "The Spring 1976 Erosion of Siletz Spit, Oregon, with an Analysis of the Causative Storm Conditions." Shore and Beach. American Shore and Beach Preservation Association, Miami, Florida. 45(3):23-30. 8 pp.

Kulm, L. D. and J. V. Byrne. 1966. "Sedimentary Response to Hydrology in an Oregon Estuary." Marine Geology. Elsevier Publishing Company, Amsterdam. 4:85-118. 34 pp.

Lund, E. H. 1973. "Oregon Coastal Dunes Between Coos Bay and Sea Lion Point." The Ore Bin. Department of Geology and Mineral Industries, Portland, Oregon. 35(5):73-92. 20 pp.

McKinney, B. A. 1977. "The Spring 1976 Erosion of Siletz Spit, Oregon, With an Analysis of the Causative Wave and Tide Conditions." M.S. Thesis. School of Oceanography, Oregon State University, Corvallis, Oregon. 66 pp.

North, W. B. 1964. "Coastal Landslides in Northern Oregon." M.S. Thesis, Oregon State University, Corvallis, Oregon. 85 pp.

North W. B. and J. V. Byrne. 1965. "Coastal Landslides in Northern Oregon." The Ore Bin. Department of Geology and Mineral Industries, Portland, Oregon. 27(11):217-241. 25 pp.

Prestedge, G. K. 1977. "Stabilization of Landslides Along the Oregon Coast." Engineering Report, Department of Civil Engineering, Oregon State University, Corvallis, Oregon. 53 pp.

Twenhofel, W. H. 1946. "Mineralogical and Physical Composition of the Sands of the Oregon Coast from Coos Bay to the Mouth of the Columbia River." State of Oregon, Department of Geology and Mineral Industries, Bulleting No. 30, Portland: Oregon. 64 pp.

Wentworth, C. K. 1922. "A Scale of Grade and Class Terms for Clastic Sediments." Journal of Sedimentary Petrology. Society of Economic Paleontologists and Mineralogists, Tulsa, Oklahoma. 30:377-392. 16 pp.

Wilson, B. W. and Alf Torum. 1968. "The Tsunami of the Alaskan Earthquake, 1964: Engineering Evaluation." U. S. Army Corps of Engineers Coastal Engineering Research Center Technical Memo No. 25, Fort Belvoir, Virginia. 401 pp. + appendices.

Rea, C. C. 1975. "The Erosion of Siletz Spit, Oregon." M.S. Thesis School of Oceanography, Oregon State University, Corvallis, Oregon. 105 pp.

Rea, C. C. and P. D. Komar. 1975. "The Erosion of Siletz Spit, Oregon." Reference 75-4, School of Oceanography, Oregon State University, Corvallis, Oregon. 105 pp.

Rosenfeld, Charles. Perronal Communication. 1979. Assistant professor, Geography Department, Oregon State University, Corvallis, Oregon.

Schatz, C. 1965. "Source and Characteristics of the Tsunami Observed Along the Coast of the Pacific Northwest on 28 March 1964." M.S. Thesis, Department of Oceanography, Oregon State University, Corvallis, Oregon. 39 pp.

Schatz, C. E., H. Curl, and W. V. Burt. 1964. "Tsunamis on the Oregon Coast." The Ore Bin. Department of Geology and Mineral Industries, Portland, Oregon. 26(12):231-232. 2 pp.

Schlicker, H. G. 1956. "Landslides." The Ore Bin. Department of Geology and Mineral Industries, Portland, Oregon. 18(5):39-43. 5 pp.

Schlicker, H. G., R. E. Corcoran, and R. G. Bowen. 1961. "Geology of the Ecola State Park Landslide Area, Oregon." The Ore Bin. Department of Geology and Mineral Industries, Portland, Oregon. 23(9):85-90. 6 pp.

Schlicker, H. G., R. J. Deacon, G. W. Olcott, and J. D. Beaulieu. 1973. Environmental Geology of Lincoln County, Oregon. Department of Geology and Mineral Industries, Bulletin 81, Portland, Oregon. 121 pp.

Smith, E. C. 1978. "Determination of Coastal Changes in Lincoln County, Oregon, Using Aerial Photogaphic Interpretation." Research Paper, Department of Geography, Oregon State University, Corvallis, Oregon. 29 pp.

Stembridge, J. E. 1975. "Shoreline Changes and Physiographic Hazards on the Oregon Coast." PhD Dissertation, Department of Geography, University of Oregon, Eugene, Oregon. 202 pp.

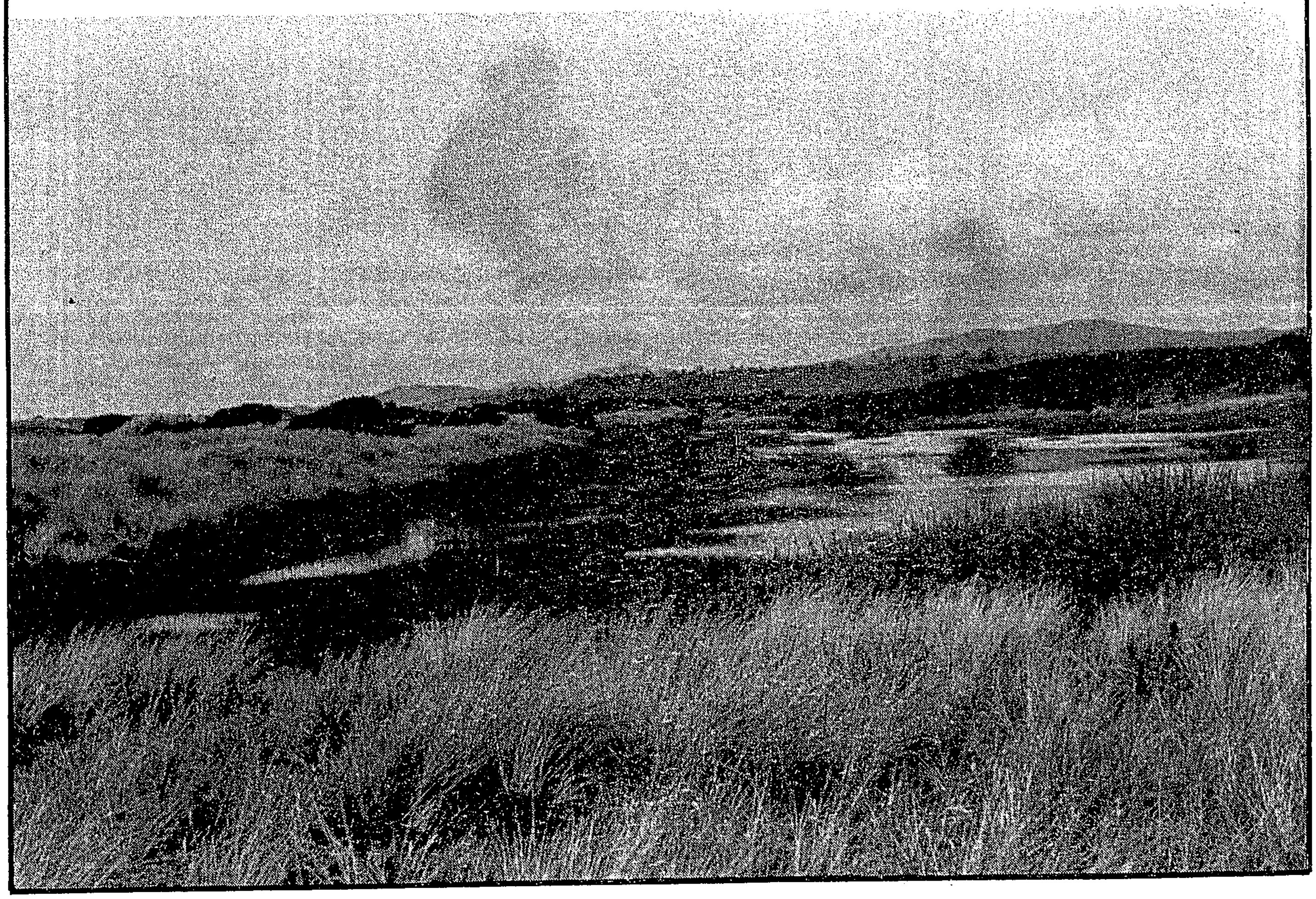
Terich, T. A. 1973. "Development and Erosion of Bayocean Spit, Tillamook." PhD Thesis, Department of Geography, Oregon State University, Corvallis, Oregon. 145 pp.

Terich, T. A., and P. D. Komar. 1974. "Bayocean Spit, Oregon: History of Development and Erosional Destruction." Shore and Beach. American Shore and Beach Preservation Association, Miami, Florida. 42(2):3-10. 8 pp.

Dune Groundwater

Planning & Management Considerations

For The Oregon Coast



Oregon Coastal Zone Management Association, Inc.

This report was prepared as part of a larger document addressing various beach and dune planning and management considerations and techniques. Other segments of the document and additional materials are:

I. BACKGROUND ON BEACH AND DUNE PLANNING:

Background of the Study

An Introduction to Beach and Dune Physical and Biological Processes

Beach and Dune Planning and Management on the Oregon Coast: A Summary of the State-of-the-Arts

II. BEACH AND DUNE IDENTIFICATION:

A System of Classifying and Identifying Oregon's Coastal Beaches and Dunes

III. PHYSICAL AND BIOLOGICAL CONSIDERATIONS:

Physical Processes and Geologic Hazards on the Oregon Coast

Critical Species and Habitats of Oregon's Coastal Beaches and Dunes

IV. MANAGEMENT CONSIDERATIONS:

Dune Groundwater Planning and Management Considerations for the Oregon Coast

Off-road Vehicle Planning and Management on the Oregon Coast

Sand Removal Planning and Management Considerations for the Oregon Coast

Oregon's Coastal Beaches and Dunes: Uses, Impacts and Management Considerations

Dune Stabilization and Restoration: Methods and Criteria

V. IMPLEMENTATION TECHNIQUES:

Beach and Dune Implementation Techniques: Findings-of-Fact

Beach and Dune Implementation Techniques: Site Investigation Reports

*Beach and Dune Implementation Techniques: Model Ordinances**

VI. ANNOTATED BIBLIOGRAPHY:

Beach and Dune Planning and Management: An Annotated Bibliography

VII. EDUCATIONAL MATERIALS:

Slide show: *Managing Oregon's Beaches and Dunes*

Brochure: *Planning and Managing Oregon's Coastal Beaches and Dunes*

*Prepared under separate contract between Oregon Department of Land Conservation and Development and the Bureau of Governmental Research, Eugene.

Cover photo by Christianna Crook, Newport, Oregon.

DUNE GROUNDWATER PLANNING AND MANAGEMENT CONSIDERATIONS

FOR THE OREGON COAST

by

Christianna Stachelrodt Crook, Research Associate

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PREFACE

The following report presents the results of an overview of groundwater planning and management considerations necesssary in beach and dune areas as conducted by the Oregon Coastal Zone Management Association, Inc. This report constitutes one element of an overall analysis of planning for, and managing, coastal beaches and dunes as required by Oregon's Beaches and Dunes Goal.

This report was prepared by Christianna Crook, OCZMA Beaches and Dunes Study Team Research Associate, with assistance from other Study Team members composed of Carl Lindberg, Project Director, Wilbur Ternyik, Project Coordinator, Arlys Bernard, Project Secretary and Kathy Fitzpatrick, Project Administrator.

In addition, valuable review and comments were made by the Beaches and Dunes Steering Committee composed of:

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Additionally, OCZMA extends appreciation to Emmett Dobey, former Lincoln County Sanitarian (presently Planning Director, City of Lincoln City), and Don Bramhall, North Coast Senior Sanitarian for the Oregon Department of Environmental Quality. Special thanks is expressed to James Luzier, Hydrologist with the USGS Water Resources Division, Portland, for his timely review and constructive comments on this report.

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I. SAND DUNE GROUNDWATER CHARACTERISTICS

Groundwater is that water beneath the earth's surface which is contained in pore spaces within the soil and rock. It is critical to acquire an adequate picture of groundwater characteristics before developing areas underlain by immense quantities of sand such as those which exist along the Oregon coast. Sand deposits are comparatively porous and thus downward percolation is quite rapid. Because of that potential, hazards associated with the development of this region include, for example, drawdown, saltwater intrusion and surface and groundwater pollution.

Groundwater exists as a large coherent body of water (or aquifer) which underlies dune sands. The boundaries of the groundwater are formed by underlying bedrock and relatively impervious terrace deposits, bedrock margins exposed at the surface (i.e. the basal western slopes of the Coast Range), and the ocean to the west, (see Figure 1). Impermeable silt and clay lenses are found within the deeper parts of the sand deposits which oftentimes restrict the vertical movement of water.

The top surface of the zone of groundwater is the water table. The general shape of the water table is a subdued replica of the land surface. It is farthest from the surface under the larger oblique-ridge dunes and closest at topographic lows. Most surface water (lakes, streams and marshes) is a surface expression of this water table occurring where the land surface dips to intersect the water table. Locally, "perched" water tables may exist. These are created by discontinuous bodies of impermeable materials located beneath the land surface but higher than the main water table. This impermeable layer catches and holds the water reaching it from above. On the western margin of the aquifer, the position of the freshwater/saltwater margin is not clearly understood but it most commonly appears to extend somewhat seaward of the beach.

The water table reflects a seasonal variation, being higher in the winter recharge months and lower in the summer. Recharge of dune aquifers occurs primarily from infiltrating precipitation. It is estimated that fully 75 to 80 percent of the 50 to 70 inches of annual precipitation received on the Oregon coast reaches the groundwater. The remainder is lost through surface runoff in streams, evaporation and plant use. Most of the groundwater eventually seeps directly into the ocean under the beach. Locally, lesser amounts enter lakes and streams especially during recharge months. Throughout the year the interaction between the lakes, streams and the water table appears to be one of mutual dependence. During summer months the water table may be lowered from three to ten feet, at which time it appears that lakes may discharge water back to the water table.

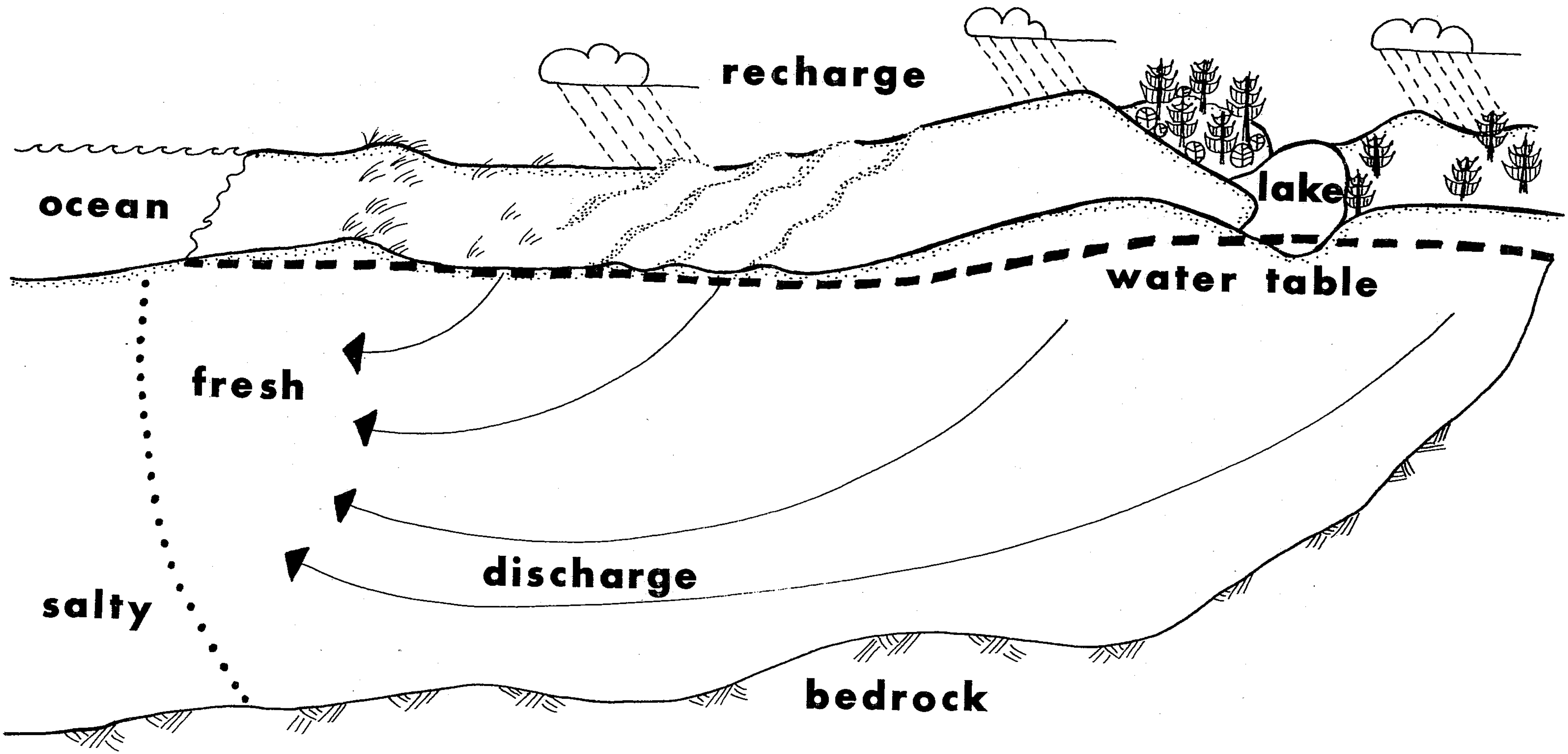


Figure 1. Schematic illustration of groundwater interactions common to coastal beach and dune areas indicates the cycle of discharge and recharge and the confines of groundwater between bedrock and the surface (source: U.S.G.S. unpublished materials).

Three larger dune areas, the Clatsop Plains and the Florence and Coos Bay dune sheets, appear to possess complete groundwater flow systems. That is the groundwater flow operates as an exclusive unit within the sand deposit and has little or no interaction with groundwater outside its own boundaries. A system may contain more than one subbasin. Groundwater moves relatively slowly both down gradient and from recharge to discharge zones. Rate of flow varies from site to site but is estimated to be five to seventeen feet per day in the Clatsop dune aquifer (Sweet, 1977, p. 11).

The chemical quality of the groundwater is generally good except for local problems with acidity. At a number of sites, high levels of dissolved iron and nitrate-nitrogen concentrations exist. These result naturally from chemical activities associated with the decomposition of vegetation in bog and marsh areas (Sweet, p. 16 and 18; Luzier, 1978).

II. GROUNDWATER HAZARD TYPES

Hazards and problems associated with the dune groundwater include high water table, ponding, saltwater intrusion, water table drawdown and pollution. It should be pointed out that hazards exist only in relation to man's use of a site. Any sites suspected of exhibiting hazard characteristics should be further investigated in light of the projected use for the area.

A. High Water Table

A high water table technically occurs at any surface intersection of the groundwater such as a lake, stream or marsh. However, those high groundwater areas associated with hazard are most commonly sites of extremely flat topography or depressions which contain water only part of the year. These sites exhibit standing water anywhere from a few weeks to eight months or more. They may be recognized in the drier summer months by the presence of such features as marshy ground, reeds, marsh grasses, soil with a high organic content and a black to gray or blue-gray color, sometimes accompanied by a strong organic aroma.

1. Potential sites

Those sand dune landforms most susceptible to the incidence of high water table problems include:

a. All deflation plains

This includes both the presently "active" forms which are situated on the lee side of the foredune and the historically active forms which are now found considerably inland from the present foredune area. These exhibit a flat surface topography, are usually forested and the water table is at or near the surface most of the year.

b. The border zone between the deflation plain and interior dunes

Both interior hummock dunes and transverse-ridge dunes irregularly interface with the deflation plain on their western border. These sites would be susceptible to high water table problems in their basal portions. They can often be recognized by the presence of marsh vegetation or surface water between dunes.

c. The fringes of mostly permanent waterbodies

The areas surrounding intersections of the groundwater table are likely to possess high water table levels themselves. This is because: (1) the water table follows the general slope of the land, (2) it fluctuates during the year and (3) because the area may be subject to flooding.

d. Occasionally wet interdune area

This includes topographic lows between dunes of any form but primarily the larger oblique-ridge and the commonly forested surface-stabilized and older stable dunes. These may exhibit mottled gray-blue soils and/or marsh vegetation.

2. Potential impacts and management techniques

Developmental activities in areas of seasonally high groundwater can incur such impacts as the flooding of surface and subsurface facilities, flotation and failure of buoyant buried structures such as pipelines and septic tanks, differential settlement of larger structures, construction and excavation difficulties, surface and groundwater contamination, destruction of valuable fish and wildlife habitat, and heightened earthquake impact.

In order to avoid such problems, certain development criteria should be adhered to. Developments should be restricted to those forms of land use which are either compatable with the characteristics of the site or which can be built to provide adequate safety and minimize impacts on the water resources. Structures, roads and sewage disposal systems should be set well above the winter high water table and well back from any water bodies. The alteration of wetlands by dredging or filling should be avoided where possible in order that the system's unique productivity and water retention capabilities will not be diminished.

Engineering studies should be undertaken particularly for any linear developments, such as pipelines and roads, which must span high water table areas. The use of pilings and drainage tiles and culverts are commonly recommended in such areas.

B. Ponding

Ponding occurs in low, poorly drained sites where excess precipitation or flood waters accumulate. Topographic restrictions and/or poor soil and bedrock permeability disallow runoff or infiltration at these sites. The result is standing water which is not necessarily associated with the local groundwater table. Ponding can be identified by the local accumulation of rain or flood waters. It can be differentiated from high water table because no lag time is involved between precipitation and accumulation and because other sites susceptible to normal high water table may not possess standing water. Although water commonly moves fairly rapidly through sand, local soil development, surface or subsurface impermeable lenses (clays or bogs), or extremely high water table could reduce infiltration. These sites may contain marsh grasses and blue-gray mottled soils.

1. Potential sites

a. Foredune/deflation plain

Some special ponding problems may occur here which involve some degree of interaction between these two landforms. Many deflation plains contain valuable freshwater marshes. Any breaching of the foredune, whether natural or man induced, may allow flooding from ocean storms to reach the marsh. The addition of saltwater could have damaging effects on the freshwater habitat particularly if the breaching allows for frequent flooding. Furthermore, particularly severe ponding in the deflation plain may cause breaching of the foredune from the inland side. Breaching from the landward side may be caused by saturation, from hydrostatic pressure, or overflow at a lowspot in the foredune. This can lead to further erosion and limit the protective capacities of the foredune.

b. Interdune and other low lying sites

Any low lying site commonly susceptible to high groundwater may develop ponding problems when the water table is too high to allow infiltration of excess water. Also those interdune areas which possess soils, particularly marsh or bog soils which may contain clays and other relatively impervious materials, could develop ponding conditions.

c. Surface stable dune and older stable dune

These dunes are susceptible to the effects of ponding because they are often underlain by relatively impermeable iron bands or older buried soils. In addition to other ponding impacts, slope failure can occur in this landform particularly when saturated strata have been bisected.

2. Potential impacts and management techniques

In addition to many of the impacts resulting from a high water table, ponding can lead to serious flooding of surface structures and habitats. Damage to subdivisions in low-lying areas, airport runway safety hazards, slope failure and possible habitat degradation could result from ponding. Those activities which would dam waterways, alter drainage routes, compact the soil surface or otherwise significantly reduce infiltration rates (i.e. blacktopping) can increase the ponding hazard.

Proper design, engineering and building techniques can avoid many problems here. Large scale developments which could have wide ranging impacts, particularly if proposed for flat or low-lying areas, merit special attention. Landfills, septic tanks or other subsurface structures should not be permitted without a thorough engineering review. There is a high possiblity of contamination of surface and groundwaters from septic tank failure resulting from ponding. The use of dikes and levees to prevent flooding along riverways should be considered carefully as these devices can prevent the natural runoff of rain and floodwaters. The use of ditches, drain tiles, floodgates and building on pilings may improve the potential for development in such sites.

C. Saltwater Intrusion

The intrusion of saltwater into the groundwater occurs when the hydrostatic pressure (head) from fresh groundwater sources is insufficient to keep the marine water at bay. As already mentioned the position of the saltwater/freshwater interface is not known for all sites along the coast. Where it has been investigated under the larger dune sheets, the interface most commonly extends slightly seaward of the beach (Sweet, p. 12; U.S. Forest Service, 1972, p. 14; USGS, unpublished). It also appears to maintain a fairly vertical slope to some depth as even those exploratory wells behind the foredune have drawn no saltwater (U.S. Forest Service, p. 14).

Areas which do not capture enough precipitation to maintain sufficient head against the marine water may be underlain by saltwater. Because freshwater is less dense than saltwater, it may form a lens which overlies the saltwater in such sites. Sand spits, because they possess so little recharge area and are nearly surrounded by marine and brackish waters, may be potential sites for this groundwater pattern.

1. Potential sites

The sites most susceptible to saltwater intrusion are sand spits and the thinner beach and dune strips which possess more marginal water supplies. Although those spits underlain by sand to a considerable depth usually contain good groundwater supplies, the lack of recharge in the summer months when water is most in demand by summer residents could be potentially hazardous. The deeper, westernmost wells would be the first to experience saltwater intrusion. With overdevelopment of groundwater resources, saltwater could intrude some distance even into the dune sheet regions.

2. Potential impacts and management techniques

Overdevelopment of the groundwater resources could lead to encroachment of saltwater into this resource. The impacts of saltwater intrusion can result in permanent or temporary pollution of the freshwater supply, loss of freshwater dependent vegetation and habitat, corrosion of pumping facilities and the added cost of providing new water supplies to developed areas.

All dune areas for which groundwater withdrawal is being considered should have adequate hydrological studies conducted to determine the amount of groundwater required to provide protection against saltwater intrusion and any secondary effects. Some surveys have been produced for the major sandsheet areas along the Oregon coast and others are currently underway (see Appendix A).

Monitoring of the groundwater head and water quality at shoreline sites could provide prompt information on any changes in the freshwater/saltwater interface.

D. Drawdown

Drawdown is the resultant lowering of the water table level from well pumping. Given homogenous materials, the water table will drawdown in a cone shape surrounding the well or wells (see Figure 2). Extended development and pumping in an area can result in general lowering of the regional water table. The pattern of groundwater reduction is complicated in the deeper sands of the dune sheets because they are commonly interspersed with less permeable lenses of clay and silty materials. Groundwater at depth tends to flow seaward laterally through these lenses (see Figure 3). Thus pumping here may not lower the water table in the immediate vicinity but rather in an adjacent region up gradient.

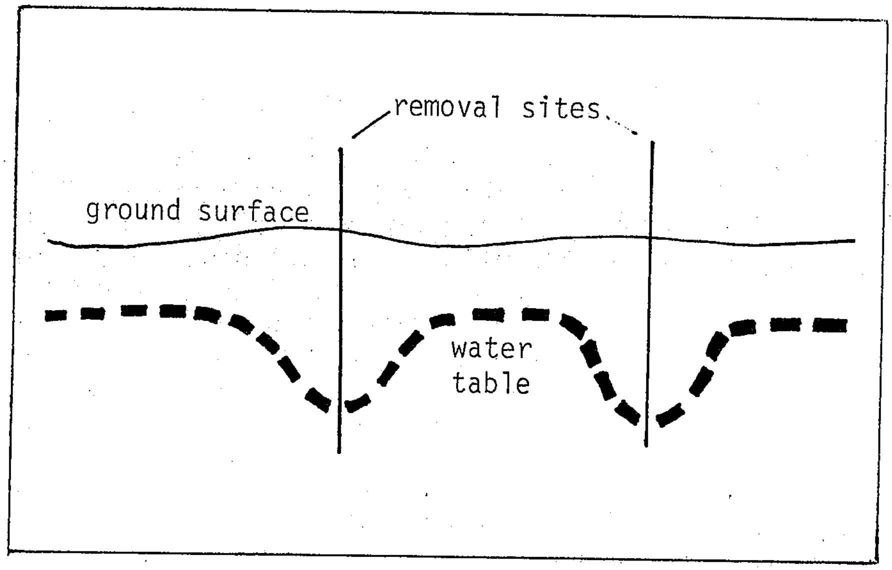


Figure 2. Generally, water withdrawn from the groundwater supply will result in cone-shaped depressions surrounding the removal site.

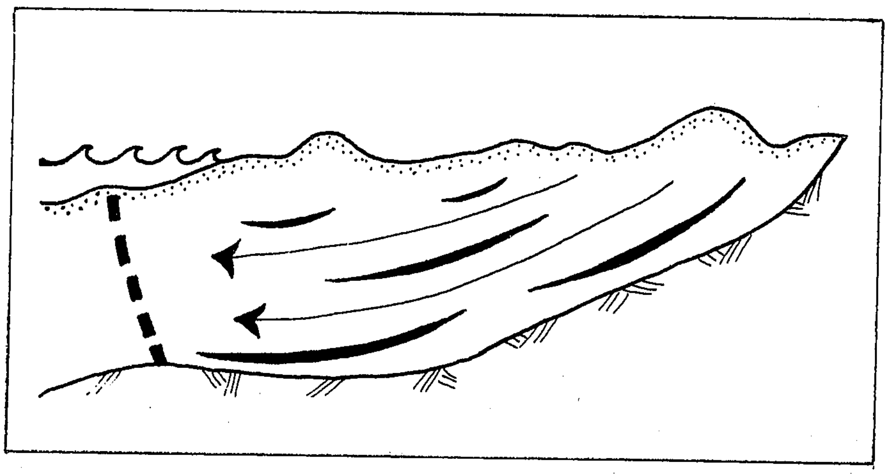


Figure 3. Impermeable lenses of clay and silty materials may direct the seaward flow of groundwater laterally.

1. Potential sites

Naturally all areas are potentially subject to drawdown. Critical areas would include recreational lakes, areas of stabilizing vegetation and those with little recharge.

2. Potential impacts and management techniques

The hydrological characteristics vary considerably from one site to another and therefore the potential impacts of a lowered water table also vary. Some potential impacts include the lowering of the water table below the depth of local wells, reduction of lake levels, draining of wetlands, loss of vegetation, seawater intrusion and intrusion of water of poor quality from underlying bedrock.

With advance planning most of these problems can be readily avoided. The proper spacing of wells to avoid overlap and regional lowering of the groundwater table can be calculated by hydrological studies. Wells should not be placed near those lakes most affected by lowering of the water table. Some dune lakes interact intimately with groundwater because this and direct precipitation are their only recharge sources and because they have highly permeable sand beds. Beale Lake and Sandpoint Lake in Coos County are examples of lakes underlain by less permeable sediments which slow down the rate of recharge from the lake back to the groundwater in the summer. Coffenbury Lake in Clatsop County and perhaps to a lesser extent Clear, Saunders and Butterfield Lakes in Coos County fit this category (Robison, 1973; Frank, 1970). These lakes may be partially fed by surface streams and runoff from hard rock areas bordering the sand dunes. Hyrological studies will provide critical background information for the safe and beneficial development of these areas.

E. Pollution

The pollution of groundwater involves the introduction of unwholesome or undesirable elements rendering the water unfit for use or environmentally degraded. Because sand dune aquifers experience particularly high infiltration rates, they are especially susceptible to pollution. Many fluid pollutants travel significant distances quickly in this sand medium.

1. Potential sites

Because the sand is highly porous and does not filter some types of harmful elements, all sand dune areas "downstream" from emission points of harmful substances should be considered potentially pollutable.

Those areas which should receive special consideration because of particular locational or high water table problems are:

a. All deflation plains and deflation plain fringes

This includes both the presently "active" deflation plain forms which are situated on the lee side of the foredune and historically active forms which are now found considerably inland from the present foredune area. These exhibit a flat surface topography, are usually forested and the water table is at or near the surface most of the year.

b. Lakes, streams and marshes

These bodies of water can be surface expressions of polluted groundwater. Conversely, polluted lakes, streams and marshes may affect local groundwater quality.

c. Near-beach sites

These areas may be occuped by temporary or permanent settlements and are major emptying points for the sand dune aquifer. Any non-filtered hazardous substances may appear here.

2. Potential impacts and management techniques

Bacteria have been shown to travel a maximum distance of only about 100 feet through similar sand aquifers (California Water Pollution Control Board, 1954, p. 99). However, sand is incapable of removing chemical contaminants. This includes those chemicals used in most household detergents which can render water unfit for domestic purposes. Some such contaminants not only produce a potential health hazard but may also threaten stabilizing vegetation.

Sand aquifers also appear incapable of filtering out viruses (Frank, p. 34). Outbreaks of hepatitis in some counties may be linked to septic tank problems in areas of high water table or ponding (Schlicker, 1974, p. 57).

Besides the naturally occurring sources of nitrate-nitrogen (NO_3-N) present in some areas of the sand dune groundwater, there also exist additional induced sources. Septic tank emissions and fertilizer used on pasture and croplands are significant sources in some areas (Sweet, p. 18). There are indications that excessive nitrate ingestion may cause methemoglobinemia (blue babies). The U.S. Public Health Service prohibits the use of water for drinking purposes if NO_3-N concentration is greater than 10 mg/liter (Sweet, 1977, p. 17). Furthermore, the U.S. Department of Environmental Quality has set a limit of 5 mg/liter in at least some sand aquifer areas on the Oregon coast (Berg, 1979). This is apparently due to seasonal population peaks and associated septic tank discharges (summer), natural seasonal peaks in the release of NO_3-N to the groundwater (winter), and high NO_3-N concentrations in some local organic soils (Sweet, p. 24).

There are a number of areas which use septic tanks and other private sewage-disposal systems which discharge into the sand. Some of these reportedly are sources of pollution to the area and others could become so (Frank, 1970, p. 34). The seriousness of the problem would depend on allowed density of development and the position of the waste discharges in relation to overall groundwater flow within the aquifer. Some experts feel that those operations which involve waste discharge, such as septic tanks and industrial lagoons, are not appropriate for sand areas under most conditions (Beaulieu, 1974, p. 30).

Local decision-makers and home owners alike will benefit from a better understanding of the potential benefits and hazards of the local groundwater regiem. Several studies have been conducted concerning water supply, quality, recharge and flow characteristics. A number of other studies are presently underway (Appendix A). Those state and federal agencies or local offices which may be contacted for further information include:

U.S.D.A., Soil Conservation Service
U.S.G.S., Water Resources Division
Oregon Department of Environmental Quality
County Sanitarian

The following references contain additional groundwater information:

Corcoran (1975)
Dugan (1976)
Hampton (1961 and 1963)
Smith (1962)

REFERENCES CITED

Beaulieu, John D. 1974. Geologic Hazards Inventory of the Oregon Coastal Zone. Paper #17 prepared for: Oregon Coastal Conservation and Development Commission. State of Oregon Department of Geology and Mineral Industries, Portland, Oregon. 94 pp.

Berg, Bill. Personal Communication. 1979. City Councilman, Gearhart.

California Pollution Control Board. 1954. Investigation of Travel of Pollution. Publication 11. California Water Pollution Control Board. 218 pp.

Corcoran, R. E. 1975. "Environmental Geology of Western Coos and Douglas Counties, Oregon." Bulletin 87. State of Oregon Department of Geology and Mineral Industries, Portland, Oregon. (maps).

Dugan, Patrick, Y. R. Nayudu, Daniel Bottom, and Kathy Fitzpatrick. 1976. A Study of Shoreland Management Alternatives - Inventory of Five Shoreland Areas. Oregon Coastal Conservation and Development Association, North Bend, Oregon. 280 pp.

Frank, F. J. 1970. Ground Water Resources of the Clatsop Plains Sand-Dune Area, Clatsop County, Oregon. U.S. Department of the Interior, Geological Survey Water-Supply Paper 1899-A. U.S. Government Printing Office, Washington, D.C. 41 pp.

Hampton, E. R. 1961. "Ground Water From Coastal Dune and Beach Sands." Geological Survey Research. U.S. Department of the Interior, Geological Survey Professional Paper 424B. U.S. Government Printing Office, Washington, D.C. p. B204-B206. 3 pp.

Hampton, E. R. 1963. Ground Water in the Coastal Dune Area Near Florence, Oregon. U.S. Department of the Interior, Geological Survey Water Supply Paper 1539-K. U.S. Government Printing Office, Washington, D. C. 36 pp.

Luzier, James. Personal Communication. 1978. Hydrologist, U.S. Geological Survey, Water Resources Division.

Robison, J. H. 1973. Hydrology of the Dunes Area North of Coos Bay, Oregon. Open-file Report. U.S. Department of the Interior, Geological Survey, Portland, Oregon. 62 pp.

Schlicker, Herbert G. 1974. Environmental Geology of Coastal Lane County, Oregon. Bulletin 85. State of Oregon Department of Geology and Mineral Industries, Portland, Oregon. 115 pp.

Smith, David L. 1962. "Lake and Stream Formation on Sand Dunes in the Florence District, Oregon." MS Thesis, University of Oregon, Eugene, Oregon. 90 pp.

Sweet, H. Randy. 1977. Carrying Capacity of the Clatsop Plains Sand-Dune Aquifer. Report for Clatsop County Commission and Oregon Environmental Quality Commission, Clatsop County, Oregon. 73 pp.

U.S. Department of Agriculture, Forest Service. 1972. The Oregon Dunes NRA Resource Inventory. Siuslaw National Forest, Pacific Northwest Region. 294 pp.

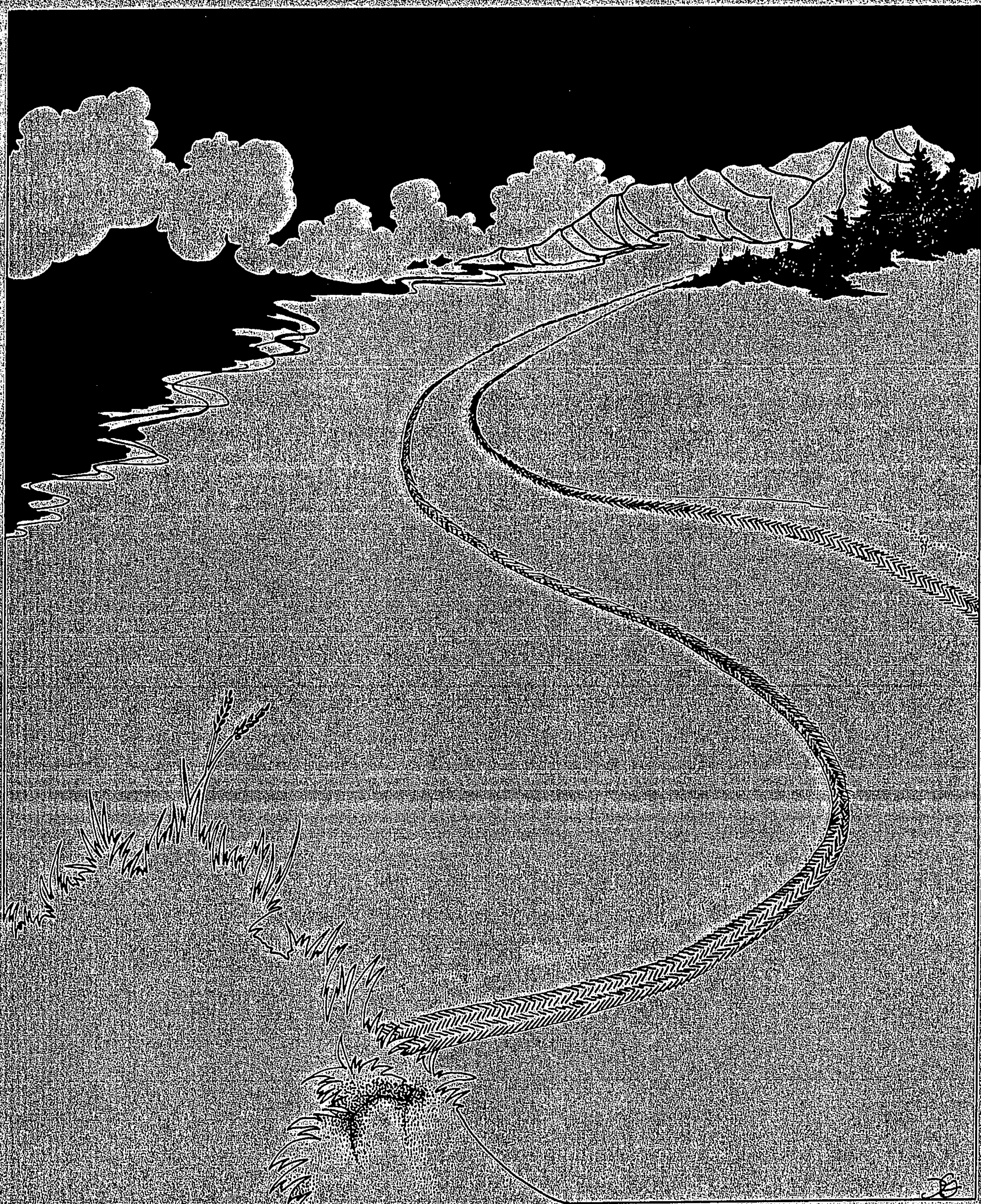
U.S. Department of the Interior, Geological Survey. Water Resources Division. Unpublished Material.

APPENDIX A

Water Resource
Studies In Progress

WATER RESOURCE STUDIES IN PROGRESS

COUNTY	AGENCY	PURPOSE	STATUS
Clatsop	Clatsop County Planning Dept. and Oregon Dept. of Env. Quality (208 Water Quality-EPA)	A continuation of the Carrying Capacity of the Clatsop Plains Sand-Dune Aquifer (Sweet, 1977). Study will allow more in-depth research on the quality and quantity of the groundwater supply.	Approval recently granted
Lane	Lane County Environmental Health Division (Lane County Coastal Domestic Water Supply Report)	Study by Charles Strong (1979) identified available surface and groundwater supplies along coastal Lane County; focused on developed and developing areas.	To be released
Lane	Lane County Division of Environmental Health--North Florence Dunal Aquifer Study	Grew out of finding in Lane County Coastal Domestic Water Supply Report which identified potential groundwater problems in this rapidly developing area. Report will consider water supply, quality and potential groundwater hazards.	In progress
Douglas	U.S.G.S., Water Resources Division (LCDC)	Tests conducted at four wells in the deflation plain at about eighty feet deep. Both water quality and quantity are being researched.	In progress
Coos	Coos Bay Water Board/ (U.S.G.S. - WRD)	1. Dissolved Iron--study being conducted to determine the distribution of dissolved iron in the dunal aquifer. Series of test wells between Jordan Cove and Ten-mile Creek to aquifer bottom. Test samples to determine changes which take place in the location and concentration of dissolved iron and other chemicals as well as pumped.	In progress
		2. Extraction System--following the above study, when the best water sources have been identified, a groundwater extraction system will be designed which will allow water removal with the best possible benefits to users and the environment.	Planning stages
		3. Spit Water Supply Investigation--Research presently underway to determine the best possible way to develop the Coos Bay Spit's water supply to serve an industrial park system.	Planning stages



Off-Road Vehicle Planning & Management On The Oregon Coast

Oregon Coastal Zone Management Association, Inc.

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OFF-ROAD VEHICLE PLANNING AND MANAGEMENT
ON THE OREGON COAST

by

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December, 1978

ABSTRACT

A framework to plan and manage off-road vehicle (ORV) use on the Oregon coast is developed. Federal and state ORV policies are compared and contrasted. Regulations applying to coastal ORV use are presented, which cover primarily equipment and noise limits. ORV environmental impacts are divided into inherent and behavioral types. Inherent impact is the minimum baseline level of impact for a recreational form, and behavioral impact is the impact, in addition to the baseline level, caused by human action. ORV inherent impact on natural terrain is greater than pedestrian impact. ORV behavioral impact is usually more significant than a pedestrian's. Coastal ORV use is divided into three activity designations for planning/management purposes: competitive events, vehicle play, and access corridors. Beach and dune areas are divided into ORV management units based on their identification and sensitivity to ORV impacts. A management unit's sensitivity is matched with an activity designation's impact to determine what type of ORV use may be suitable. Specific environmental impacts on sand, vegetation, and wildlife should be considered in planning an ORV area. They are outlined and discussed. Site criteria are provided for the activity designations. Management considerations are discussed, including posting, law enforcement, safety, user compatibility, environmental monitoring, and special permits. The Sand Lake ORV area is provided as a case study in planning and managing ORVs. Specific recommendations are offered to make ORV use at Sand Lake compatible. Also, policy recommendations are provided. Coastal areas of ORV use and potential suitability are mapped. Final recommendations are offered regarding the Oregon Dunes National Recreation Area, the north spit of the Coos River, and comprehensive State legislation.

PREFACE

The following report presents the results of an in-depth analysis of off-road vehicle use on Oregon's coastal beaches and dunes conducted by the Oregon Coastal Zone Management Association, Inc. This report constitutes one element of an overall analysis of planning for coastal beaches and dunes as required by Oregon's Beaches and Dunes Goal.

Funding for this study was provided by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, under Section 306 of the Coastal Zone Management Act through the Oregon Department of Land Conservation and Development. Preparation of this report was made possible through the cooperation of the Western Interstate Commission for Higher Education, Boulder, Colorado.

This report was prepared by Timms Fowler, WICHE Intern, under the direction of Kathy Fitzpatrick, Project Administrator, with assistance from OCZMA's Beaches and Dunes Study Team composed of Carl Lindberg, Project Director, Christianna Crook, Project Associate, Wilbur Ternyik, Project Coordinator, Dr. Paul Komar, coastal geologist under contract, Bill Burley, coastal biologist under contract, and Ruby Edwards, secretary.

In addition, valuable review and comments were made by the Beaches and Dunes Steering Committee composed of:

R.A. Corthell, U.S. Soil Conservation Service
Steve Stevens, U.S. Army Corps of Engineers
Sam Allison, Oregon Department of Water Resources
Peter Bond and John Phillips, Oregon Department of Transportation, Parks and Recreation Division
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Phil Bredesen, Lane County Planning Department
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Oscar Granger, Lincoln County Planning Department
Curt Schneider, Clatsop County Planning Department

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Pacific Northwest Four-wheel Drive Association: Cliff Bales and Gerry Brown,

Northwest Trail and Dune Association: Gene Noble and Duke Witney,

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Cover design by Denise A. Goulett, Toledo, Oregon.

Illustration (Figure 1) prepared by Lorraine Morgan, Newport, Oregon

This report was prepared as part of a larger document. If read singularly, the cross references to the critical habitat section should be disregarded.

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A. Growth

The national growth of off-road vehicles (ORVs) and their use has been explosive in recent years (Stupay, 1971, pp. 14-18). Most ORV studies' introductions are laiden with statistics on growth; two statistics on vehicle use are provided here. The Motorcycle Industry Council (1978, p. 32) offers statistics for off-road motorcycle use in 1977. Thirty-five per cent or 4.5 billion miles of the total motorcycle mileage was off-highway use. In 1977, of the 142,700 motorcycles in Oregon, 105,700 were used off-highway at some time (p. 30). Oregon's coastal beaches and dunes are no exception to the growth and popularity of ORV recreation, however, ORV user counts are unavailable.

B. National Response

Initially, national planning and management of ORV recreation failed to keep pace with the rapid evolution of this sport; thus, its potential problems have become real problems. Gradually, since the early seventies research has helped identify the problems (McCool and Roggenbuck, 1974) and provided information on ORV user behavior, environmental impacts, and management techniques.

Baldwin and Stoddard (1973) summarize the concerns about ORV recreation, while Bury, Wendling, and McCool (1976) provide a literature review. Lodico (1973) reviews the early environmental effects of ORVs, and Rasor (1978) provides examples of viable ORV programs in five states. The State of Washington (1976) and California (1978) have well developed programs including legislation, registration, and a self-supporting funding system.

C. Federal Policy

Federal policy and planning for ORV use was initiated by Executive Order 11644 (Nixon, 1972) which requires that federal agencies develop plans to administer ORV use (Appendix A). Later it was modified by Executive Order 11989 (Carter, 1977) which enables federal land managers to close areas open to ORV use if such use is causing or will cause adverse environmental effects (Appendix A). Thus, federal agencies have developed or are developing their respective plans pursuant to the Executive Orders. The proposed Bureau of Land Management regulations provide an example and a background of national policy evolution (Appendix B).

The Forest Service policy and regulations are given in the Code of Federal Regulations 36CFR 295 -- Use of Off-Road Vehicles (Appendix C). A portion of those regulations (295.6 - 295.8) were revoked February 15, 1977, pending probable revision and are included for informative purposes (Appendix C). Finally, under the Code of Federal Regulations 36CFR 261.13 (prohibitions) certain rules apply to ORV use (Appendix C).

D. The Oregon Situation

1. Federal involvement

The United States Forest Service (Siuslaw National Forest) plays an active role in management of ORVs at Sand Lake, in Tillamook County, and at the Oregon Dunes National Recreation Area (NRA). The regulations adopted pursuant to Executive Order 11644 form the basis of their management plan (U.S. Department of Agriculture, 1976). Different areas can have differing regulations so an ORV recreationalist should check to make sure all regulations are understood. Oregon Department of Environmental Quality noise standards are enforced at the NRA and Sand Lake. The state ORV equipment requirements are only enforced at the NRA (Oregon Revised Statute (ORS) 483.833 - 483.847) (Appendix D); however, the Hebo Unit presently is working to resolve this inconsistency.

2. State involvement

Oregon, despite several legislative attempts, does not have a comprehensive plan to accomodate and manage ORV recreation. House Bill 2764 is a good example; it was rewritten three times during the 1975 Regular Session and at the session's close was left in committee. The basic issues considered were: registration, limitation of use to specified areas on public land, area development, application of the snowmobile law, a funding system, and an advisory council. Lacking sufficient political support, a comprehensive ORV program for Oregon, presently, does not exist.

Several state statutes apply to ORVs, which are defined as: "...any motorized vehicle designed or capable of cross-country travel on or immediately over land, water, sand, snow, ice, marsh, swampland or other natural terrain." (ORS 483.333) (Appendix D). The most extensive body of law deals with snowmobiles. It covers operator certification, operator conduct, accident reporting, law enforcement, and local provisions (ORS 473.710 - 483.755) (Appendix D). Cities and counties can regulate snowmobiles on public lands, waters, and other properties under its jurisdiction if such regulations are consistent with state law (ORS 483.755).

Another state statute establishes equipment requirements for ORVs operating only in the Oregon Dunes National Recreation Area and the ocean shore open to vehicular traffic within the NRA (ORS 483.833 - 483.847) (Appendix D).

Two noise standards for ORVs exist at the state level (Department of Environmental Quality (DEQ)). First, ORVs must meet in-use noise limits (decible limits) (ORS 467.030, Oregon Administrative Rule (OAR) 340-35-030(1)(b)) (Appendix E). Also, ORVs must not cause surrounding (ambient) noise levels to exceed standards near houses or other noise sensitive property. The vehicle operator and/or the property owner on which the vehicle is operated may be responsibile (ORS 467.030, OAR 340-35-030(1)(d)). Noise considerations are covered in the DEQ Handbook for Environmental Quality Elements of Oregon Local Comprehensive Land Use Plans (1978). Further information and assistance is available from DEQ. Enforcement of the noise standards by DEQ is on a complaint basis and is not an adequate management program for ORV areas. Apparently local law enforcement officers have the authority to enforce ORV noise standards but lack the equipment and direction to do so.

Other state involvement includes regulations of motor vehicles in certain zones on the ocean shore. The Oregon Department of Transportation may establish zones where vehicle use is restricted or prohibited through a specified procedure including public hearings and consultation with local government as provided for in ORS 390.688 (Appendix F). These zones are enforced by the Oregon State Police and local law enforcement agencies.

The ocean shore is defined by ORS 390.605 (Appendix F) as the area between extreme low tide and a survey line, based on the Oregon Coordinate System called the "vegetation line". It is not really the vegetation line but is a survey line defined by a series of points along the coast as described by ORS 390.770 (Appendix F). This line is often referred to as the "zone line". Also most of the wet sand area (the area between ordinary high tide and extreme low tide) is a state recreation area (ORS 390.615) (Appendix F). Many of the motor vehicle laws apply to the ocean shore except such areas within the Oregon Dunes National Recreation Area, which are addressed by the State ORV requirements.

3. ORV planning

Pertinent planning goals and guidelines administered by the Oregon Department of Land Conservation and Development are: (1) Beaches and Dunes: (2) Recreation; (3) Coastal Shorelands; (4) Estuarine Resources; (5) Open Spaces, Scenic and Historic Areas, and Natural Resources; and (6) Areas Subject to Natural Disasters and Hazards. Coordination between related goals is significant because of ORV use in beach areas as well as in upland areas. Sand Lake is a good example where the Estuarine, Coastal Shorelands, Beaches and Dunes, and Recreation Goals must be dovetailed.

The Recreation Goal does not specifically mention ORV use while in the beach and dunes guidelines, ORV recreational use is mentioned by name. One must assume ORV activities would be classified as: "...active or passive games and activities" in the Recreation Goal. Its guidelines (paragraph five) suggest that the State Comprehensive Outdoor Recreation Plan (SCORP) be used as a planning guide when developing recreation facilities. SCORP (1977) specifically considers ORV use, providing standards to determine state and local needs, and should be used directly by the planners when providing for ORV recreation.

E. ORV Policy: Comparisons and Contrasts

The federal government recognizes ORV use as a legitimate recreational form, planning and managing it, while the State of Oregon only tactily recognizes ORV use without a plan or management scheme. The Department of Transportation's vehicle zones, SCORP (1977), and the Beach and Dune Guidelines are the only recognition of ORV use. ORV recreation is not mentioned by name in the Recreation Goal.

Many of the motor vehicle laws apply to vehicles operating on the beaches except within the NRA, where only the ORV equipment standards are required (ORS 483.837). Also, the Forest Service has no jurisdiction over the beaches, and the state or county cannot enforce federal regulations on federal land except through special agreements (under Public Law 92-82).

II. UNDERSTANDING ORV ENVIRONMENTAL IMPACT

A. Introduction

Plainly, whether a given impact[1] is "good" or "bad" is value dependent. When impacts are variable in degree, it becomes more difficult for people to agree on what is an acceptable level of impact for a given activity because of different personal values and different interpretations of the "facts".

To place ORV use in perspective with other types of recreation, it is useful to make a distinction between two types of environmental impacts. Specifically, it can be divided into two types: (1) inherent impact and (2) behavioral impact. The distinction is based on how much the impact's size can vary and the factors that determine the impact's size. Inherent impact is fixed in size while behavioral impact varies.

B. Inherent Impact

Inherent impact is the minimal impact on the environment for a given type of recreational activity. It is the least impact possible

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[1]Whether written in the singular or plural form, impact shall be considered as the sum total of the effects for a given activity. One action rarely has a single effect on the environment.

(determined by common sense and scientific research) provided that a specific activity does, in fact, take place in a given environmental setting. Thus, it forms a baseline.

The inherent impact is determined by the nature of the activity and where the activity takes place. Specifically, ORV recreation is motorized and for the purposes of this study, takes place on the beach and dune areas of the coast. Thus, the inherent impact would be less than that for ORV activity in a desert or alpine tundra area. Typically, ORV inherent impact is greater than that for non-motorized recreational forms.

C. Behavioral Impact

Behavioral impact is the impact that exceeds the minimal baseline effects (inherent impact) as a result of human action(s). It can vary greatly in size depending on one's behavior, regardless of whether it is intentional or unintentional. Specifically, ORVs (primarily motorcycles and four-wheel drive vehicles) can be tools of destruction if used thoughtlessly; their power and weight are no match for soil, vegetation, and wildlife.

D. Illustration of Inherent and Behavioral Impacts

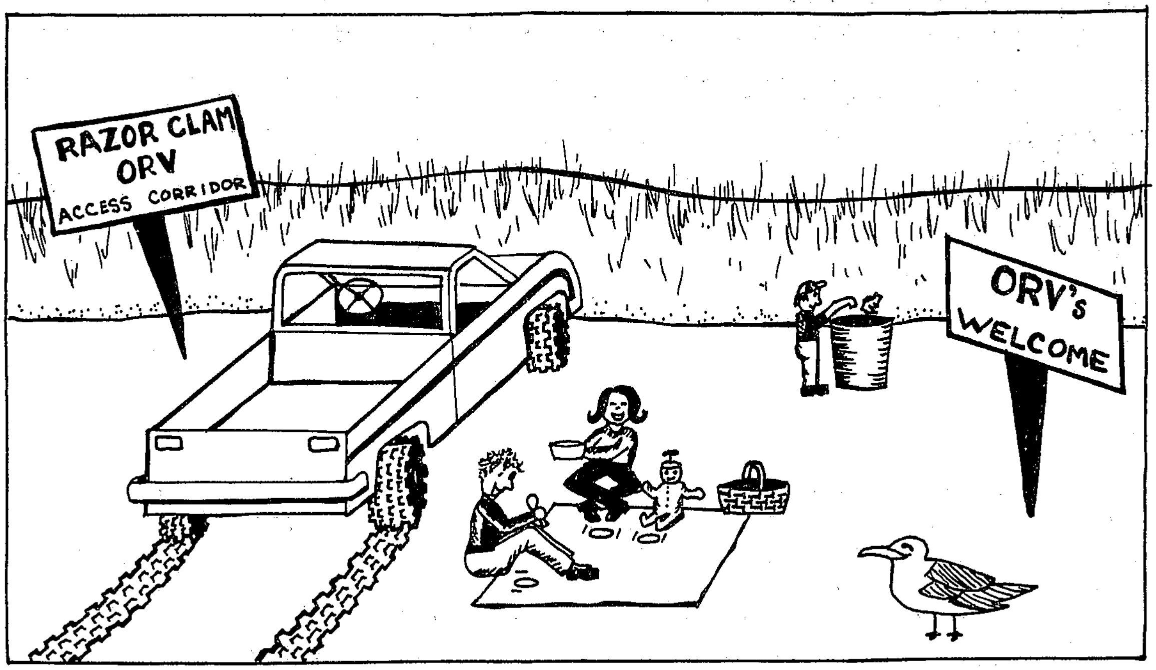
A simple example is the difference between a person driving a vehicle down a beach to go clamming and another person going clamming but deciding to play "hill climber" on the foredune (breaching it) and "trailblazer" through the deflation plain (destroying its vegetation). Clearly, going from one place to another for access and sightseeing has a minimal impact (inherent impact), while active vehicle play in unsuitable areas caused impact far beyond the baseline level. Vehicle play is acceptable only in specific areas; outside of those areas it is inappropriate and results in large behavioral impacts. Behavioral impact is important in ORV planning, management, and the recreation itself (see Figure 1).

E. Inherent and Behavioral Impacts: ORV Recreation Relative to Pedestrian Recreation

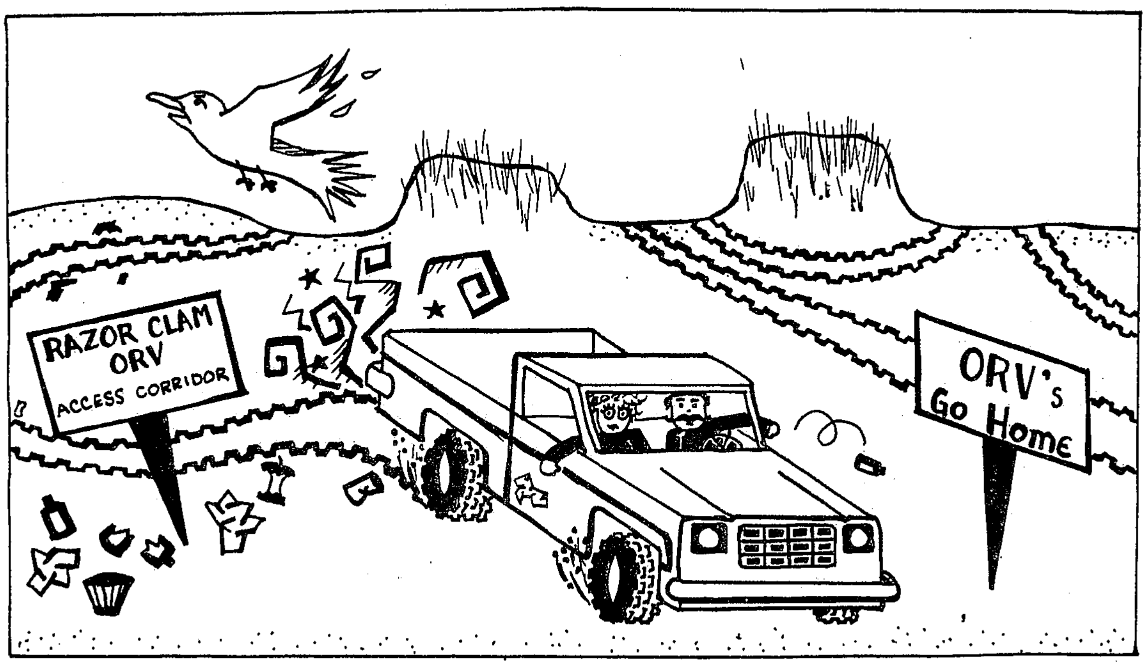
1. Motorization is the difference

The fundamental difference between ORV recreation and other recreational activities (particularly pedestrian) is the use of a motor vehicle to traverse areas typically unsuitable for a normal vehicle. This difference is the largely unique, attractive aspect of the recreation, but paradoxically, also is potentially a detriment to this recreational form. The problems with this motorized sport, as well as the

USE IT



BUT DON'T ABUSE IT



OR YOU'LL LOSE IT

Figure 1. Behavioral impacts are important to consider when planning for and managing ORV areas. Caption is based on a phrase from the BLM'S Operation ORVAC, 1970.

positive aspects, must be recognized and understood by both participant and non-participant.

2. Inherent impact

The inherent impact is greater for ORV recreation than it is for pedestrian types on natural terrain. An analysis follows comparing a trail bike and a pedestrian which illustrates how motorization and degree of impact relate. Although ORV recreation also includes dune buggying, four-wheel driving and special events such as sand drag-races, they all take place on the Oregon coast and share the common motorized character.

ORV impact is larger because it is motorized. Three specific areas can be identifed showing how the motorization increases the inherent impact's size: (1) the specific area contacted by the recreationalist or the recreationalist's ORV (interface between the recreationalist and the environment), (2) the range or area covered by a recreationalist in a given amount of time (total area contacted or total interface area), and (3) the area of recognition based on sight or sound (area of recognition).

First, at the area of immediate contact between the recreationalist and the environment, the interface, the inherent impact is greater for the ORV (recreationalist) because its greater mass and power production is translated proportionally into environmental impact. "Generally, the greater the torque applied at the machine/environment interface, the greater the potential for impact." (Bury et al., 1976, p.41). Also Muntz, Deglow and Campbell comment generally, not quantitatively, on the relative erosional effects between a trail biker and a hiker (1972, p. 9):

> For example, in the case of trail bikes, erosion should be considered. It seems that the trail bike must be worse than the hiker since the trail bike and rider represent something like three times the mass of a hiker. In addition, feet intelligently guided are rather more efficient at gaining firm holds than wheels, thus allowing a hiker to gain or lose altitude and generally to accelerate or decelerate per unit mass with less displacement of trail surface material than a trail bike.

The behavior described above as "feet intelligently guided" is indicative of pedestrian behavior with minimal environmental impact, and suggests that even the most consciencious trail biker's inherent impact would be greater than that of the hiker, due merely to the use of a motorized vehicle.

Second, comparing the range or contact area covered in a given amount of time (total interface) for the ORV user versus the pedestrian a tool of destruction far exceeding the potential harm done by a lone individual exhibiting such depreciative behavior. The mechanical advantage makes the operator's behavior the crucial determinant in controlling environmental impact (see Figures 2 and 3).

Second, the great range and ability to venture into remote areas with ORVs may be a positive attribute of ORV recreation. On the other hand, if ORVs serve as a vehicle to carry depreciative behavior into back country areas they are ruinous. ORVs remove many of the functional barriers (distance, elevation, etc.) that have limited access in the past.

Thus, when irresponsible behavior takes place involving an ORV, the damage is extraordinarily large and the ORV can serve to transport that damage to areas previously protected by limited access.

Bury *et al*. summarized these points (p. 20):

> While the proportion of individuals assuming depreciative behavior forms may be no larger than in other recreation activity groups (although research is needed to determine the proportion), the potential for impacts of this behavior may be considerably larger because of the mechanized nature of the activity. Mechanization not only allows individuals to cover more terrain than most other recreational pursuits, ... Stated perhaps more succinctly, the geography of depreciative behavior among ORV operators will be more dispersed than that caused by other recreational participants.

Due to the possibly large, negative behavioral impact and its wide geographical distribution, management becomes very difficult and expensive. Perhaps an effective means to deal with depreciative behavior is through peer influence. An ORV participant may respond more favorably to regulations by observing others' respect for them and following their encouragement to do likewise for the benefit of all ORV recreationalists. This can be promoted by user education programs. Also, planning can greatly reduce many user conflicts and management requirements regarding environmental impacts.

III. OFF-ROAD VEHICLE ACTIVITY DESIGNATIONS

A. User Types

ORV recreationalists are a diverse group of people and utilize various types of vehicles in different ways. However, three groups can be identified (Peine, 1973, pp. 9-10; State of California, pp. 9-10): (1) vehicle oriented, (2) activity oriented, and (3) land oriented. The first group see the vehicle as an end in itself enjoying the performance, skill of operation and maintenance. This group would include the most

avid riders and competitors. The second group, activity oriented, are using their ORVs as a means to another end, transportation to areas in which to hunt, fish, clam, camp, etc. The last group, land oriented, seek to be out of doors and enjoy remote scenery and points of interest. These groups are useful in distinquishing some of the different user motivations but are limited in their application to planning and management because their respective impacts are not considered.

B. Activity Designations

As previously discussed, different activities have different impacts, so based on their functional differences and related potential impacts, three ORV activity management designations can be made: competitive events, vehicle play, and access corridor.

1. Competitive events

Organized competition can be planned in detail, managed and monitored very closely through special permits issued to an individual or a club that assumes the responsibility for the event. Thus, impacts and problems can be dealt with in advance. Events like sand drags, because of their organized structure, are quite manageable (see Table 1).

Table 1. The relative potential impacts and manageabilities for the three vehicle activity designations

Activity Designation	Impacts		Manageability
	Inherent	Behavioral	
Competitive Events	High	High	High
Vehicle Play	High	High	Low
Access Corridor	Low	High	Low

Thus, their potentially large impacts (inherent and behavioral) can be mitigated, raising their compatibilities with adjacent lands.

2. Vehicle play

The distinction between vehicle play and vehicle access is dependent on the ORV users' behavior since their machines, especially in the case of four-wheel drive vehicles and motorcycles, have the dual capacity for play and access.

Vehicle play includes the active testing of one's machine and skill to negotiate steep hills, rough terrain, etc. Generally, it can consist of a mixture of activities such as touring an area, hill climbing, and informal racing with a friend. Vehicle play is basically vehicle oriented. Perhaps, it is best described as an activity resulting from the use of a powerized vehicle to freely traverse a variety of terrain (large dune bowls, small dunes, open sand straight-aways) at a variety of speeds.

Both the inherent and potential behavioral impacts are great because of the motorized, free, and relatively wide-open nature of the activity. Management must be sufficient to deal with these problems. However, management is difficult due to the range and mobility of an ORV. An overly enthusiastic driver may venture into areas not appropriate for such use; simple rules become difficult to enforce. Vehicle play is much harder to administer than competitive events and therefore, may be less compatible with adjacent areas (residential areas, important habitat areas, stabilized vegetation areas) (see Table 1).

3. Access corridor

Vehicle access, in theory, would include transit from one point to another on a single path or corridor, the vehicle serving as a means of transportation whether it be for fishing, clamming, or sightseeing. Thus, it functionally includes the activity and land oriented ORV user groups. Assuming normal driving habits (shortest distance routes, low speeds, etc.) and no thrill-seeking behavior, the inherent impact for an access corridor would be significantly smaller than that for vehicle play. This would likely increase the compatibility of this activity, facilitating its provision since it could be permitted in or near more areas. However, if individuals ranged over inappropriate terrain, outside the access areas as if it were a vehicle play area, this would constitute depreciative behavior and result in unacceptable behavioral impacts. Clearly, the ORV user's behavior in beach and dune areas determines, in reality, whether an access area can exist or not. The inherent impact would be less than that for vehicle play, but the potential for behavioral impact would still be large (see Table 1). This should be kept in mind while planning and working with the ORV groups.

IV. COASTAL ORV MANAGEMENT UNITS AND THEIR SUITABLE ACTIVITY DESIGNATIONS

A. Management Area

The management area is the largest land division having identifiable boundaries, natural (headlands, rivers, etc.) or man-made (highways, etc.). It includes all planning elements (house construction, recreational areas, wildlife habitats, etc.), stressing the interactions between all the elements. The aim of such a division is to promote the consideration of an activity's impact on the adjacent land or land uses both immediate and distant.

B. ORV Management Units

Subdivisions within the management area are management units. Specifically, ORV management units are readily identifiable contiguous landforms and/or plant communities sharing in part a common sensitivity to ORV traffic. The ORV management unit's sensitivity determines which activity designations are suitable. Within each ORV management unit, the significance of ORV impacts can vary and so the exact location of an ORV activity should be situated accordingly. Suitability of a given activity designation is not an absolute policy statement. Other factors must be considered, and suitability can change over the period of a year or more.

The environmental impacts of ORVs in coastal settings such as beaches, dunes, salt marshes, and tidal flats were studied at Cape Cod National Seashore between 1974 and 1977. The results are summarized by Godfrey, Leatherman, and Buckley in Coastal Zone '78 (1978, pp. 581-600). These studies conducted by the University of Massachusetts National Park Service Cooperative Research Unit, are used extensively in the following explanations of ORV impacts on habitat types.[1] The following ORV management units are defined by their sensitivity to ORV traffic and their easy identification.

1. Protected intertidal

The protected intertidal ORV management unit includes salt marshes, sand flats, and estuarine areas generally protected from direct ocean wave action. The sand flats within river outlets are not really protected and may be more appropriately considered in the beach foredune management unit as an intertidal "beach".

Of the areas studied, the protected intertidal unit is the most sensitive to vehicle traffic. "These are the salt marshes and sand flats which harbor a variety of marine and coastal organisms, as well as supply-

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[1]The author gratefully acknowledges the Unit's comprehensive research.

ing primary productivity to the estuarine and nearshore marine food webs," (Godfrey et al., p. 590). In salt marshes, very low levels of vehicle traffic can maintain bare areas indefinitely. In open intertidal sand flats, vehicle traffic may stop the natural development of marsh vegetation and may affect the survival of marine life such as worms, clams, and other mollusks (Godfrey et al., p. 592).

Typically, the protected intertidal ORV management unit is not suitable for any ORV activity designation. This is consistent with the estuarine and other related goals. However, in the case of emergencies, salvage operations, and special management needs, an access corridor might be a necessity.

2. Beach foredune

The beach foredune ORV management unit consists of the beach and the entire foredune and makes a naturally identifiable unit with regard to ORV use.

Within the beach foredune area, impact sensitivity varies. The intertidal beach (wet sand area between high and low tide) is probably the area most resistant to ORV impact, since it is so naturally variable (sand transport during tidal cycles and storm cycles, etc.). The natural changes are much greater than any vehicular effects. However, the high beach (berm) where only the highest tides reach can be heavily impacted. In this area, birds nest and drift accumulates. Where vehicles pass only a few times on driftlines, organic deposits can be broken up along with the destruction of pioneering plants and reduced bacterial counts (Godfrey et al., p. 586).

Although foredune vegetation is highly susceptable to destruction by ORVs, it is also an area of vigorous growth and recovery. (Note: there are special erosion hazards associated with destabilized foredunes, which are considered in the specific impacts section.)

Overall, the ORV impacts on the beach foredune unit are significantly less than in the protected intertidal areas. In light of the foredune sensitivity and associated wildlife habitat, an access corridor is the only suitable designation for the beach foredune management unit. User compatibility and other management factors should be considered in making such a designation (refer to those sections).

3. Vegetated dune

Vegetated dunes are susceptable to removal of their stabilizing vegetation causing erosion hazards and esthetic impacts. Access corridors are the only suitable designation for this ORV management unit. Some dune areas that were stabilized at public expense have been damaged by ORV use. Does recreation justify this destruction?

4. Vegetated deflation plain

Vegetated deflation plains are similar to vegetated dunes in that the vegetation can be destroyed by vehicles. The impact is significant regarding wildlife habitat and its associated flora. Vegetated deflation plains constitute an ORV management unit that is potentially suitable only for a carefully planned and monitored ORV access corridor designation.

5. Open sand

Open sand areas and open sand dunes constitute ORV management units which apparently are ideal for all ORV activities. Clearly, open sand areas (excluding beach areas) are most suitable for ORV use with little lasting inherent impact. Wildlife distrubance is probably minimal, however, open sand deflation plains can serve as resting areas for migrating birds. During those periods, such areas are not suitable for any ORV activity. Also where dunes are encroaching on valuable land, ORV activity is inappropriate because it might accelerate dune migration (through down slope sand transport and wind transport).

V. SPECIFIC ENVIRONMENTAL IMPACT CONSIDERATIONS

Consider the inherent ORV impacts on sand, vegetation, and wildlife. Some impacts on these resources are certain to occur and require special attention. The general topics concerning ORV impacts for each subject are listed. Only those pertinent and previously documented in the literature are reviewed. Some management recommendations are offered to reduce the impacts, however, a more complete analysis of management techniques is discussed in Chapter VII.

In the planning process, the ultimate determination is whether the probable ORV recreational impact is consistent with LCDC's land use goals and a community's values (recreational and environmental). Regarding environmental impacts, goal number five concerning natural resources is the most applicable: to conserve open space and protect natural and scenic resources which would include fish and wildlife areas and habitat, as well as ecologically and scientifically significant natural areas.

A. ORV Effects on Sand

1. Downslope sand transport and compaction (geomorphological effects)
2. Wind erosion (wind transport)
3. Water erosion (beach, creeks)

Niedoroda studied the effects of ORVs on the beaches and dunes of Cape Cod (1974). Although the Oregon oblique dunes are very different from other dune forms (Cooper, 1958), the process of sand transport, compaction, etc., due to vehicles, would be similar in nature.

1. Sand transport and compaction

Niedoroda's work indicates sand transport downslope was a significant effect, changing the dune relief locally. This appeared not to threaten the overall relief of the dunes given the level of ORV use. The major factors in sand transport were the slope of the hill and tire pressure; compaction was minimal (pp. 76-78).

The study raises the question of whether ORV activity on the oblique dunes of Oregon have significant effects on their relief. Apparently these effects depend on the natural process of sand movement. If the natural sand transport (dune building) is greater than the effects of sand movement from ORVs, then there is probably no observable net effect. Conversely, if the ORV activity moves more sand than the opposing natural processes, the dunes' relief may be changed.

Any quantitative answer is impossible to provide, although general observation may be useful. It appears the oblique dunes are much larger than those studied by Niedoroda. Therefore, the ORV impact might be less significant. However, this question should be considered further.

2. Wind erosion

Regarding wind erosion in open sand, Niedoroda's work indicated ORV disturbance of the sand surface had no effect (pp. 84-85). However, this is not definitive. On some dune ridges, tracks accelerate wind transport. Tracks either increase or retard wind erosion depending on their orientation to the prevailing wind. (The winter wind from the southwest is the most significant wind.) If the tracks parallel the wind direction, erosion is accelerated; tracks oriented at some angle to the wind direction retard erosion, (Ternyik, 1978).

3. Water erosion

Water erosion appears to be pertinent only in regard to ORV activity on the beach. Here, Niedoroda indicates that for eroding beaches, the natural sand loss exceeds any possible effects from ORVs (p. 39). However, on accreting beach areas ORV activity has a detrimental effect on the newly forming (thinly vegetated) dunes. A local example of such an area would be the prograding area of South Beach in Lincoln County.

B. ORV Effects on Vegetation

1. Loss of vegetation and wind erosion
2. Loss of vegetation and water erosion
3. Fire hazards during dry periods
4. Destruction of rare species (cross reference to critical habitat section)

The open sand areas have no vegetation so there is no opportunity for mechanical destruction. It is highly suitable for ORV activity.

However, ORVs are often not restricted merely to open sand areas; when this occurs the vegetation damage is significant and can have potentially disastrous effects on nearby land uses and habitat.

1. Vegetation loss and wind erosion

Unfortunately, the likelihood of vegetation damage from ORVs is high, since few vehicle passes are needed to remove beach and dune vegetation. Once removed, other ORV users feel the open area is a "legitimate" trail, and vegetation removal progresses.

Wind erosion resulting from the destruction of stabilizing vegetation is of vital concern. Removal of European beachgrass (Ammophila arenaria) and other species that help bind the sand and reduce wind speeds (causing deposition), allow the sand to blow and possibly inundate adjacent areas. Careful site investigations must be conducted before such destabilization occurs to protect nearby land uses (homes, recreational facilities, etc.) and natural resources (habitat). Liability is an important issue here.

Generally, areas sensitive to wind erosion after ORVs remove the stabilizing vegetation include any temporarily stabilized dune area that has, at most, a thin soil layer underlain by loose sand. The degree of vegetation loss which would result in wind erosion varies depending on factors such as orientation to the prevailing wind, sand consolidation, adjacent land forms, water table depth, etc.

The effects of ORVs were studied on American beachgrass (Ammophila breviligulata), and reported by Godfrey et al. (pp. 587-590). Different areas showed somewhat different impacts. On the seaward edge of the foredune, where the beach grass advances, less than one hundred vehicle passes reduced the vegetation to low levels. Recovery of the beachgrass was dependent on its location relative to a new sand source (high in nutrients). Given three growing seasons without ORV use, the affected areas almost recovered to the pre-impact levels. However, in back dune areas, further away from the sand source, recovery was much slower. Thus, the ORV impact lasts longer in areas receiving less new sand. These observations are applicable to the Pacific oast (Ternyik, 1978). The general impact process and idea of a carrying capacity is discussed (Godfrey et al., p. 587):

> The first 175 vehicle passes over beach grass inflict maximum damage; after that, incremental damage is less because most of the harm is already done. A "minimum number" or a "carrying capacity" of dune vegetation for vehicles is really quite low, since any track can require several years to return to pre-impact conditions.

Generally, more dynamic (storms, wind, salt spray, etc.) areas have more resistant vegetation relative to stable areas, although it varies for different plant species and habitats (p. 589).

The ORV impacts on American beachgrass and European beachgrass are similar although the recovery rate of European beachgrass would be faster since it is a heartier species (Ternyik, 1978). ORV activity unquestionably removes significant amounts of beachgrass as evidenced by the Godfrey et al. study and casual observations at Sand Lake in Tillamook County. The problems with vegetation loss and wind erosion can be avoided by operating ORVs strictly on open sand, or allowing ORVs to remove vegetation only where increased wind erosion would not threaten valuable adjacent land.

2. Vegetation loss and water erosion

Water erosion of foredunes may be increased by ORV related vegetation loss. Foredunes serve as protection during winter storms. If there is destruction of the stabilizing vegetation, the foredune is more susceptible to winter storm-wave erosion (Ternyik, 1978). This means the foredune will suffer more damage and provide less protection until it redevelops. Breaching the foredune can also result in a blowout, leading to wave intrusion and salt deposition.

These considerations are important where protection from winter storms is needed. For example, houses immediately behind the foredune would need such protection. Typically, foredunes should not be designated as vehicle play areas and access should be provided to the appropriate beach areas on specified access corridors which minimize destabilization and erosion. ORV access corridors should be located in areas where protection is not vital.

3. Fire hazards

During periods when the fire hazard is high, ORV activity may need to be temporarily curtailed. Actual vehicle fires and emission sparks constitute the likely ignition sources from the vehicles. Careless campfire use would be a behavioral impact source (from any recreationalist). Generally, carrying a fire extinquisher as required in the NRA would reduce the hazard. Also, fire resistant plant species could be planted.

4. Rare plant species

There are relatively few plant species in the beach and dune areas as a whole, and only a few of those are considered rare. Thus, implementation of the natural resources goal and its guidelines would not be difficult. Reference should be made to the critical habitat section and at the time of planning or site investigation, the Oregon Natural Heritage Program or other programs monitoring the state's flora and fauna should be contacted. ORV participants have an interest in such protection, thus demonstrating their legitimacy and compatibility as a recreational form on the Oregon Coast.

C. ORV Effects on Wildlife

The evidence with regard to ORV impact on wildlife is far from complete. Basic concerns about negative effects from ORV disturbance are widespread, but there is little scientific evidence available to indicate definitely what the effects are.

Obviously, chasing or harassing game will have an adverse effect on them, but less intense disturbance is a different problem. Bury et al. state (p. 43): "Changes in daily routine plus additional stress are probably the major effects of ORVs, rather than direct mortality."

Research has focused primarily on snowmobiles, but the problems of noise and visual disturbance probably have some application to ORVs in general. The literature reviewed by Bury et al. indicates whitetail deer are not as disturbed by snowmobiles as resource managers suspected. Elk may be more sensitive. Impact from snowmobiles, on medium sized mammals is not generally clear (pp. 43-46). Thus, some evidence indicates snowmobile activity may not be as negative as at first thought, however, this is neither conclusive nor directly applicable to all ORVs.

While planning and managing any of the ORV activity designations, special attention must be paid to the following considerations for birds, mammals, marine life, and their sustaining environments:

1. Birds

a. Rare species (cross reference to critical habitat section)
b. Nesting areas
c. Resting areas for migratory species
d. General disturbance

The most visable forms of wildlife within beach and dune areas are birds. Many different species are seen providing recreation and amusement for people.

In regard to rare species, it appears there is only one in the beach and dune areas; it is the snowy plover (Charadius alexandrinus nivosus). When planning and managing ORV areas, the critical habitat section of this report should be reviewed and the Oregon Natural Heritage Program contacted.

A full background on the snowy plover may be obtained by reading the critical habitat section.[1] Only the points relevant to ORV recreation

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[1]This is a significant issue regarding ORV activity since a relatively complete knowledge of the situation may promote ORV recreation compatibility.

are considered here. The snowy plover nests along the foredune areas, often, but not exclusively, in the driftwood areas. Occasionally, they nest on open sand areas and into the foredune area for some distance. The nesting period is the most critical time of year for the plover and ranges from April into June. Snowy plovers' nest selection seems to vary in geography. During the nesting period, pedestrian and ORV disturbance could result in negative effects on snowy plover nesting success. Although in a study on Least Terns (Sterna albifrons), that was not the case (Blodget, 1978, p. 60). Any direct application of the Blodget study would not be reasonable, but it is a consideration. A low and declining population within Oregon justifies a conservative approach to protecting the snowy plover, which is consistent with goal number five.

It is significant that the disturbance can result from pedestrians as well as ORVs. In the case of the Least Terns, this was certainly true (Blodget, p. 61). Dogs are also a threat to them. In remote beach areas (where access points are widely dispersed), the only likely disturbance is from ORV recreationalists (and their dogs) due to their extensive range relative to pedestrians.

In addition to the plover, other shorebirds forage on the beaches and the effects of general disturbance are not specifically known. Resting or wintering areas for migratory species should not be areas of ORV activity.

To specifically reduce nesting disruption of the snowy plover, land managing agencies should implement a short closure period in the more remote (few access points) beach areas during April through June. Also research on the effects of vehicle and pedestrian traffic on plover nesting success is needed.

2. Mammals

a. Rare species (cross reference to the critical habitat section)
b. Breeding areas
c. Calving areas
d. General disturbance

Generally, ORV effects on mammals are unclear. ORV noise may have detrimental effects on mammals, however, research is needed to confirm this. The points listed above should be considered, especially as more data becomes available.

Within beach and dune areas, probably the most immediate consideration is the occurrence of a rare species, the white footed vole

(Phenacomys albipes). Details are noted in the section on critical habitat. The Oregon Natural Heritage Program should be contacted for any new data. Typically, areas of importance for rare species should not be designated for any vehicle activity. In instances where an important species has been identified a buffer or other appropriate management techniques should be employed for protection.

3. Fish

Siltation of streams from either direct stream crossings or erosion can be avoided if vehicles remain in open sand areas away from lakes and streams.

4. Marine life

ORV activity may have a significant effect on clams and other marine life (Godfrey et al., p. 592). The degree of impact is related to the characteristics of a given species so it is advisable to consult marine biologists prior to making ORV designations in estuarine or beach areas.

VI. SITE CRITERIA

A. User Interests

1. Vehicle play

Most vehicle play participants seek a variety of challenging terrain. The large oblique dunes (e.g. Umpqua Lighthouse State Park) and associated bowls are favorite areas. These areas offer steep hills for climbing and wide, open land to traverse freely. The parabola dune at Sand Lake is a good hill climb area, while transverse dunes are less suitable being small and rough, and sometimes quicksand occurs between them in the winter. Despite some shifts in use due to closures, concentrated ORV use generally helps to identify the favored areas. The most reliable and effective way to determine specific needs and areas for site designation is to work with the ORV recreationalists -- organized clubs provide a readily identifiable group. Selecting an ORV site in concert with the potential users ensures it will be a positive experience for them and reduces management concerns.

2. Access corridor

Regarding vehicle access corridors, the same approach is applicable.

3. Competitive events

The specific club or individuals sponsoring an event will probably have an idea where they would like to locate it. The location should be jointly worked out between the sponsors, the land holding party, and the adjacent land owners.

B. Size

1. Vehicle play

The sizes of general use ORV areas vary for minibikes, motorcycles, four-wheel drive vehicles, and dune buggies or a mixture of such vehicles, on a local level from ten acres (State of California, 1978, p. 92) to several thousand acres on the state level (p. 60). Pismo Dunes State Vehicular Recreation Area was 810 acres and was expanded to 2,000 acres (State of California, 1975, p. 7; State of California, 1978, p. 60). Turkey Bay ORV area (located in Kentucky and Tennessee) is 2,350 acres in size (McEwen, 1978, p. V). The size determination of an open sand vehicle play area is dependent on the prefered topography, management strategy, and available land. It is difficult to provide a figure for the minimal size of a vehicle play area because its viability is linked with an overall management strategy (total area open coastwide to ORVs, potentially different areas for different vehicle types, management compatibilities, etc.).

A rough estimate to guide a major development for multi-vehicle (motorcycles, dune buggies, four-wheel drive) play areas might be 500-1,000 acres. Smaller sizes may be feasible. The only practical solution is to work with the ORV recreationalists within the constraints of land availability.

2. Access corridor

The length depends on the location of the point of interest relative to a conventional access point (parking lot, pull out for cars, etc.).

3. Competitive events

The sponsors will, or should, have clear specifications as to the area needed for the event itself, parking, spectators, concessions, buffer zones, etc. The planning and actual size determination must be determined well in advance with technical assistance when necessary (e.g. noise buffers).

C. Access Control

1. Vehicle play

There must be access to vehicle play areas, however, <u>it must be controllable</u>. This point cannot be over emphasized. In dune areas lacking abundant natural barriers, the mobility and range of ORVs are important considerations.

First, the number of roads that provide conventional access to an area should be small to facilitate complete control. Any more than one or two access points make management extremely difficult. In the planning of Turkey Bay, access control was very important, and it was limited to one road (McEwen, p. 6). Also, the implementation of temporary contact stations (check booths on access routes) at Pismo Beach helped reduce management problems such as uncontrolled over-crowding and law enforcement (State of California, 1975, p. 48). In area selection, access must be controllable although it may only have to be monitored at certain peak-use periods.

Second, the freedom to traverse a given area is what many ORV recreationalists seek and should be provided for. In beach and dune areas with few functional barriers, this is done best by providing areas rather than trail systems. However, vehicle play should be strictly contained in specified vehicle play areas to limit environmental impacts and incompatibility (regarding noise and esthetics).

The level of management (law enforcement) necessary to patrol a trail system's perimeter as a means of containment is extremely high compared to that for a designated play area. Regarding a vehicle play designation, keeping people on a set of trails is difficult. Thus, the area used for recreational play should be maximized and the management boundary minimized (the area to boundary ratio should be large). This will reduce the management responsibilities and still provide the ORV experience people seek (McEwen, p. 6).

Using natural boundaries that are easily recognized and that functionally limit access further reduce management responsibilities. The ideal boundary is a creek like Ten Mile within the NRA, while the type of boundary to be avoided is a posted line through open sand like the Coos-Douglas County line. In selection of an ORV play area, viable boundaries should be used in conjunction with controlled road access to greatly reduce management responsibilities.

The capacity to control access is important to (1) limit the total number of people into an area at peak-use periods for reasons of safety, public health, resource damage, and law enforcement (i.e. if needed, implement an optimum carrying capacity), (2) obtain accurate user counts, and (3) facilitate distribution of important information (rules, maps, etc.).

2. Access corridor

An access corridor, in reality, constitutes a trail system within beach and dune areas, and thus constitutes a large management boundary that is difficult to maintain. The behavior of the users is critical to keep an access corridor from becoming a play area.

The impact of only a few vehicles disobeying the designation can be great. Thus management may need to be intensive to eliminate depreciative behavior. Vehicle play areas provide for free-sport driving, while access corridors should provide for transportation resulting in minimal environmental impact.

3. Competitive events

Access control is very important at these events to manage crowds in a safe and orderly manner. A clear plan of crowd and access control in an events area is necessary and should be worked out prior to approval of such an event.

D. Staging Area

1. Vehicle play

For a vehicle play area, a simple staging area is necessary. A parking area for conventional two-wheel drive vehicles with ORV trailers is needed, along with adequate litter barrels, a bulletin board to post all needed information (maps, rules, etc.), drinking water and perhaps sanitary facilities. Other facilities such as camping areas are often enjoyed along with the use of an ORV and could be developed as funds permit. Campsites are usually near the staging areas, since they are a natural focal point of activity. Backcountry ORV camping requires policing and maintenance of designated sites, and limitations on the number of campers to avoid land use conflicts (State of California, 1975, p. 53).

2. Access corridor

The only requirements would probably be adequate litter barrels and a bulletin board to post necessary information.

3. Competitive events

Staging areas for a competitive event would refer to the pit area, but the entire layout should be planned with parking, spectator areas, crowd control, etc.

E. Jurisdictional Considerations

The selection of an area for any of the three ORV designations should include analysis of the political and legal responsibilities of the land holding party or parties. In general, fewer agencies simplify management and planning, however, through the management area concept a joint management plan may be developed. Since various agencies have different legal authorities and skills, they may serve to compliment each other, particularly regarding law enforcement and environmental concerns. (For an example see Appendix G). Due to the large impact of ORVs and their potentially damaging effects, management must be in proportion to these problems. Regardless of the number of land holding parties involved, at least one must have the managerial capacity to post, regulate, monitor impacts, and render aid within the area.

F. Adjacent Land Compatibility

Compatibility of all three designations (vehicle play, access, and competition) to adjacent lands must be considered while planning. Practical concerns are wind and water erosion hazards to nearby land uses or valuable habitat. Perhaps a more common problem is the compatibility of ORV noise to adjacent noise sensitive areas, primarily private residences. Use of ORVs in de facto vehicle play areas results in complaints that affect the public's attitude toward ORV use. Some sand dunes on the coast are privately owned and should be respected. DEQ ambient noise standards for residential areas (noise sensitive property) would apply here (see Appendix E), as would the in-use noise emission standards.

The technical determination of buffer type and size to adequately limit noise from disturbing other areas depends on the topography and on other factors. Therefore, in the planning of any ORV designation, especially a vehicular play area and a competitive events area, DEQ should be consulted for specific technical assistance to ensure that a proper buffer zone is established.

To provide a rough estimate of how far ORV noise can be heard, the following is taken from Harrison's "Off-Road Vehicle Noise Measurements and Effects" (In Chubb, 1973, p. 138). The measurements were made at fifty feet with the vehicle accelerating, using practices proposed or established by the Society of Automotive Engineers (SAE).

> The range of sound levels measured at 50 feet was from 74 dbA [decibles on the A scale] for the quietest all-terrain vehicle (ATV) to 100 dbA for the loudest dune buggy. The real question here, however, is how far will these vehicles be audible above a normal forest background. Using the method developed by Fidel, Piersons, and Bennett of Bolt, Beranek & Newman, we determined that the quietest ATV can be heard from 1,500 feet, while the noisiest dune buggy will be audible for 21,000 feet.
>
> Table I embodies many assumptions, one of which is that the background is approximately 45 dbA. Background levels as low as 11dbA have been measured near Lolo Pass, Montana, a popular snowmobiling area. Low backgrounds, downwind propagation, absence of intervening mountains and trees, etc., all could considerably expand the distances shown. Calculating the detectability distance of a vehicle under forest conditions is very difficult, and involves making assumptions which are justified only some of the time. However, these numbers are generally conservative, and probably represent distances which would not be exceeded in more than 25% of the cases.

TABLE I

	Detectability Distance, ft.		
	Quiet	Average	Loud
Dune buggy	3,200	12,000	21,000
ATV	1,500	4,600	6,200
Snowmobile	4,000	8,000	15,200
Motorcycle	4,000	7,000	11,500

The differences in distance show how important noise standards (mufflers) can be in increasing an ORV's compatibility with adjacent areas. How the ratings: quiet, average, and loud relate to the DEQ standards is not easily determined because different tests are used. DEQ uses the twenty-inch test and Harrison used the fifty-foot test. Assuming DEQ standards are not any quieter than the "quiet" rating, a minimum buffer distance might be, roughly, one mile. To determine buffer size, many factors must be considered; the only reliable way is to seek technical assistance.

VII. MANAGEMENT CONSIDERATIONS

A. User Education

User education is both an immediate and long term solution to most of the problems regarding ORV recreation. An informed user should understand the rules, why they exist, how they relate to the individual, and their costs and their benefits to the individual and to ORV recreation as a whole. Special programs could be developed to promote this understanding and responsible ORV use.

B. Posting ORV Designations

If management plans are to succeed they must be understood by the people they affect. All rules and ORV designations must be readily available in written form, posted, and publicized (this is not directly applicable to competitive events areas). Posting should take place on all key access routes to designated ORV areas (play and access), and within the ORV area as well. At an ORV play area posting should take place at the staging areas or other appropriate focal points. At vehicle access corridors, posting should occur where the corridor begins and at various locations along the way.

The distributed written information should include:

1. The type of area one is entering (ORV play area, ORV access corridor, ORV competitive area).
   a. An explanation of what the designation means and what is expected from the ORV recreationalist in such an area.
   b. Why there is such a designation.
2. A simple map indicating where the designated area is and its boundaries.
3. A list of regulations that apply to the area.
   a. Equipment
   b. Conduct
4. Who enforces the regulations and that violators will be subject to prosecution.

Uniform graphic signs should be used to mark each ORV designation and all boundaries. These should be developed with the users and all agencies managing ORVs on the Oregon coast (state and national uniformity in this regard would be very useful).

1. Vehicle play

Regarding the nature of a vehicle play area the following must be understood by all recreationalists:

1. This area has been specifically designated as an ORV PLAY AREA for vehicular recreation.
2. An ORV PLAY AREA is a place where you are free to ride anywhere you wish as long as you stay within the area's boundaries and off any vegetation.
3. This area is provided for hill climbs and other active vehicle uses.
4. In some vehicle play areas, pedestrian use may be prohibited; violators could be prosecuted.

2. Access corridor

Regarding an ORV access corridor the following must be understood:

1. This area has been specifically designated as an ORV ACCESS CORRIDOR.
2. An ORV ACCESS CORRIDOR is a designated path through or to areas of interest (to relax, fish, clam, walk, etc.). Vehicle traffic of any kind is allowed only on specifically identified routes.

   These routes must be indicated on a map and be identifiable in the field. The path would not be an official road since in time it would return to a natural state (revegetate). Vehicles would be restricted only to the predetermined and identified routes; no traffic would be allowed on other routes.

3. Any vehicle off a designed route would be subject to a boundary violation and prosecution.

3. Competitive events

Competitive events areas can be managed according to the event and location. Posting should reflect the sponsors plans and regulations.

C. Law Enforcement

Along with education and posting, an active law enforcement program is necessary to make the management plan work. Safety and resource protection are promoted by some regulations and they must be enforced. Management and enforcement should be in proportion to the real and potential problems of a recreational type; enforcement of ORV regulations should be thorough.

Law enforcement would likely come from a federal agency if on federal land or a sheriff's deputy as support, under Public Law 92-82 (see Appendix G). On county or state land the sheriff and state police would have jurisdiction. The beach is state land and no federal agencies have law enforcement jurisdiction over it, thus, the sheriff or state patrol will need to be included in the law enforcement plan. Basically, the enforcement program would include:

1. Boundary violations
2. Equipment violations
3. Noise violations
4. Operator violations
5. Criminal acts

Law enforcement is expensive but essential in ORV management, because of its extraordinary impact, potential damage of adjacent land, and incompatibility with noise sensitive areas. Planning can effectively reduce the level of management needed but it cannot replace it. Patrolling ORV area boundaries is a big job; self-policing by organized clubs may fulfill a large part of the management requirements.

Self-policing is not law enforcement, but would serve as a monitoring system over ORV activities. ORV clubs could plan and schedule interested people to monitor specific areas on weekends or other peak-use periods. Their function would be, primarily, one of observation and communication. They could encourage compliance with regulations and watch for and report boundary violations. No actual law enforcement would be necessary, but they could serve as a witness and testify as to the violation. Self-policing procedures could be developed and implemented. For example, the volunteer patrols could be linked to sheriff's deputies through citizen band (CB) communications, and if actual enforcement or help of any kind was needed, they could quickly contact the appropriate authorities. This capacity has been demonstrated by ORV recreationalists in search and rescue missions within the dunes. Many of the "rigs" have CB's. Potentially, such volunteer patrols could work in coordination with law enforcement personnel directly or indirectly providing observations and communications. The experience may be positive for the individuals involved, as well as for ORV recreation in general. Since management is necessary and costly, this may provide a substantial part of that management at minimal cost allowing more areas to be open for ORV designation. In special cases, ORV clubs could provide joint assistance in protecting critical habitat areas too. They have the potential to play an active, positive role in recreation management. Their efforts in picking up litter from the back dune areas is a good example.

D. Safety

1. Equipment

To promote public safety, uniform ORV equipment requirements should be adopted and uniformly enforced on all public lands throughout Oregon (better still, nationally). At present, there are state equipment requirements for ORVs only in the NRA (ORS 483.837-483-847) (Appendix D). Those requirements serve as a basis for the following suggestions and specifications:

a. Muffler

A muffler should be required which meets in-use noise emission standards (decible limits) and visual inspection standards. There are already DEQ standards for ORVs in the State (see Appendix E).

Enforcement of DEQ standards will reduce the potential for operator hearing loss. There is considerable literature demonstrating how noise can have an effect on hearing. Evidence indicates hearing loss can result from the operation of an ORV (snowmobile) (Bess, 1973, p. 147). Vehicles participating in competition are usually exempt from noise restrictions, but the spectators should be aware of a potential hazard from long exposure to noise. Noise limits may also help increase the compatibility of an ORV area to adjacent land.

b. Flags

All vehicles operating in vehicle play designations should have a flag, especially small vehicles such as three wheelers and motorcycles. This is to increase visibility around blind corners that are everywhere in the dunes. Increased visibility should reduce the likelihood of collisions in heavily used areas. These blind corners and hills are dangerous even when extreme caution is used. The flag must be red and at least eight inches wide on one side and twelve inches long to the other. It should be displayed at least nine feet from the ground level.

c. Brakes

Brakes must be hydraulic, except for motorcycles, and must effectively control at least two rear wheels on three or four wheeled vehicles, and the rear wheel of a two wheeled vehicle. Motorcycle brakes may be mechanical or hydraulic.

d. Seat Belts

All vehicles, except motorcycles, must be equipped with seat belts for each occupant. Seat belts must be of the quick release type and must be securely fastened to a frame member.

e. Roll bar

All vehicles, except motorcycles, must have installed a roll bar or other enclosure that will support the vehicle's weight, and must protect the occupant's head when the vehicle is resting on the roll bar or enclosure.

f. Lights

Every vehicle operating from one-half hour after sunset to one-half hour before sunrise shall be equipped with and display headlights and taillights. Definite specifications should be adopted.

g. Seats

All seats must be securely mounted.

h. Fire extinquisher

All vehicles, except motorcycles, must be equipped with a functional, dry chemical-type fire extinquisher of at least two pounds. Fire extinquishers must be approved by Underwriters Laboratories or another acceptable testing agency.

i. Chain guide

Any vehicle equipped with a chain shall have a guard designed so that in the event of failure, the chain will remain under the vehicle.

j. Floor pan

All vehicles, except motorcycles, must be equipped with floor pans. Motorcycles must be equipped with foot pegs or the equivalent. Floor pans and foot pegs must be designed so they will keep the driver's and any passenger's feet within the frame or from beneath the vehicle.

k. Fuel tank

All fuel tanks shall be securely mounted and connections kept secure and tight.

l. Windshield wipers

Any vehicle, except motorcycles, equipped with a windshield must have a windshield wiper.

2. Rules of operation

In addition to equipment requirements, operating restrictions should be developed and enforced:

a. Prohibit the operation of an ORV while under the influence of any drugs and include an open container law.
b. Prohibit the harassment of any wildlife or livestock with an ORV.
c. Prohibit boundary violations.
d. In access corridors, establish a maximum speed limit of 15 mph whenever a pedestrian is present and 25 mph when they are not present; the speeds should be lower if the conditions warrant it. This is consistent with the concept of an access corridor and will provide vehicle access, greater compatibility, and safety for all recreationalists. This is especially important on beaches where both vehicles and pedestrians are allowed.
3. A junior operator's education and certification program could be developed similar to the hunter safety program and snowmobile program.

3. ORV designation

Understanding the ORV designation system should promote safety. Both pedestrians and vehicle operators should know what to expect while in a given area.

Typically in planning ORV play areas, high pedestrian use areas should be avoided. However, if an ORV play area experiences high levels of use and overlaps with a pedestrian area, pedestrian use should be prohibited and the pedestrian closure enforced.

Generally if pedestrians enter an ORV play area they should be aware vehicles will be present, and it is potentially hazardous. However, ORV operators should always proceed carefully over dunes because either a pedestrian or a vehicle could be hidden on the other side.

In access corridors, pedestrians and ORV users should expect to encounter each other. People should not camp in access corridors such as beaches. If everyone knows where vehicles will be operating accidents will be prevented.

E. Compatibility

1. Adjacent land uses

The compatibility with adjacent land uses is primarily a concern in the planning of an ORV designation (ensuring critical habitats were avoided, erosion hazards were considered, noise buffers were established, etc.). Thus, management can only be an extension of the overall plan ensuring ORVs stay in the appropriate areas. Enforcement of the boundaries and noise limits are the most practical follow-ups to ensure an ORV designation is compatible.

2. User compatibility

The compatibility of different user groups, primarily motorized and non-motorized, is a concern. Differences in esthetic values and the types of recreational experiences sought result in what is often called user conflict. The only practical solution to this problem is to provide some areas that meet specific recreational needs. Heavy use in ORV play areas functionally exclude other types of recreation. Sand Lake in Tillamook County is an example. The area's heavy traffic, high speeds, and noise make it primarily suitable for ORV activities. Specific play areas should be designated and maintained for such recreation. On the other hand, areas without any ORVs should be established to offer an environment free from the noise and the reminders of machines. Thus, separation and clear posting of the designations will inform people what to expect in a given area. This will reduce disappointment for those who seek specific recreational experiences.

If people wish to test their vehicles and drive actively, then they should go to a designated ORV play area. Likewise, if people seek a quiet natural setting free from machines, then they should go to such an area. Separation will work, but what proportions will be allotted to various groups? Allottment may be based on: (1) the area needed for the given recreational experience, (2) the relative numbers of individuals seeking the given recreational experience, (3) the overall environmental impact of the activity, and (4) the availability of land (which is finite).

Also, some unique recreation areas probably cannot be divided so specific interests may have to give way to more general interests. For instance, an ORV play area would be typically unsuitable for an area used for many other activities, while an access corridor may be suitable. However, multiple use of all land is not feasible since it does not provide the specific experiences sought by motorized and non-motorized recreationalists.

F. Environmental Monitoring Plan

Since ORV recreation is mechanized, it must be carefully monitored to determine what environmental impacts are taking place. This could be done in detail with scientific studies starting with baseline data from a thorough inventory or perhaps a simple and less expensive approach could be used.

The most basic concerns would be shifts in wildlife populations and changes in vegetation. True baseline data for areas already ORV impacted are difficult to obtain, but data from present inventories and academic research should be of some use. Monitoring census statistics and distribution is a big job but an effective effort must be made.

To monitor changes in vegetation destruction and dune migration, yearly comparisons of aerial photographs would be easy and effective. It would illustrate major changes in vegetation patterns and the resulting erosion. This would also show if boundaries were being observed, particularly in access corridors. Sources of aerial photos could include the Oregon Department of Transportation and the Environmental Remote Sensing Applications Laboratory (ERSAL) at Oregon State University.

Based on aerial photos and field observations effective changes in management strategy and boundaries could be made, as well as an overall assessment of management effectiveness. Development of such a monitoring program is necessary prior to the designation of an ORV area. In this regard, a joint management plan could prove useful to obtain biological expertise from one of the agencies involved. By Executive Order (Nixon, 1972) all federal agencies, including the U.S. Forest Service, must monitor the effects of ORVs on lands within their jurisdiction.

G. Special Events Permits

Special events permits for organized ORV events such as sand drag-races on public property usually address the issues of liability, performance, and planning. This discussion only suggests what some permits include--legal counsel and persons knowledgeable about insurance should be contacted if a permit is to be issued. (See Appendix G for an example).

1. Liability

The land holding party should be indemnified against all damages (to property and life). This could include naming the land holding party as a co-insured party. The land holding party should require sufficient insurance be held by the event's sponsor to cover any damages resulting from the event.

2. Performance

A performance guarantee should be obtained from the event's sponsor perhaps as a bond or security deposit. If the sponsor fails to carry out the tasks agreed to, then the land holding party would use the deposit to carry out the tasks neglected. Trash removal, restoration of stabilizing vegetation, etc., can be expensive.

3. Adjacent land

If an event is to occur, the adjacent land uses should be given consideration. Specifically, private land and residences must be protected from trespass and nuisance acts.

4. Events plan

A complete plan for the event should be required. It should describe in detail provisions for access control, parking, crowd control, sanitation, security, cleanup, distribution of regulations and other information, fire prevention, and a mapped site plan.

5. Requirement deadlines

Planning should be done well in advance, prior to the granting of formal approval. The land holding party should allow ample time to review the sponsor's plan and suggest additions or deletions to it.

VIII. SAND LAKE

A. Background and Analysis

Sand Lake is a small undeveloped estuary twelve miles southwest of Tillamook, Oregon. There exists an open sand area of roughly 1.5 square miles and most of it is heavily used as an ORV play area. The use has grown rapidly in the past few years, however, user counts are not available from the Unites States Forest Service. The Forest Service administers the campground and adjoining federal land.

Numerous problems have developed which reach crisis proportions on major three-day weekends. How these problems relate to the comprehensive planning process and to ORV management in general make Sand Lake an excellent example on which to focus.

Sand Lake exhibits the classic problems: (1) extreme over use, (2) significant environmental impact, (3) multi-jurisdictional area, (4) incompatibility with adjacent lands, and (5) requirements to comply with LCDC's goals. These problems can be categorized as either a management problem or a legal policy problem, although the two are related.

The management problem consists of the first four topics listed above. However, the most fundamental issue is simply -- severe over use. User demand far exceeds the limited open sand area because of Sand Lake's proximity to Portland and other major urban centers. It is the only recognized ORV area on the northern half of the coast, so use in this region is focused at Sand Lake.

In such over-crowded conditions, impact can be expected to be extraordinarily great. Vehicles are not limited to the truly open sand areas. ORV use has destroyed large areas of vegetation and cut deeply in the foredune and dune hummocks, reducing the latter to small barren sand mounds that will erode leaving just sand (see Figures 4 and 5). Perhaps the two bowls and other open sand areas are insufficient in size and topography to satisfy the users. A balance must be reached when demand reaches the limit of the resource or when user satisfaction declines. Satisfaction for some users has declined at Sand Lake as evidenced by ORV club members speaking of it as a "no man's land" filled with the "crazies" on three-day weekends.

If it is a no man's land, where are the land agencies and an enforcement program? They are outnumbered and doing what is possible within the limits of human safety to enforce the regulations. Typically, this is Forest Service personnel supported by the Tillamook County Sheriff's Department under a special agreement (see Appendix G).

There are really two sets of jurisdictions at Sand Lake--the land holding agencies and the users. The land holding agencies are the Forest Service, the State of Oregon and Tillamook County (see Figure 6). The county land lies between the State beach on the west and the Forest Service's campground on the east and extends north across Galloway Road for some distance. ORVs freely traverse all three lands.

Regarding the users, there is the public using the general facilities and there is the Northwest Trail and Dune Association. The Association is highly organized and has a special use license to hold up to seven drag races (sand drags) between April 1 and October 15 through 1983. The agreement was entered into by the Commissioners of Tillamook County in March of 1978 (see Appendix H).

In addition there are private residences along the eastern perimeter that report trespass and various types of abuse from some ORV users (see Appendix I) and feel the vegetation destruction is a threat to their property. Much of the stabilizing vegetation in the

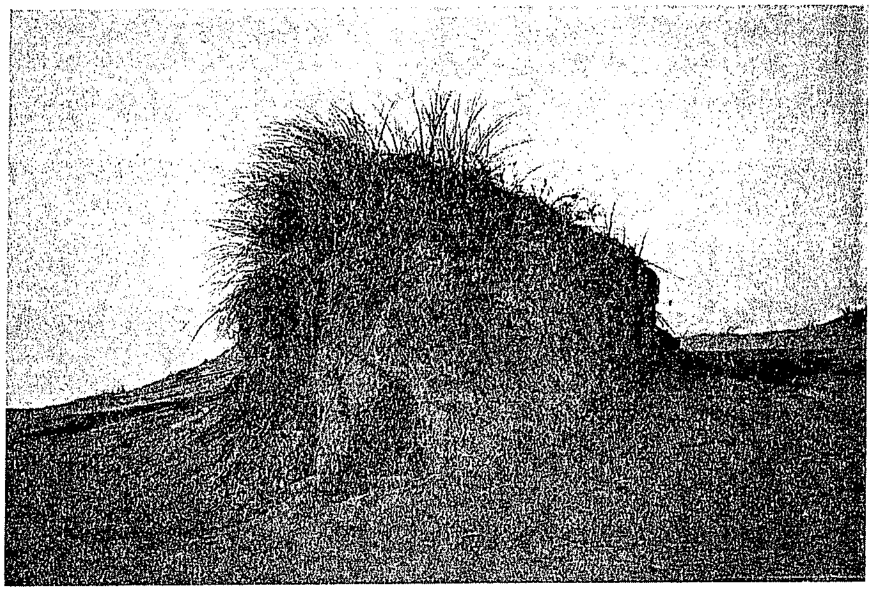


Figure 4. Dune hummock cut on all sides by ORVs at Sand Lake, Tillamook County, Oregon.

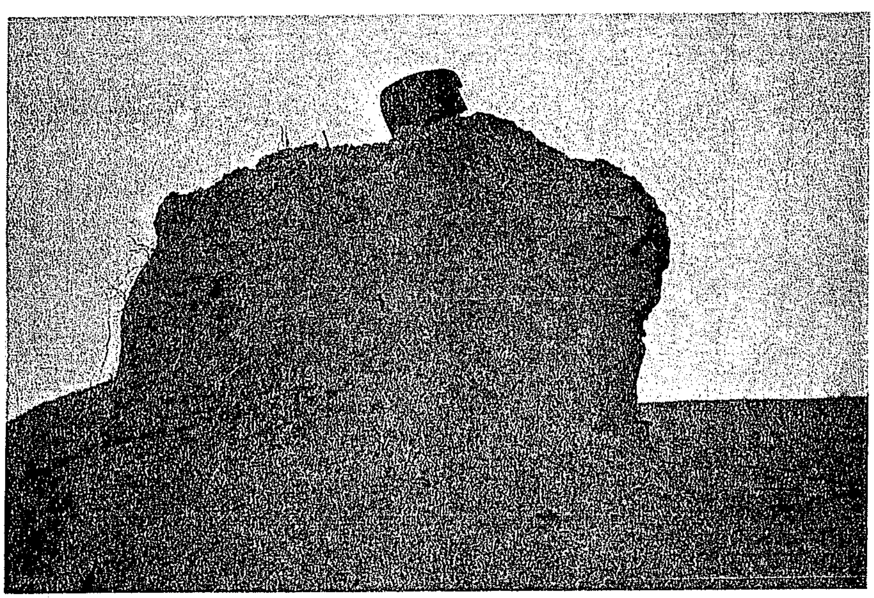


Figure 5. A barren sand mound cut by ORVs at Sand Lake. The black object is a 135 mm camera case.

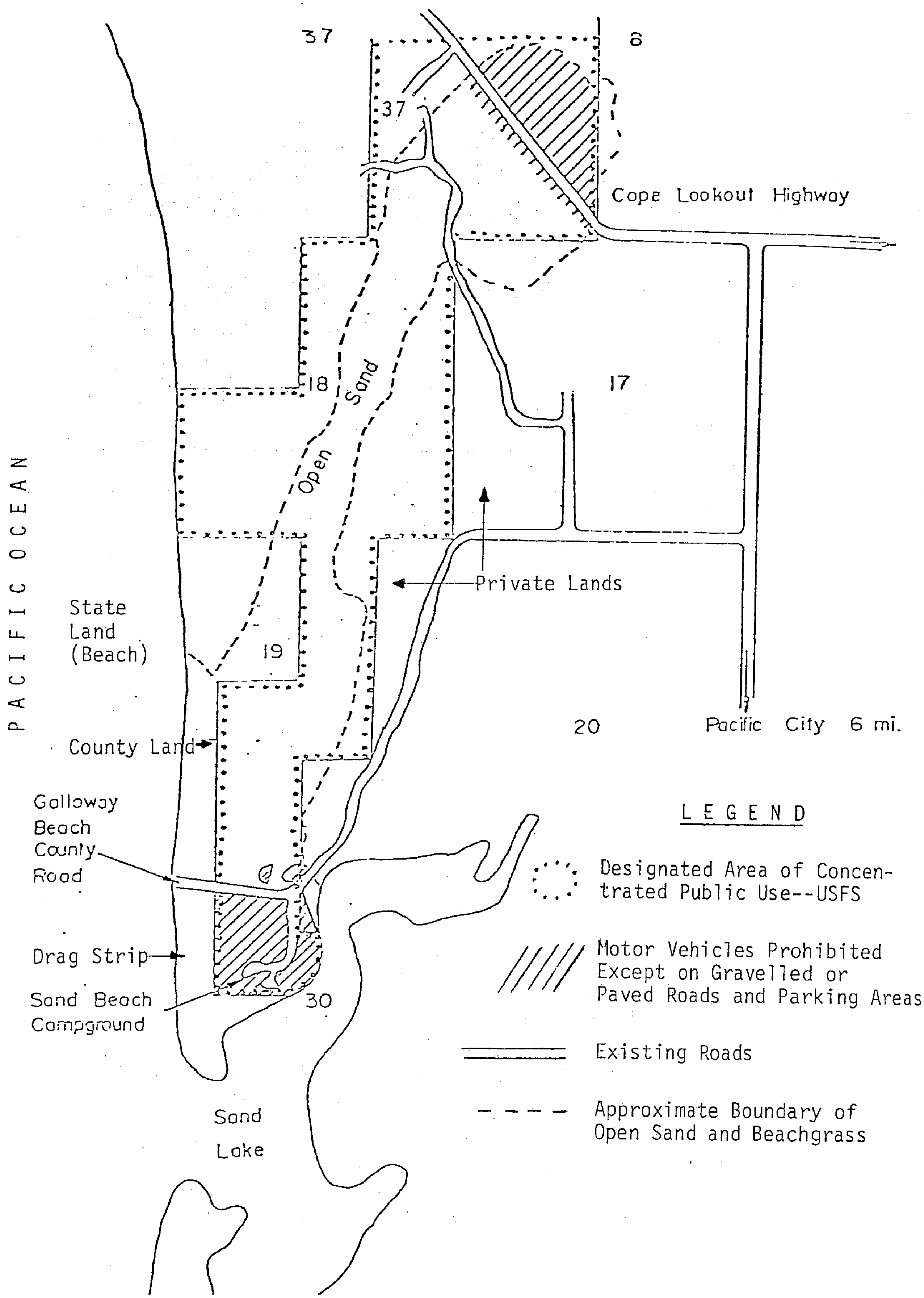


Figure 6. A map of the Sand Lake Dunes Area illustrating areas of concentrated public use, and areas of regulated cross country motor vehicle travel. Map also illustrates the various land holding agencies in the Dunes Area--U. S. Forest Service, the State of Oregon, Tillamook County and private land owners.
Source - U.S. Forest Service

area, planted at considerable public expense during the 1930's, has been allowed to be destroyed by sanctioned ORV use (Ternyik, 1978). Fire associated with ORV dune camping and vehicle operation is a potential threat to the security of these private lands.

Also, there is a question of dune migration onto these private lands. A soils report by the Forest Service (Bush, 1976) indicates vegetation will continue to take over the open sand, and the effect of ORVs is merely to alter the vegetation's appearance, not significantly changing its rate of encroachment. The active sand migration is not mentioned as a threat to the nearby private land. Ternyik (1978) indicates sand migration may be a threat to these lands.

In addition to all the parties involved (federal, state, county, private land owners, a private club, and the general public) is the issue of compliance with LCDC's land use goals. The Beaches and Dunes, Estuarine, Coastal Shorelands, and Recreation Goals directly apply. They must be dovetailed to produce a viable plan.

Sand Lake is classified as a natural estuary by LCDC; it is one of five in the state. Such a classification determines what activities will be allowed within the estuary. Since it is classified as a natural estuary, only natural management units can be established within it. In establishing these natural management units, the following must be considered: (1) adjacent upland characteristics and existing land uses, and (2) compatibility with adjacent uses, according to the Estuarine Goal. Therefore, an assessment of the upland ORV activities' compatibilities relative to the estuary is necessary.

The uses of a natural estuary are very specific (Administrative Rule Classifying Oregon Estuaries):

> Natural estuaries shall only be used for undeveloped, low intensity, water-dependent recreation; and navigation aids such as beacons and buoys; protection of habitat, nutrient, fish and wildlife and aesthetic resources;

In light of these considerations, the compatibility of the ORV use should be determined. To analyze this problem, two separate criteria may be used: (1) the impact of ORV activities on the ecological processes of the estuary, and (2) the impacts on the natural esthetic resources of the estuary and upland area. It is reasonable to consider only the ecological impacts actually on the estuary which would include upland impacts if they affect the estuary. The ORV impact on the upland area would be a separate issue if it does not directly affect the estuary. The esthetic consideration must be broader including the upland area, since the esthetic perception is impacted by what is seen and heard in the entire area.

ORV activity at Sand Lake is not a single phenomenon. In a compatibility assessment it may be separated into two activities: the club's drag strip, and the general public's ORV use. The estuarine compatibilities of both are conditional with regard to the ecological impacts, and subjective with regard to the esthetic impacts.

First, consider the drag strip activity and its facilities. The drag strip is located close to the estuary's edge (estimated less than 1,000 feet). There are permanent structures erected--two steel guard rails and a tower. The strip was leveled removing the vegetation and a gravel parking area established. The boundary along Galloway Road has a log barrier built by the club. Many thousands of dollars are invested in the facility. Their races are nationally sanctioned "drags". When the drag strip is not in use, its ecological compatibility is high since there is probably minimal impact on the estuary. The drift log barrier serves to limit ORV access south of Galloway Road toward the estuary. However, the beach provides access onto the foredune, north spit area, and estuary.

On race-weekends the drag strip area is filled with several thousand people. Control of the crowd and their vehicle activities is the condition of compatibility. If ORVs are not operated in or on the shore of the estuary, then there will probably be little direct impact on the estuary. The unrestricted noise and heavy general disturbance of the area would likely add to the disruption of the adjacent nesting snowy plover located on the north spit area during the months of April through June.

Esthetic compatibility on non-event weekends is low due to the presence of the permanent structures and the conspicuous man-made open sand area. The tower is colored with earth-tones making it less conspicuous.

On the race wekends, the esthetic compatibility is extremely low relative to the natural esthetic resources criterion. A drag strip with its hundreds of vehicles and noise are not consistent with a natural setting.

In summary, if the drag races are strictly controlled and occur only at certain times of the year, it may be compatible ecologically but esthetically it is incompatible.

Similar to the club's compatibility is that for the general ORV use. The direct effects on the estuary are potentially less because most of the vehicle activity appears to be north of Galloway Road. However, there is significant ORV use on the foredune south of Galloway Road, on the north spit (may effect the nesting plovers), and sometimes in the estuary. Again, the compatibility is conditional on the restricted use of ORVs in or immediately adjacent to the estuary, which at present is low.

Vehicles, their tracks, and their noise diminish the natural esthetics of the estuary. Also, the upland use of ORVs has resulted in the highly visable vegetation damage and background noise which are not compatible esthetically.

In conclusion, the drag strip is more compatible than the general ORV area because it better meets the condition of use (no operation of ORVs in or immediately adjacent to the estuary). Presently, the general ORV activity is not a compatible upland use ecologically. During the plover nesting period, both activities are incompatible with the natural estuarine classification which specifically protects all wildlife. Esthetically, both the drag strip and general ORV use are not compatible adjacent land uses.

B. Policy Recommendations: Goal Compliance

To meet the criterion for ecological compatibility, no estuarine impacts should result from ORV use, regardless of the location. It appears this condition can be met if ORV use is limited to the area north of Galloway Road. The drag strip is located on the south side of the road but may be ecologically compatible provided no vehicles (competitive or recreational) operate near the estuary, the crowd is controlled, and no races are held April through June. These suggestions are probably viable means to make each activity ecologically compatible with adjacent land uses.

Esthetically a compatible land use should reflect the same natural esthetic resources of the estuary itself. Both ORV activities fail to do this and are not compatible adjacent land uses.

The intent of the Recreation Goal and the Beaches and Dune Guidelines is to provide for ORV recreation in an "appropriate" location. Sand Lake, in light of the estuarine designation, its implications, and the other problems discussed, is not the best location. However, on the northern half of the coast it provides the only open sand area for ORV recreation. Thus, Sand Lake, in spite of its multitude of problems, is fulfilling a recreational need.

Sand Lake provides a regionally unique recreational and ecological experience within Oregon. If the ORV area is brought into compliance as a compatible adjacent land use ecologically and no permanent land committment is made to ORV recreation, Sand Lake should remain open as a designated ORV area (including the appropriate vehicle play areas and access corridors) for an interim period of several years. This does not reconcile the non-compliance on the basis of esthetic compatibility. The value ecologically and esthetically of Sand Lake will increase dramatically as the number of natural areas diminish in the future. Therefore, over the interim period, an alternate site for a major ORV park should be developed near the major metropolitan areas. Ultimately, ORV use at Sand Lake should be phased out.

Regarding the Northwest Trail and Dune Association's drag strip, it is in reality a regular drag strip and is sanctioned as one. A specialized use on unique public land which is inconsistent esthetically with a specific land use goal may be inappropriate. The Association has a very good reputation for managing its events and this should be given consideration. However, the nature of the event cannot be changed. It appears reasonable during the interim period to seek a location more suitable for a drag strip nearer a large metropolitan area.

C. Management Recommendations

1. Develop a joint management plan

Develop a joint management plan for the entire area giving consideration to the estuary, federal land, state land (the beaches), county land, and private land. The ORV activities affect all these lands in some way and so the planning and management should encompass the entire area affected. The parties involved in such planning should include the Forest Service, the State, the County, the Northwest Trail and Dune Association, and the local residents. Formation of an advisory council may promote communication and help to provide information during the planning stage.

2. Control all access

Access control during peak-use periods can be used to limit the total number of people in the management area. This will reduce health, safety, environmental impact, compatibility, and law enforcement problems. Derrick Road should be closed as an access route for recreation and the road off the Cape Lookout highway should be closed or at least controlled.

3. Establish a total capacity for the area

Set a total capacity for the management area including federal, state, and county land. A special use permit system could be used to implement it. Permits for peak-use periods would be obtained in advance to secure entry into the area. A fee may or may not be needed. Distribution of permits and other details should be jointly worked out and well publicized in advance.

A set capacity for the general use area and the drag strip area would have to be determined respectively, and their sum would be the total capacity for the area at a given time. If races were not held on major weekends, then the drag strip's capacity could be larger and the total capacity would not be exceeded.

4. County responsibility

The county should be responsible for the provision of water and trash removal for activities it sanctions.

5. Back dune camping restrictions

The number and location of campers should be restricted to prevent damage to vegetation, trespass on adjacent private land, and other problems. Camping should be allowed only in designated areas. It could be located in the "county strip" along the deflation plain and should not be anywhere on the north and east sides of the open sand areas near private land. Such restrictions will provide for camping and reduce trash and resource damage problems. Another alternative would be to close the area to overnight camping altogether.

6. Law enforcement

A law enforcement plan should be an integral part of the overall management plan. All lands should be covered through a joint enforcement plan and patrol. The beach and estuary are areas requiring special attention. To manage the resource effectively, a high level of enforcement is necessary. This would include a high enforcement profile on the part of the Forest Service.

7. Beach status

The short stretch of beach from Galloway Road south to the estuary outlet should be closed year around to ORVs and enforced. This will provide a beach area for pedestrian recreationalists to enjoy without vehicles passing immediately by them. The majority of the Sand Lake area is open to ORVs so a small closure for another recreational pursuit seems reasonable. It may promote safety and reduce user conflict.

This closure would protect the estuary from ORV traffic which is a necessary condition for upland ORV use. Regarding erosion, it is advisable to keep vehicles away from the outlet area (Komar, 1978). Also, the snowy plover nests on the spit area and should be protected from disturbance during that period (April through June). Pedestrian disturbance should be discouraged by posting it as a nesting area.

It is a viable closure since the area is readily identifiable (where Galloway Road intersects the beach south to the outlet). It could be posted and enforced. Also, the adjacent foredune should be enforced as a closure forming a viable buffer between the general ORV activity and the estuary.

The protection of the estuary and its wildlife, public safety, and increased user compatibility all warrant this closure. Simply, if this buffer is not established and enforced, ORV activities will continue in and around the estuary which is a violation of the Estuarine Goal.

8. Residential protection

On peak-use weekends a peace officer with the power of arrest should be assigned solely to patrol Galloway and Derrick Roads offering protection to private property against trespass and harassment.

9. ORV practice area

An ORV practice area for children or others learning to operate an ORV should be established. The deflation plain and the small dunes nearby (north Galloway Road and between the foredune and gravel parking area) may be suitable. It is relatively flat, but offers some small dunes to learn on and is close to the campground so parents can check on their children. This concept is to promote fun for the children, peace of mind for the parents and relative quiet in the campground. Few people enjoy hearing someone drive endlessly through a campground.

10. Environmental monitoring program

A program should be developed that monitors changes in vegetation and sand movement. Aerial photography may be a useful technique. Also the snowy plovers status could be monitored.

IX. COASTAL ORV AREAS

The vast majority of ORV use on the Oregon coast occurs on or within the Oregon Dunes National Recreation Area, Sand Lake in Tillamook County, the north spit of the Coos River and the beaches open to vehicles. The areas described and mapped (by county) are typically those of heavy use and large size. Small, lightly used areas are not generally included, however, they may be significant in regard to erosion (see Maps 1-25).

The areas mapped were identified by one or more methods: aerial photography (from ODOT and ERSAL), a flight from Newport to Brookings, field observations (from vehicles and on foot), and interviews with various ORV clubs.

The topographic maps indicate <u>generally</u> the locations of areas used by ORVs, not necessarily the actual boundaries of such use. The various beach zones are <u>not</u> indicated on the topographic maps. To determine the vehicle status of a beach area refer to the Oregon State Highway Commission's maps. If a beach is open, one can assume it will be used by ORVs to some degree.

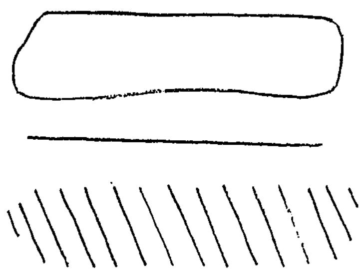
Finally, identification of areas suitable for ORV use should be done carefully on a case by case basis including coastal and statewide coordination to balance regional supply with demand. Coastal ORV use should not be totally separated from that of the rest of the state. Presently, there seems to be a need for a major non-coastal ORV area near the large metropolitan areas (Portland area).

Coastal areas that are <u>potentially</u> suitable for an ORV designation, are crosshatched on the topographic maps. The areas identified are already in use with one exception. The mapped areas are <u>not</u> the only open sand areas potentially suitable for an ORV designation. The mapping and determination of ORV access corridors should be done on an individual basis so they are not mapped. The final determinations of ORV designations require careful planning and management decisions locally and regionally that are beyond the scope of this work.

MAPS 1-25

Vehicle Status of the Ocean Shore,
Areas of Present ORV Use, and
Areas Potentially Suitable for ORV Designation by County

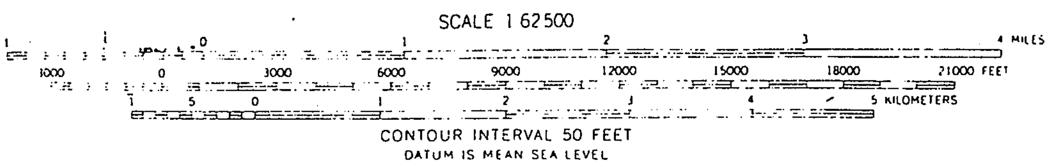
K E Y*



Enclosed areas indicate general ORV use

A single line indicates an ORV trail

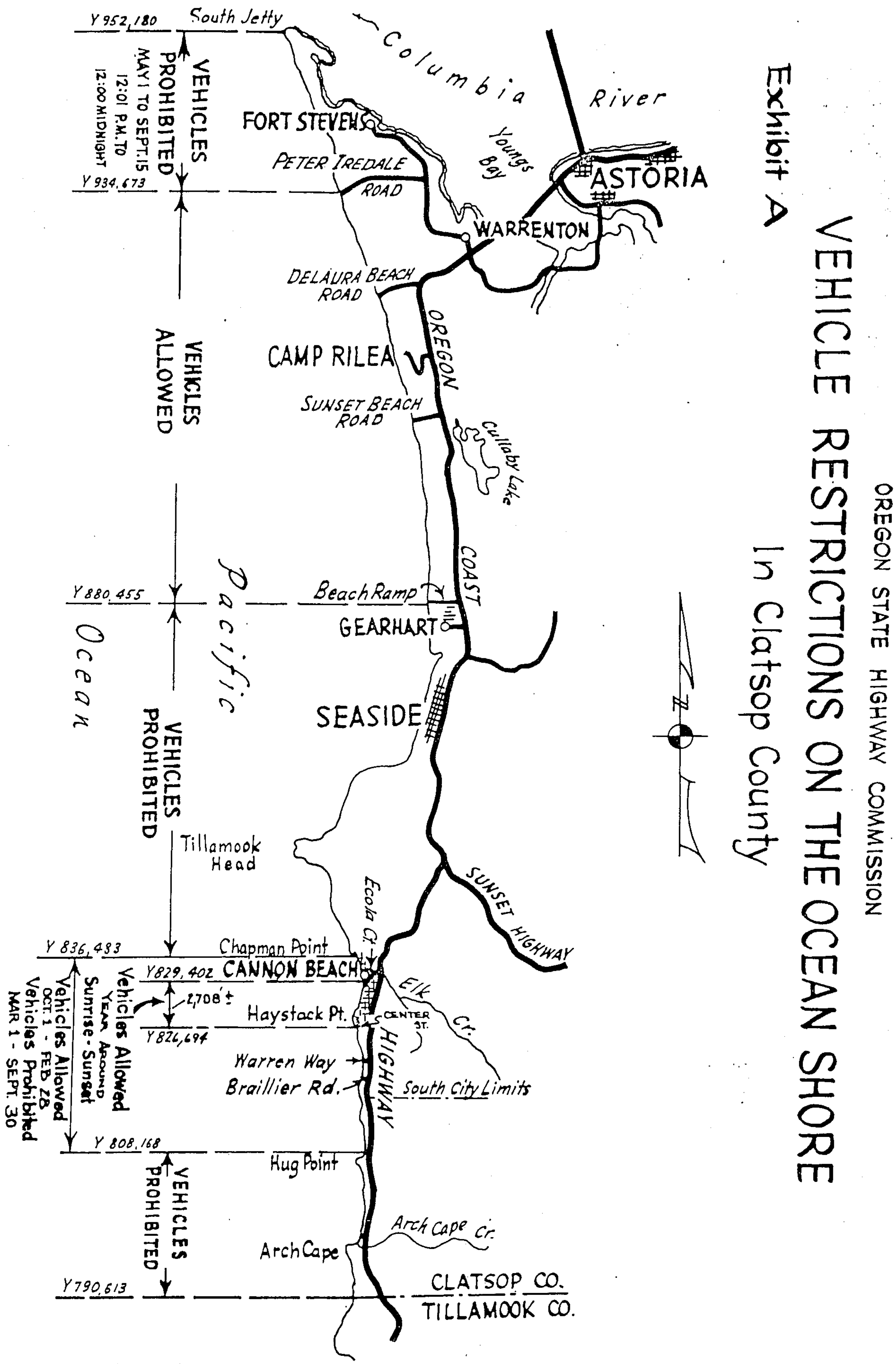
Crosshatching indicates areas potentially suitable for an ORV designation



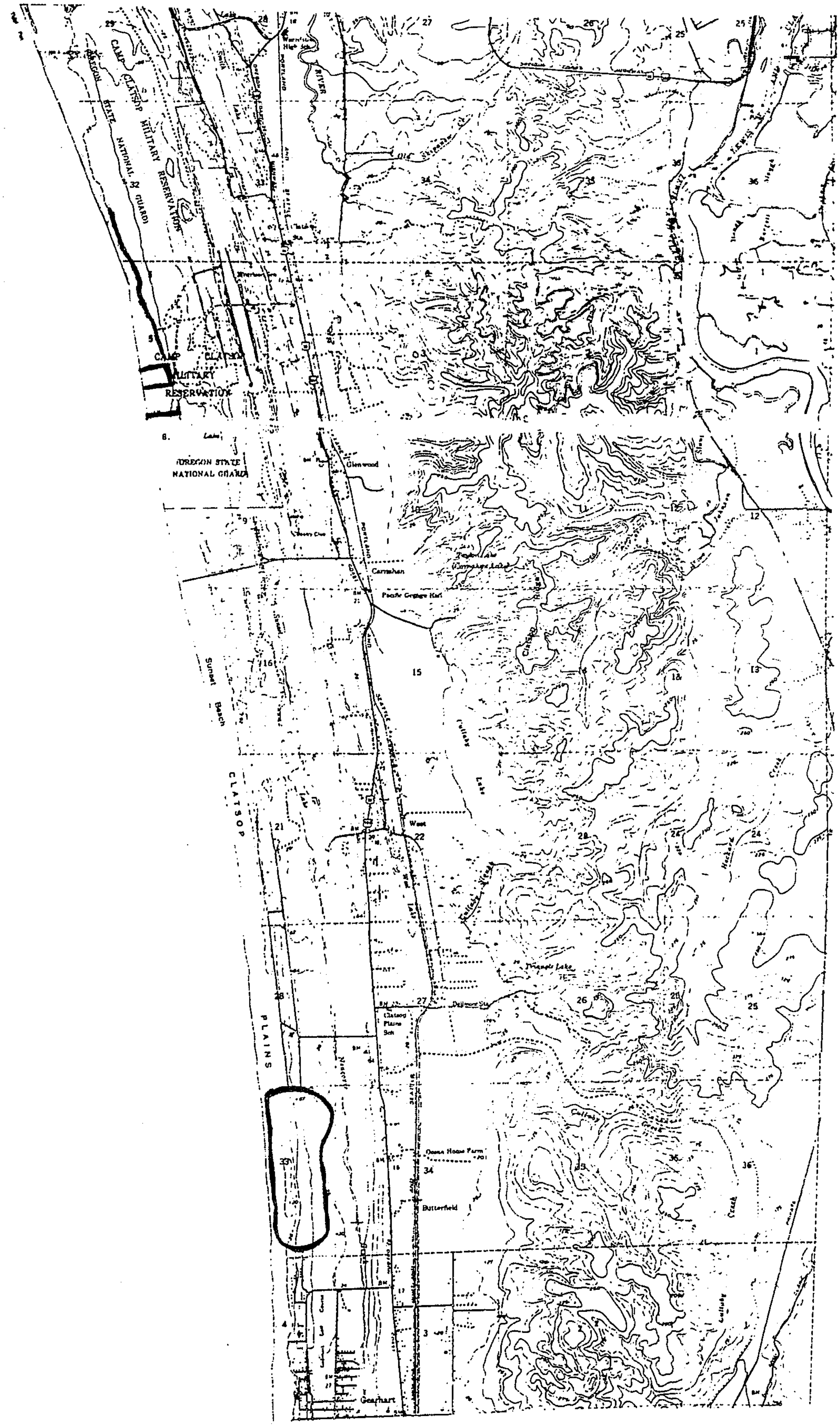
Scale in Miles

*The key and scale in miles applies to the topographic maps.

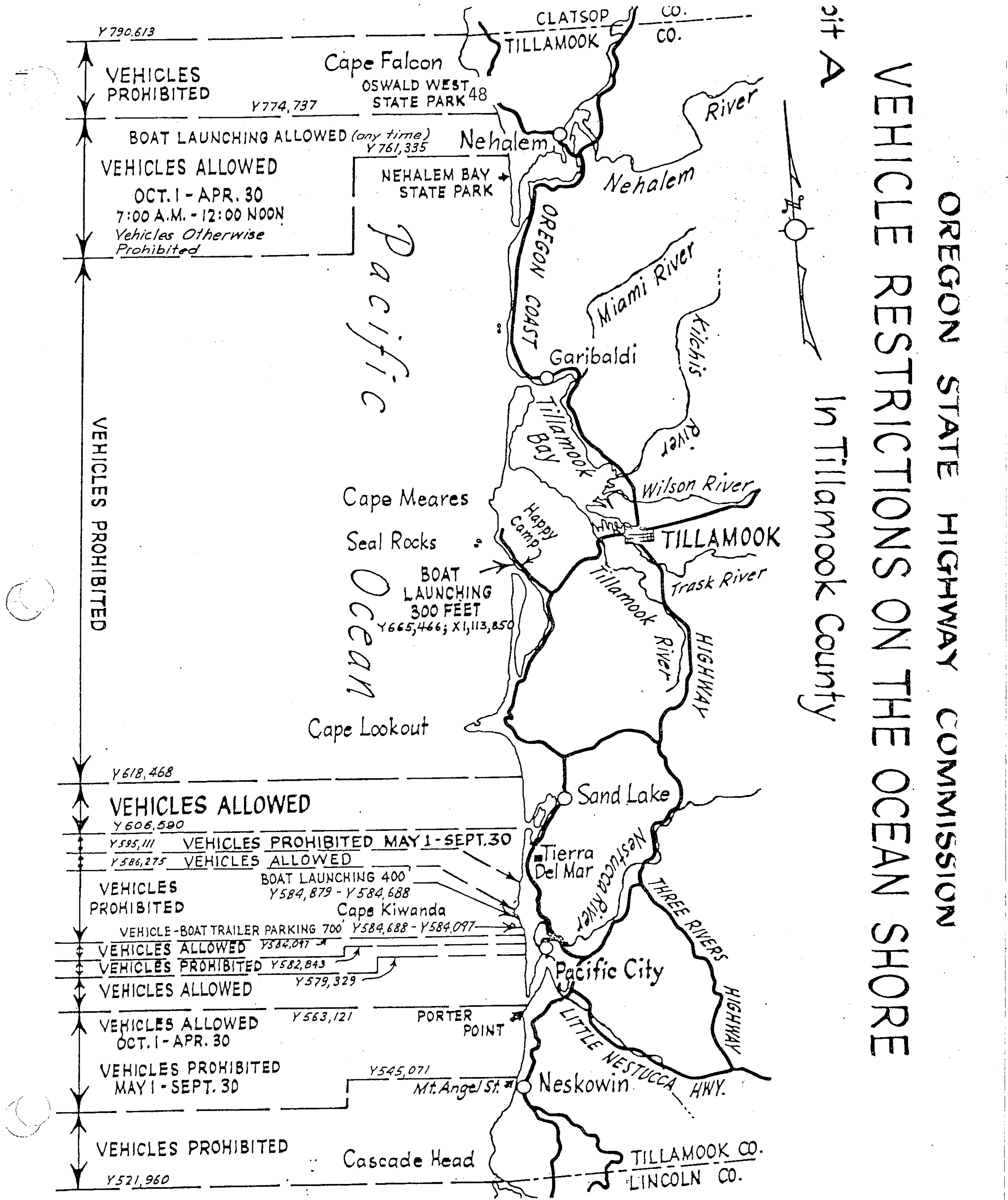
Map Sources: Oregon Coastal Conservation & Development Commission
Oregon State Highway Commission



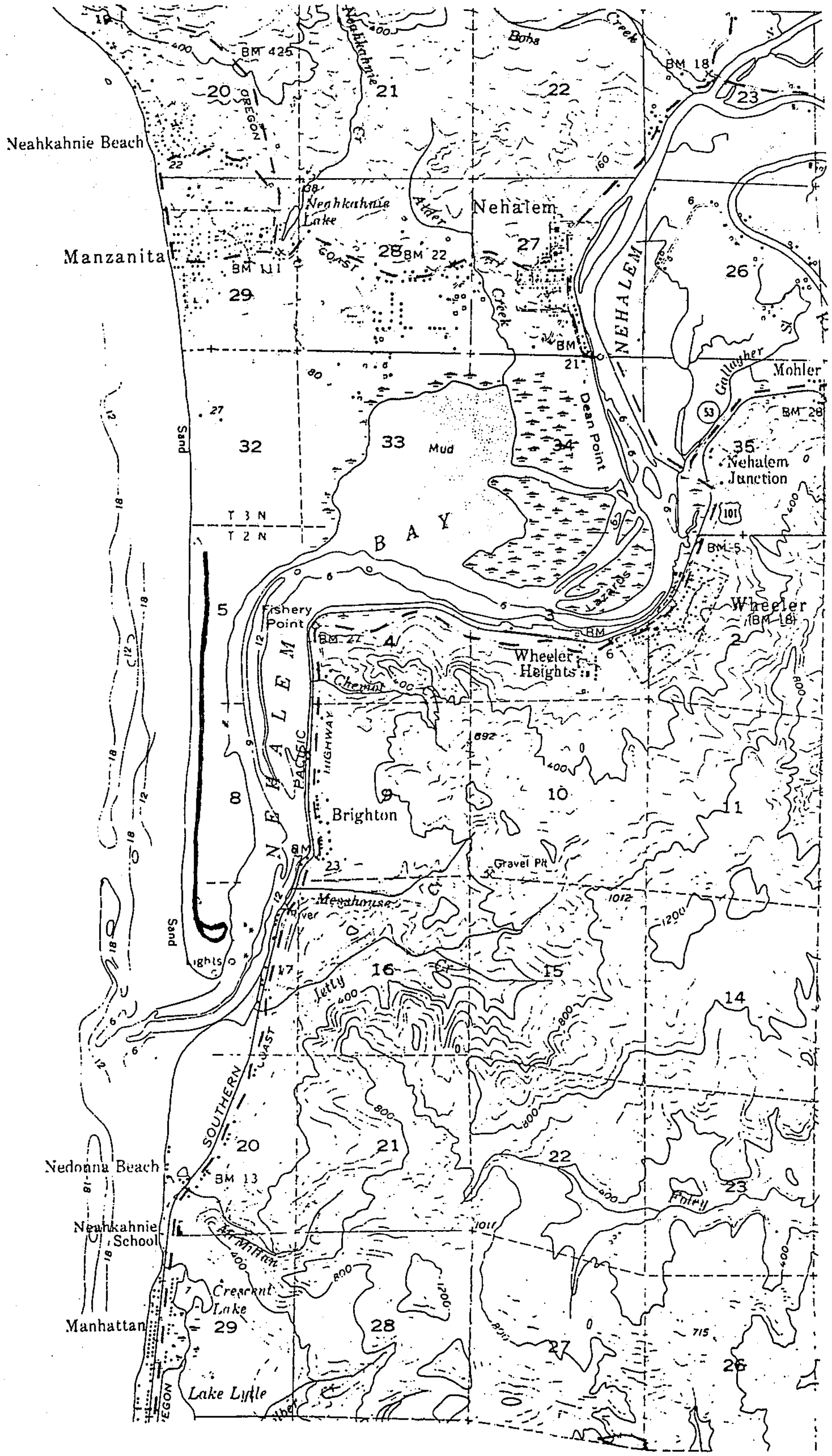
Map 1. Clatsop County beach status.



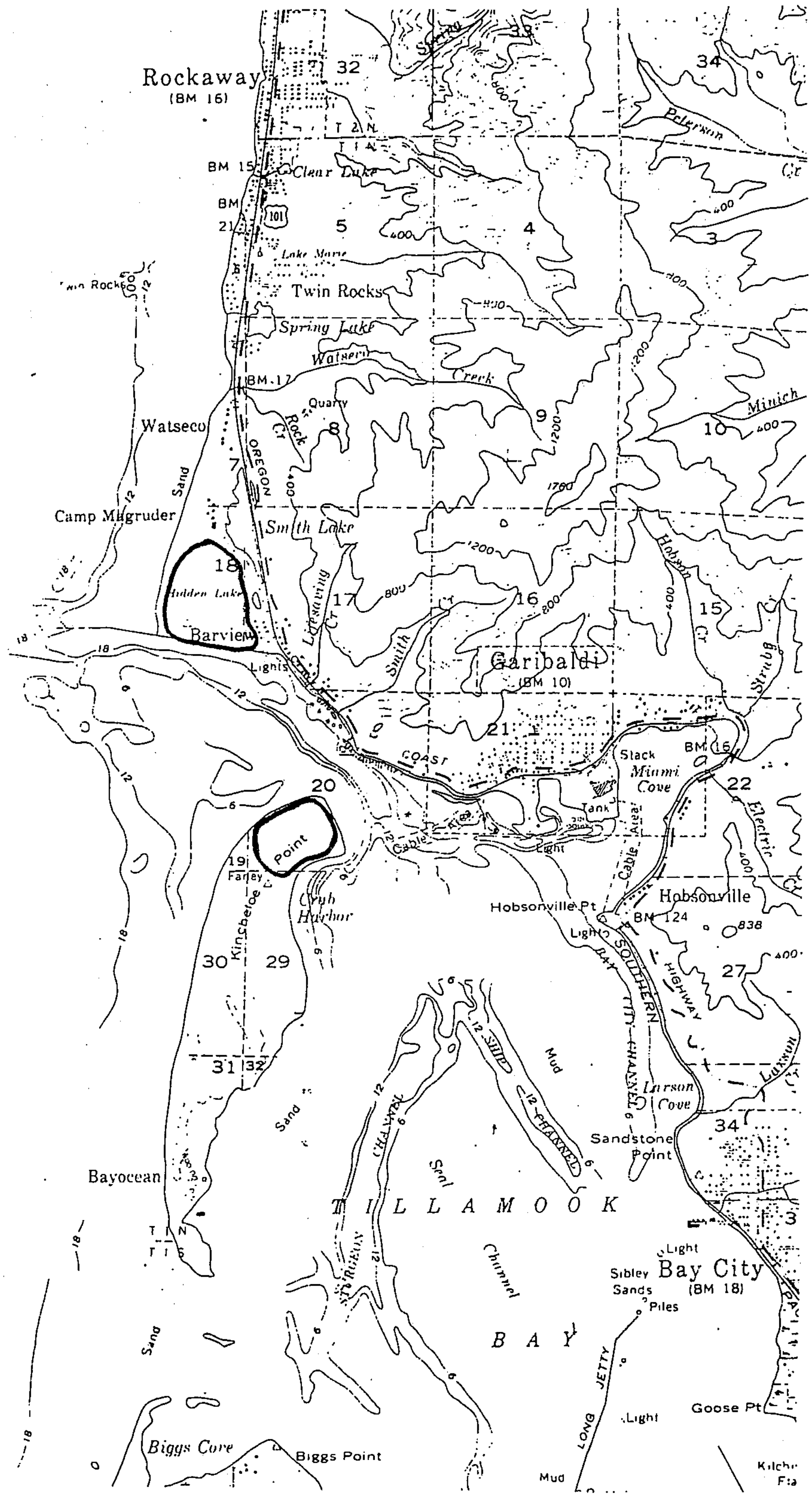
Map 2. ORV use in Clatsop County.



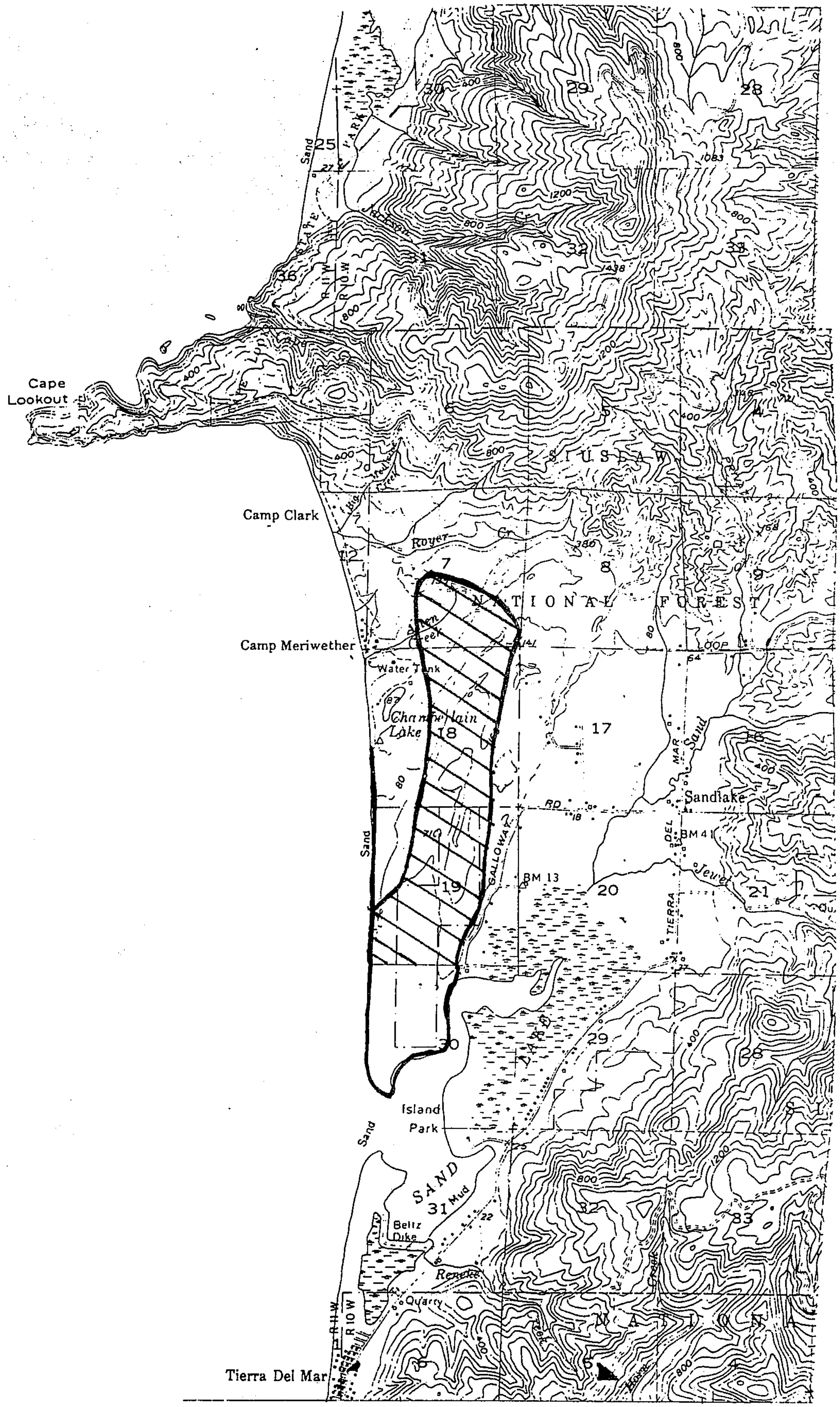
Map 3. Tillamook County beach status.



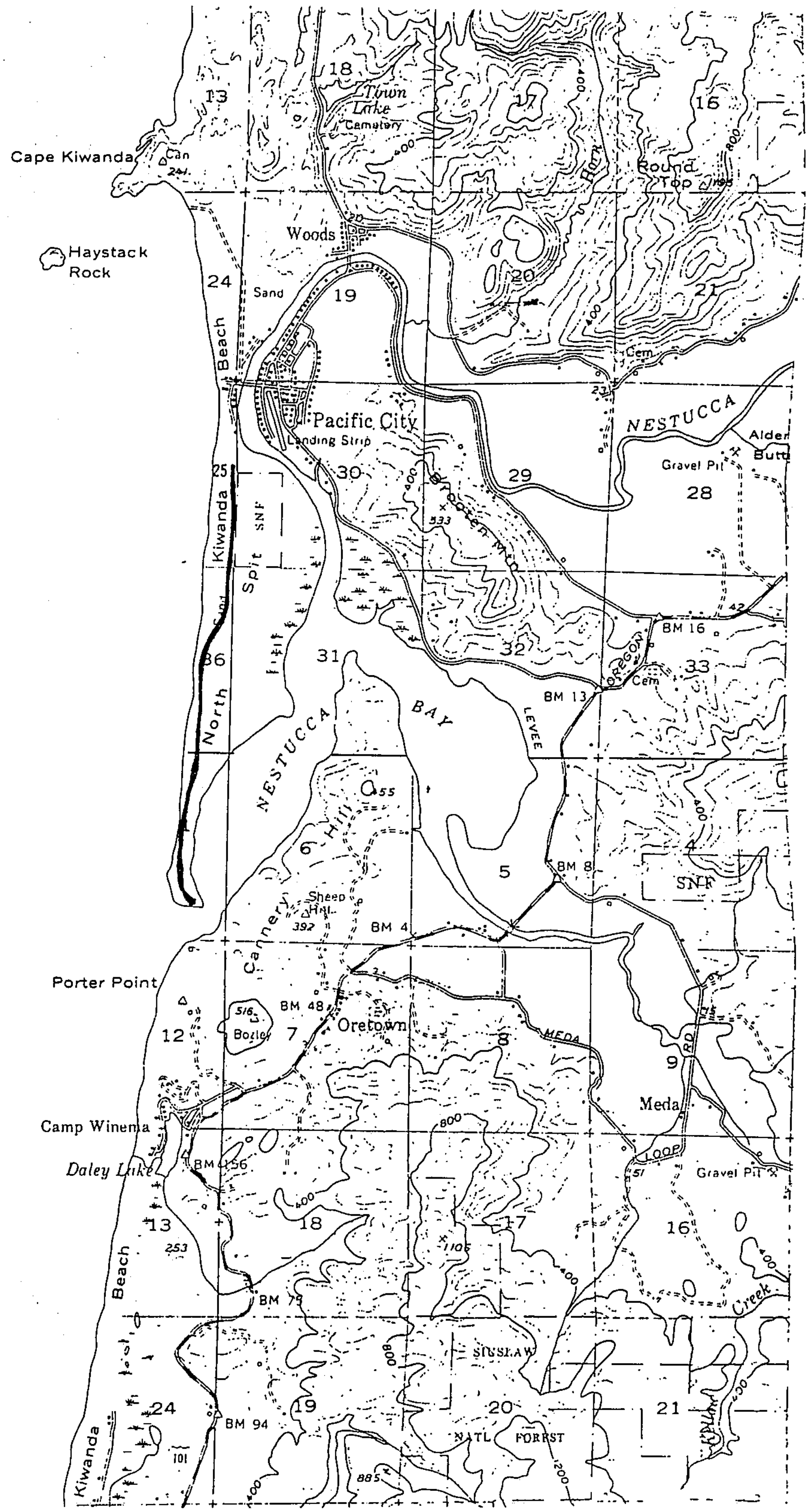
Map 4. ORV use in Tillamook County.



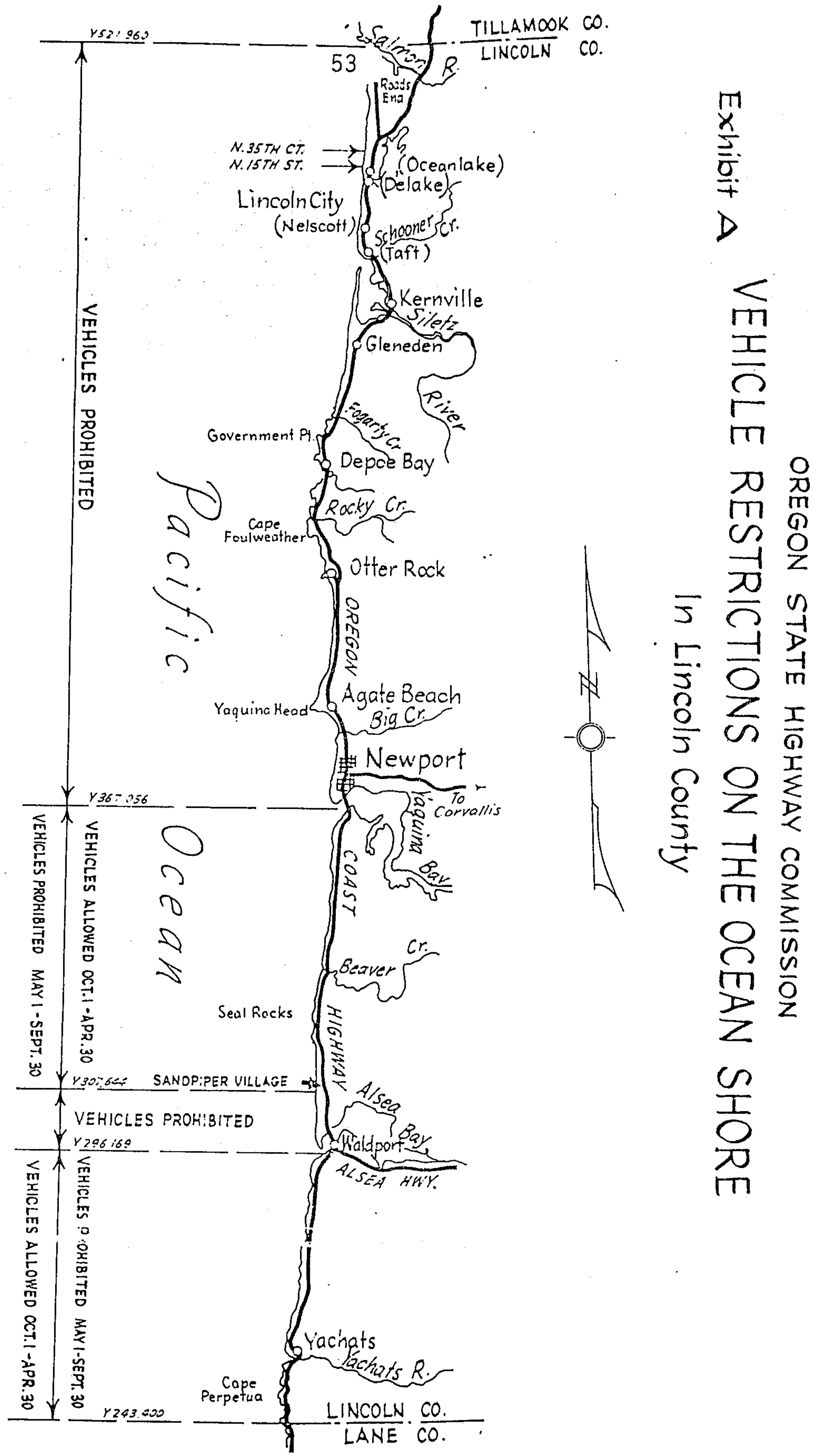
Map 5. ORV use in Tillamook County.



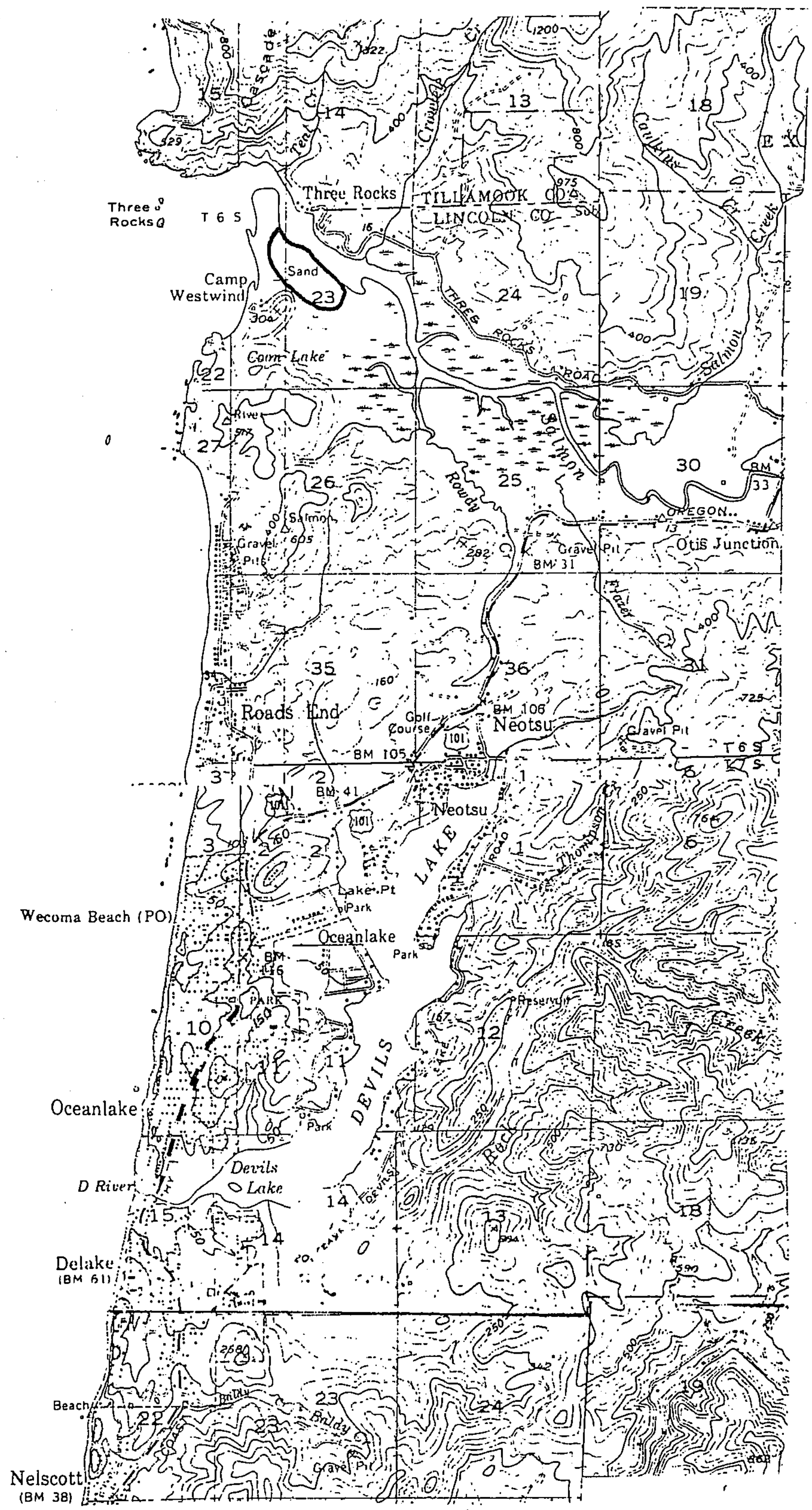
Map 6. ORV areas of use and potential suitability in Tillamook County.



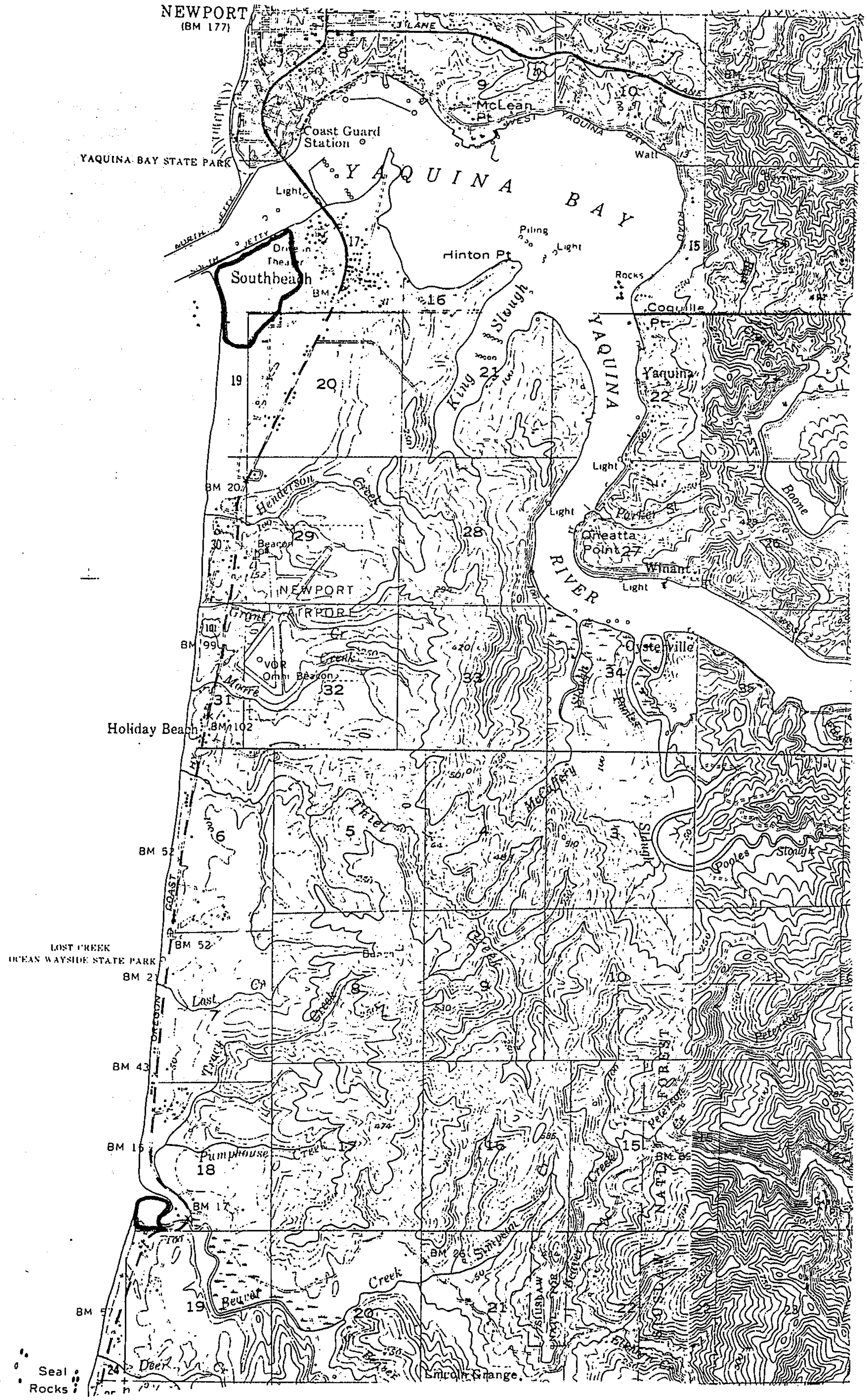
Map 7. ORV use in Tillamook County.



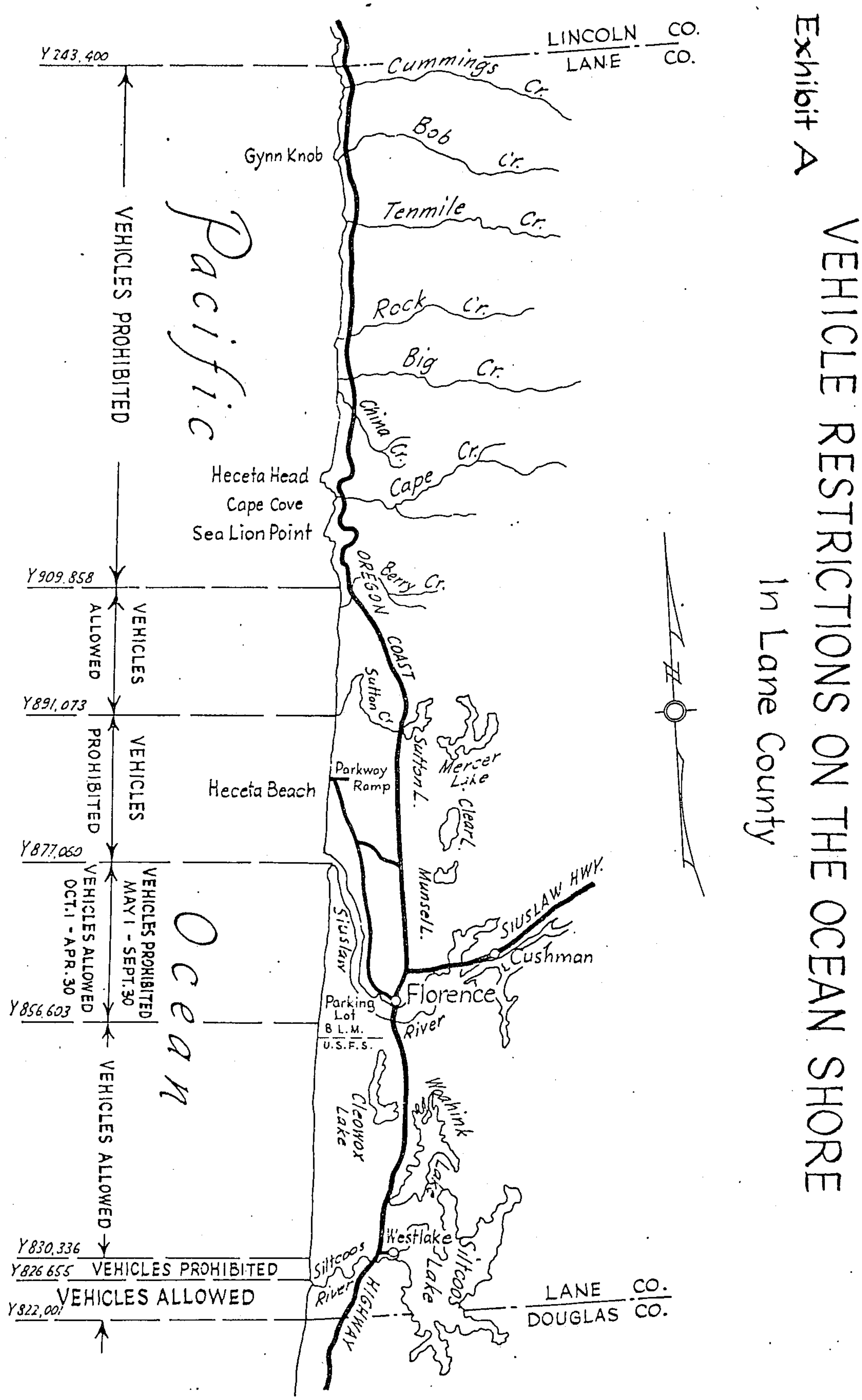
Map 8. Lincoln County beach status.



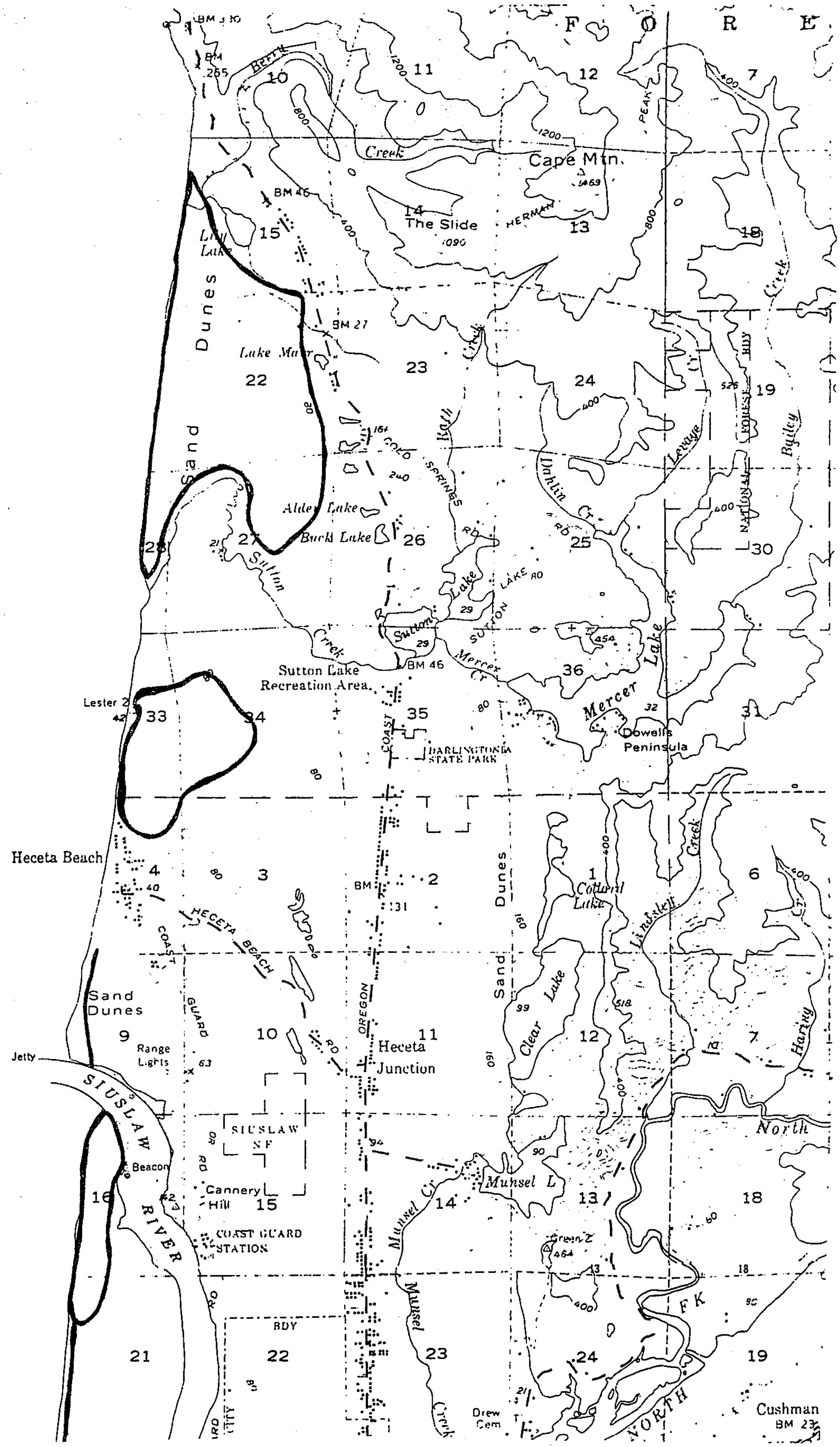
Map 9. ORV use in Lincoln County.



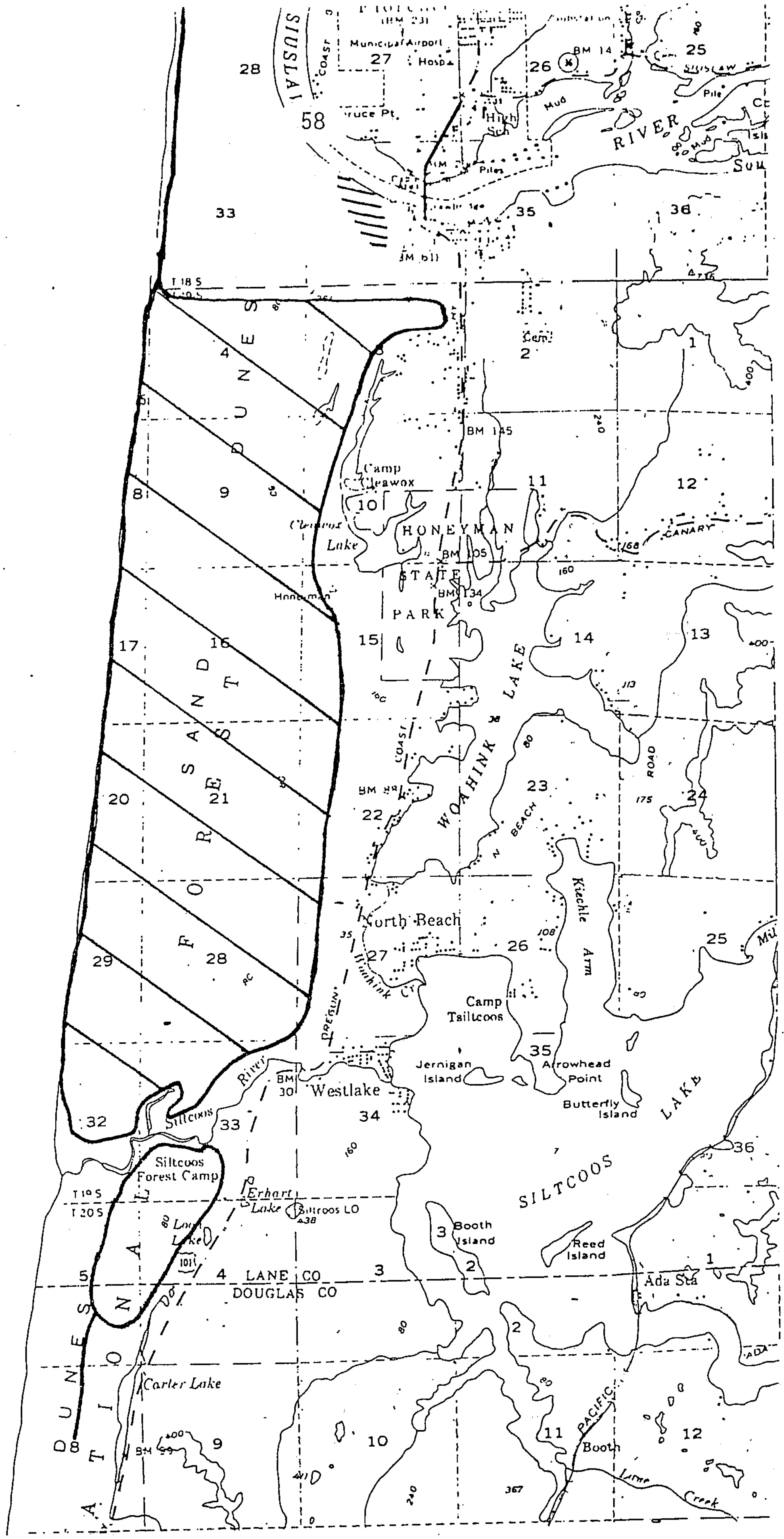
Map 10. ORV use in Lincoln County.



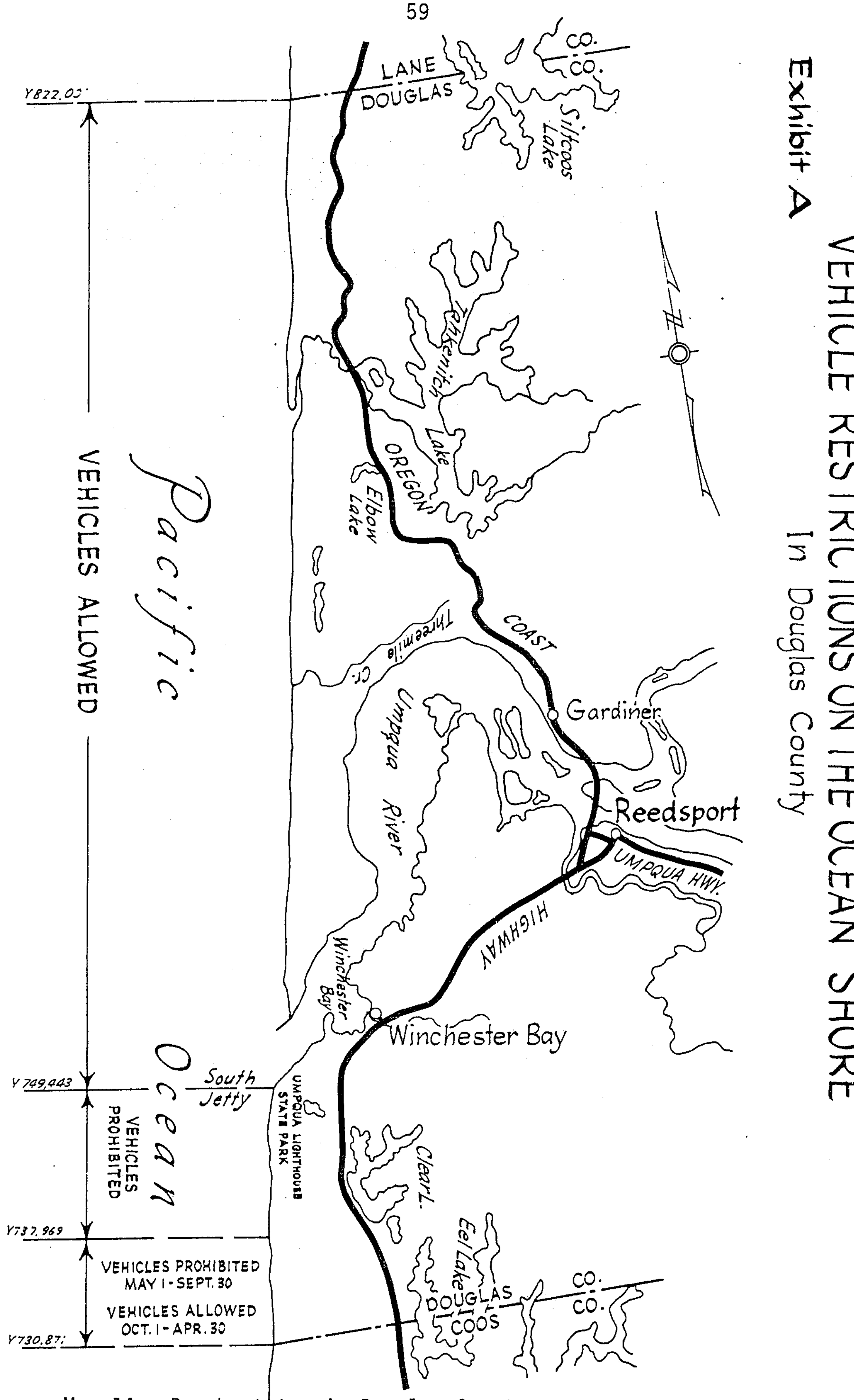
Map 11. Lane County beach status.



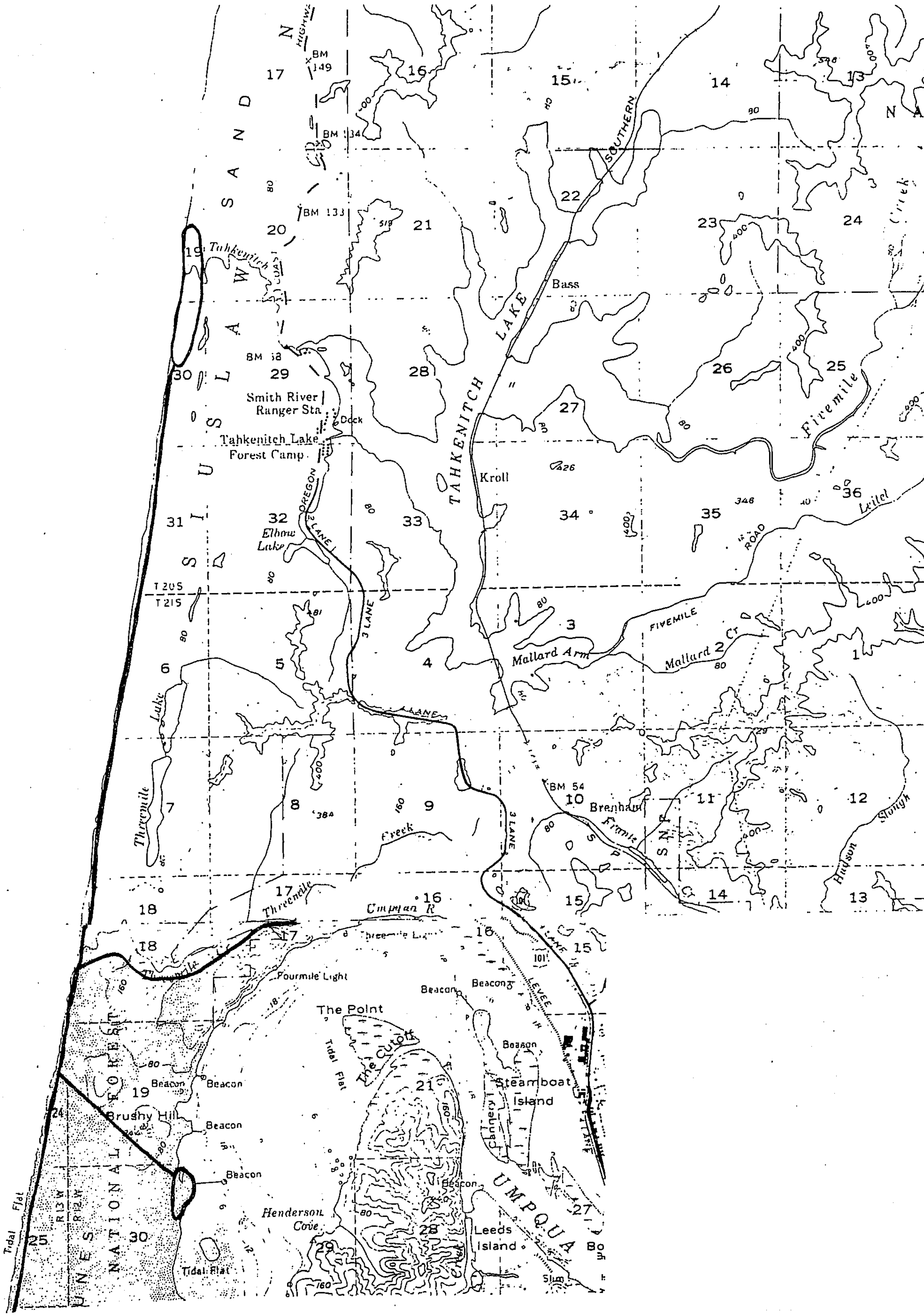
Map 12. ORV use in Lane County.



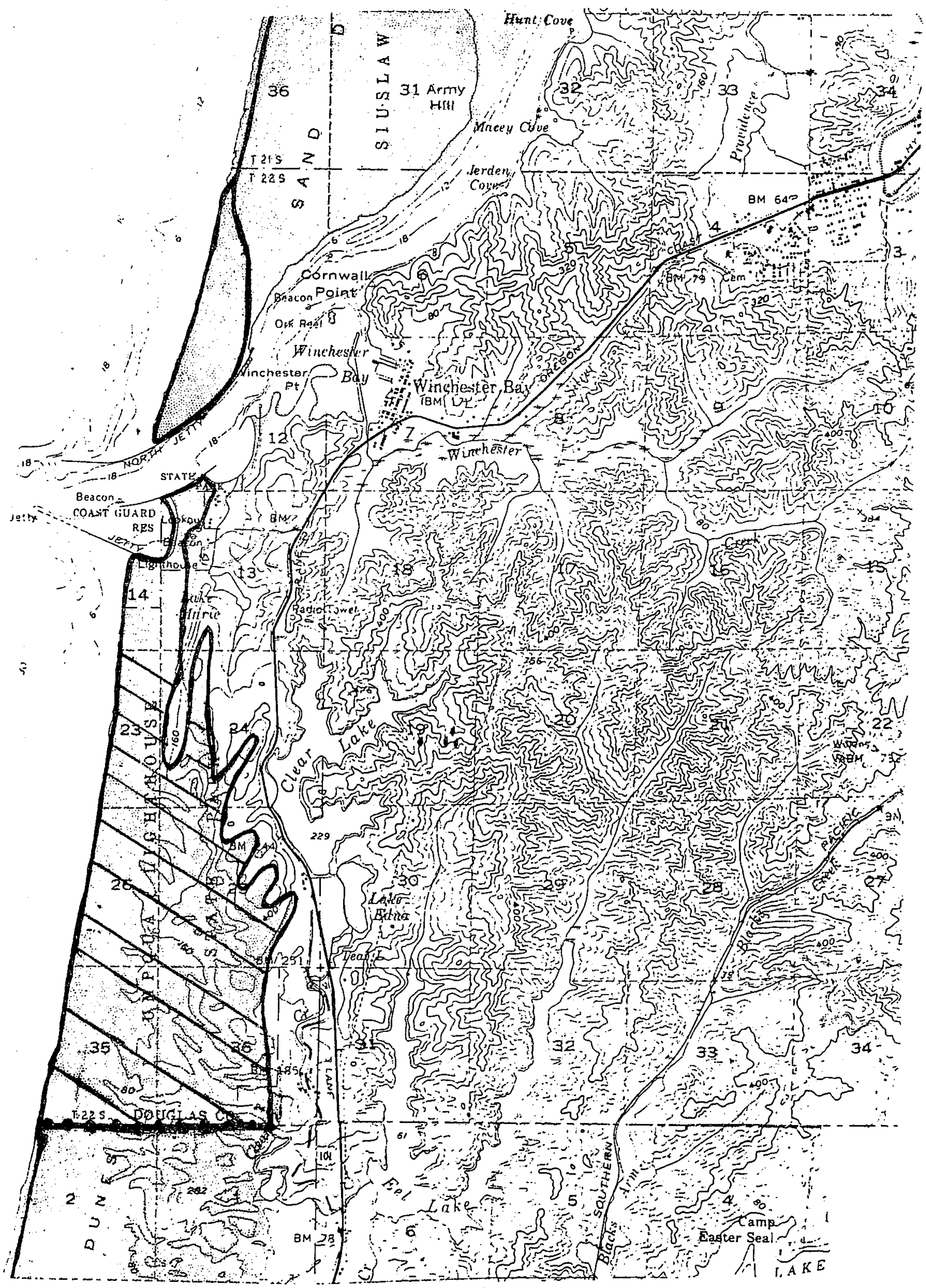
Map 13. Areas of ORV use and potential suitability in Lane County.



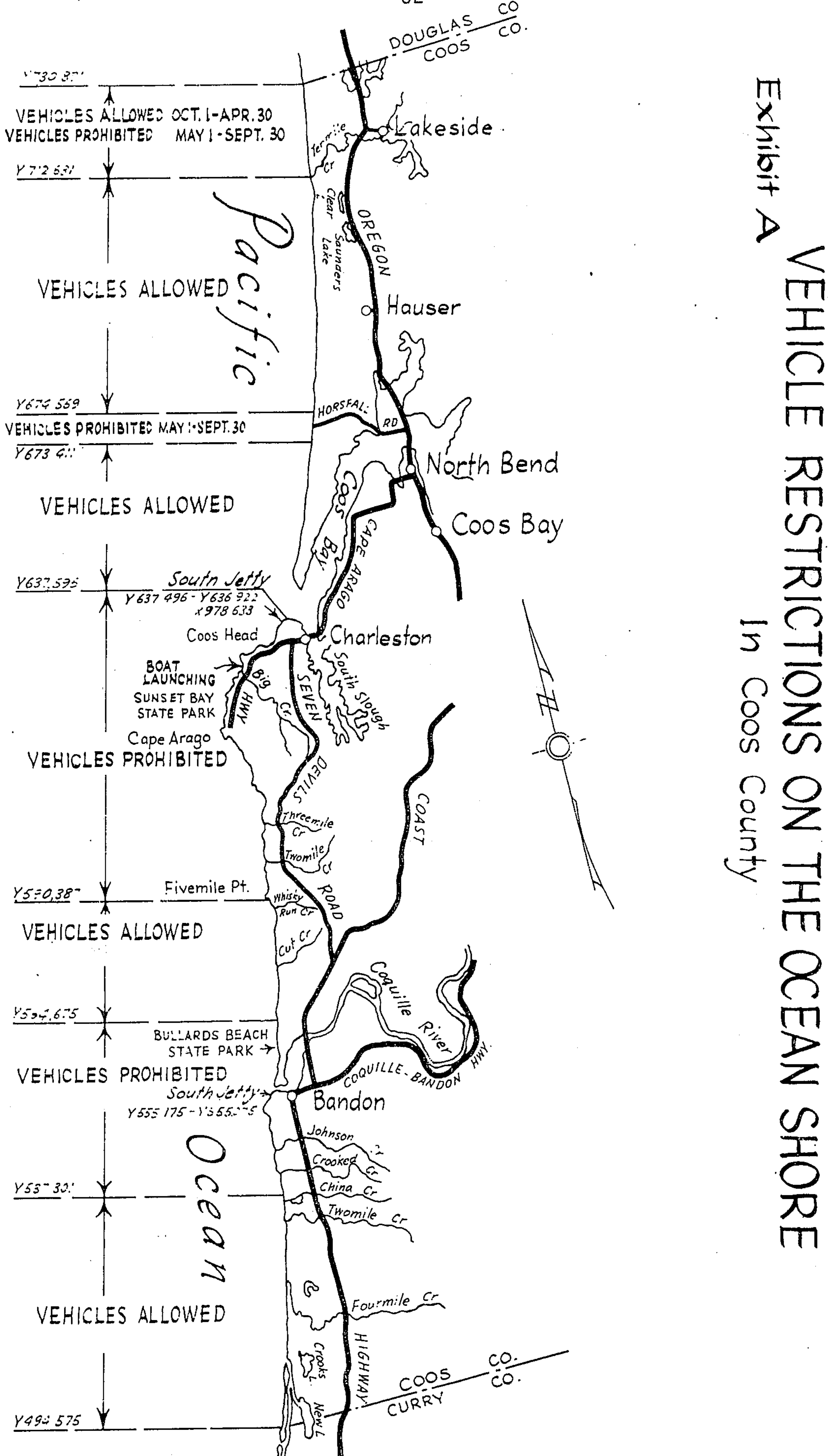
Map 14. Beach status in Douglas County.



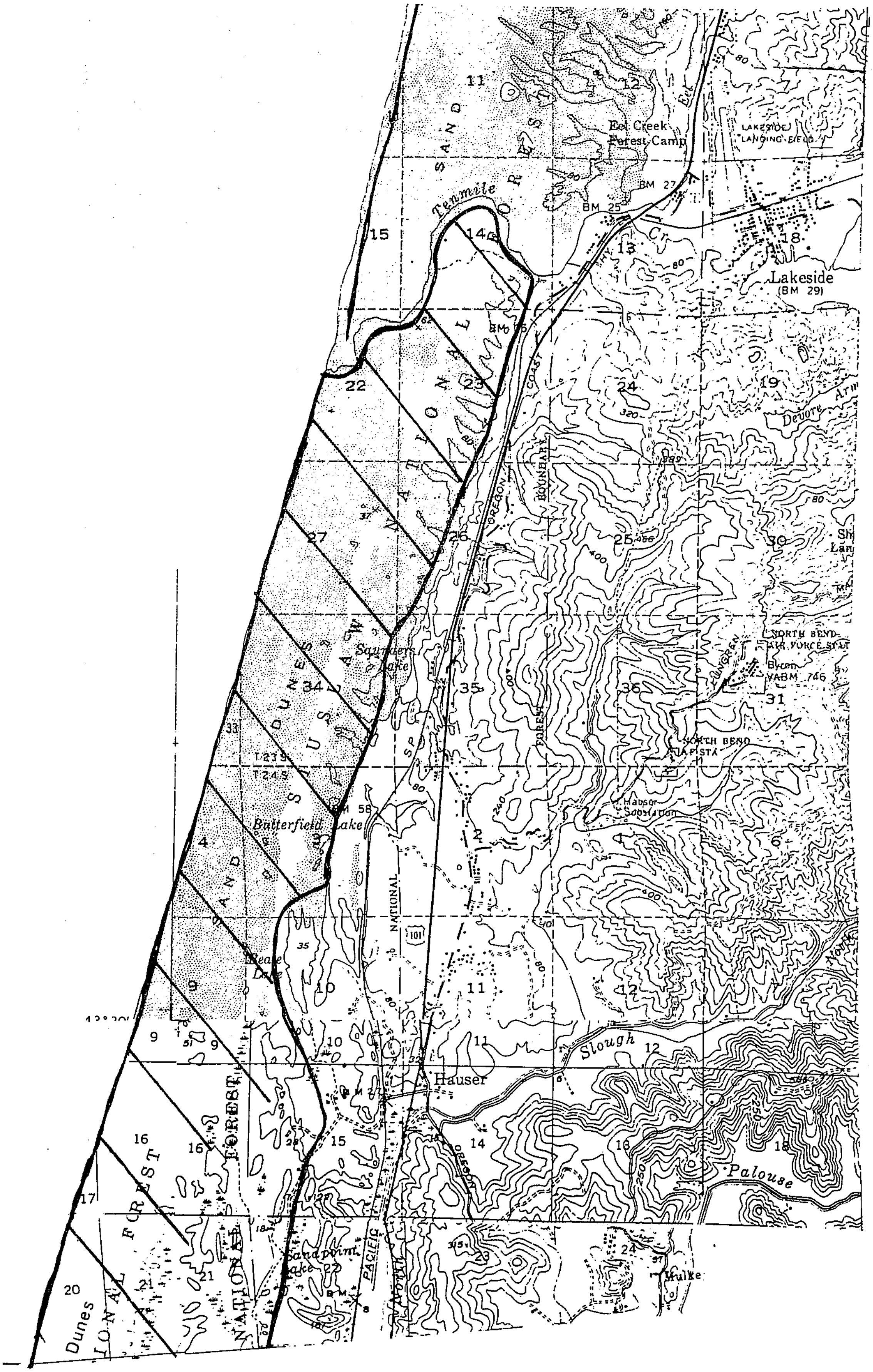
Map 15. ORV use in Douglas County.



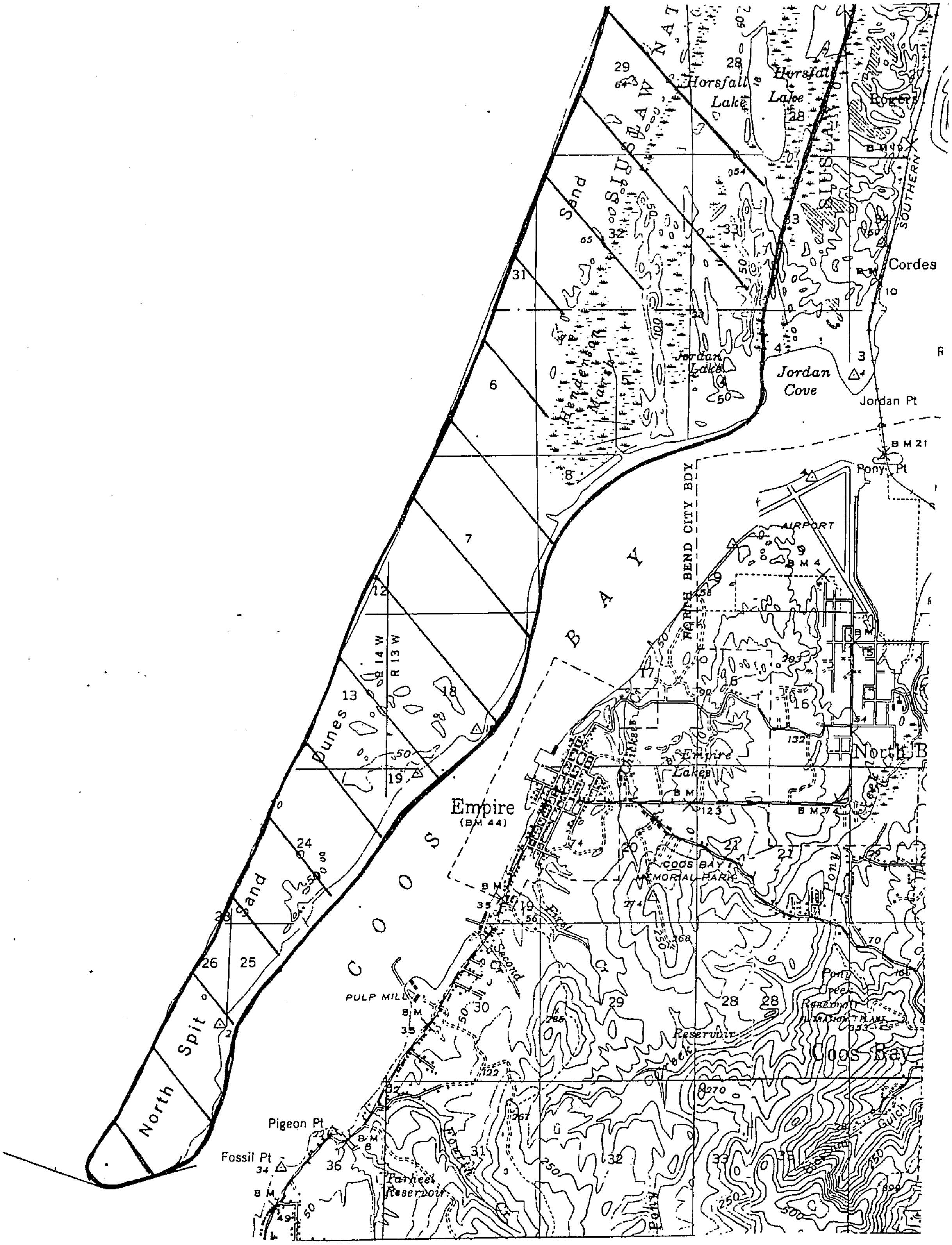
Map 16. Areas of ORV use and potential suitability in Douglas County.



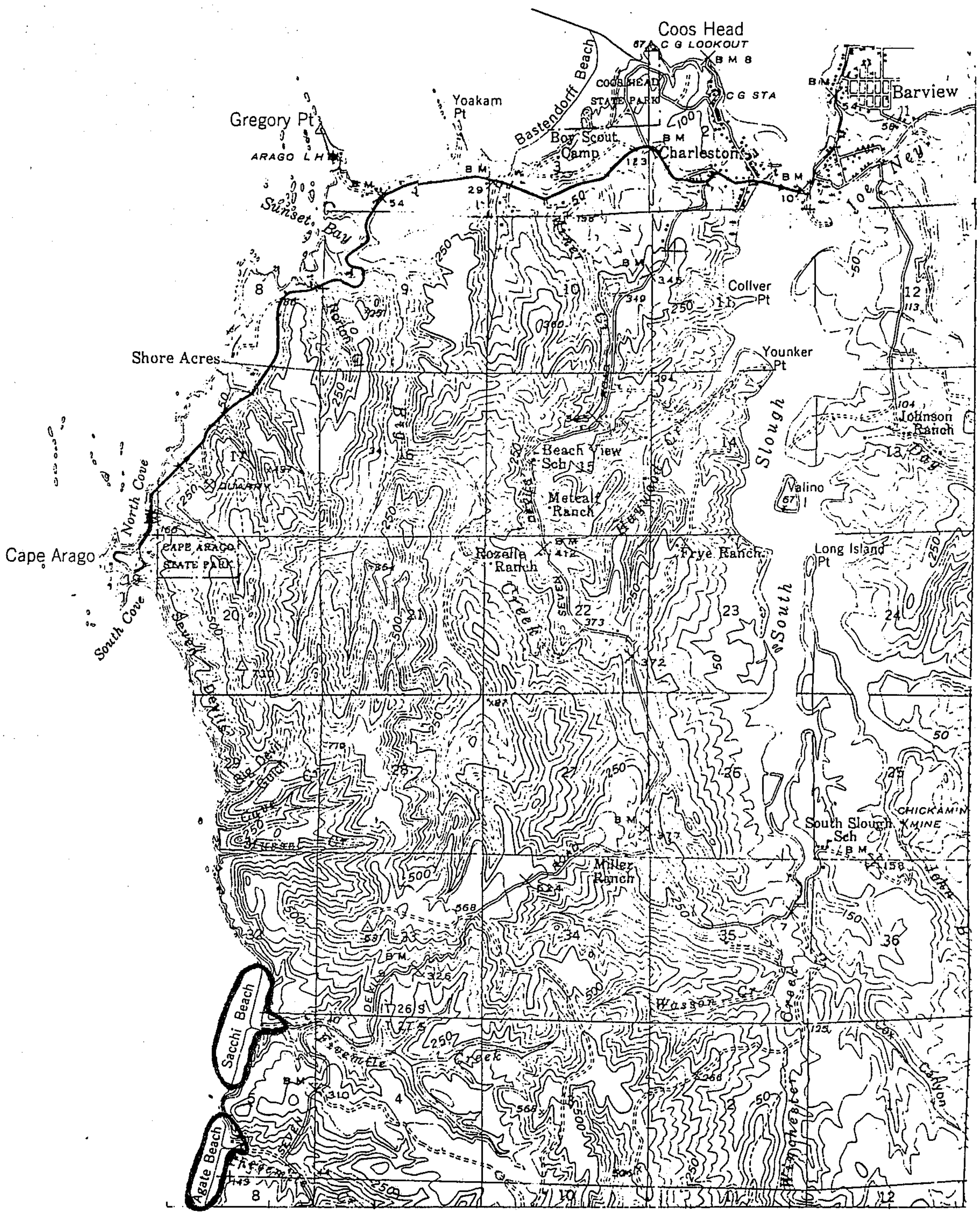
Map 17. Beach status in Coos County.



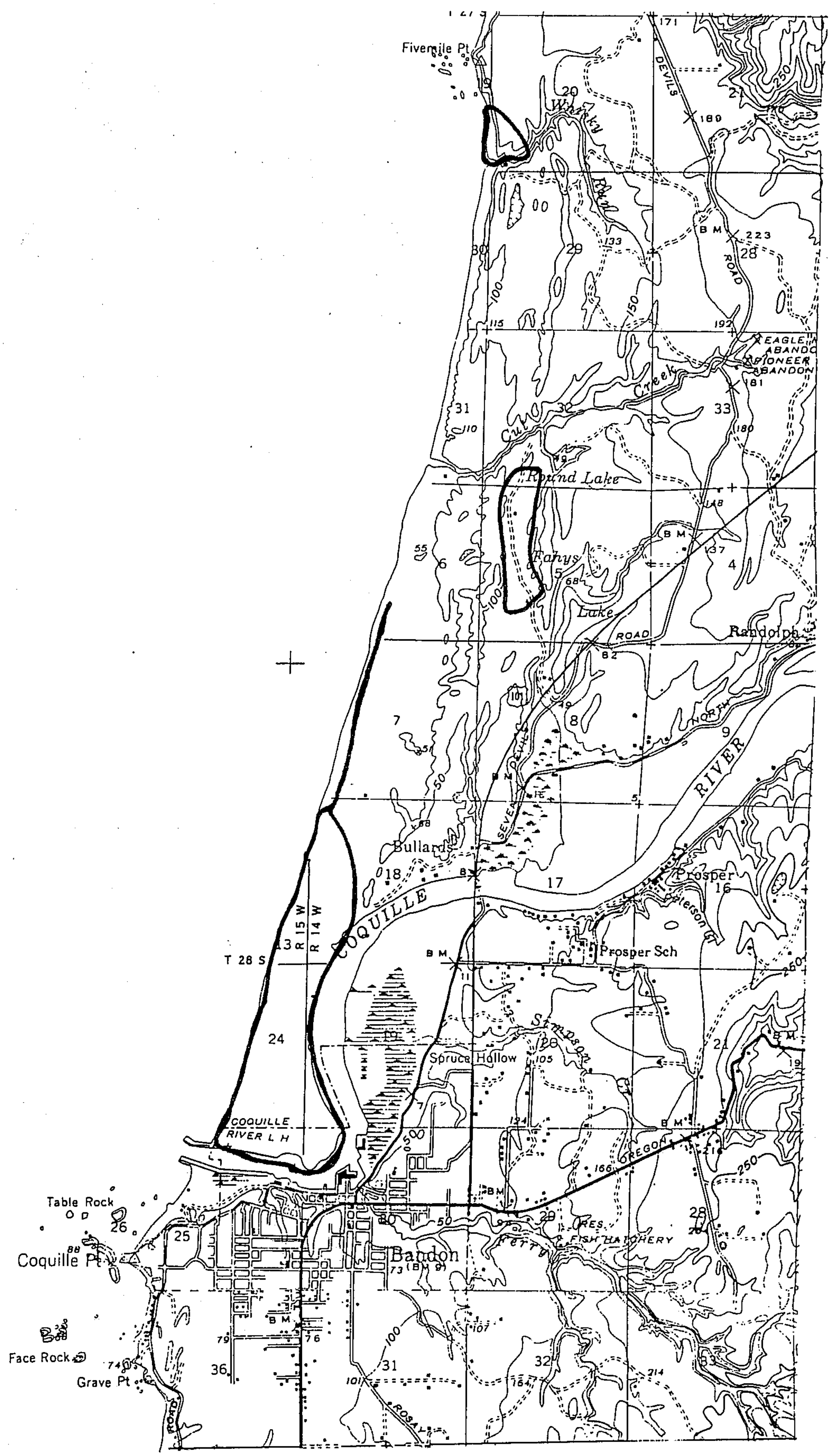
Map 18. Areas of ORV use and potential suitability in Coos County.



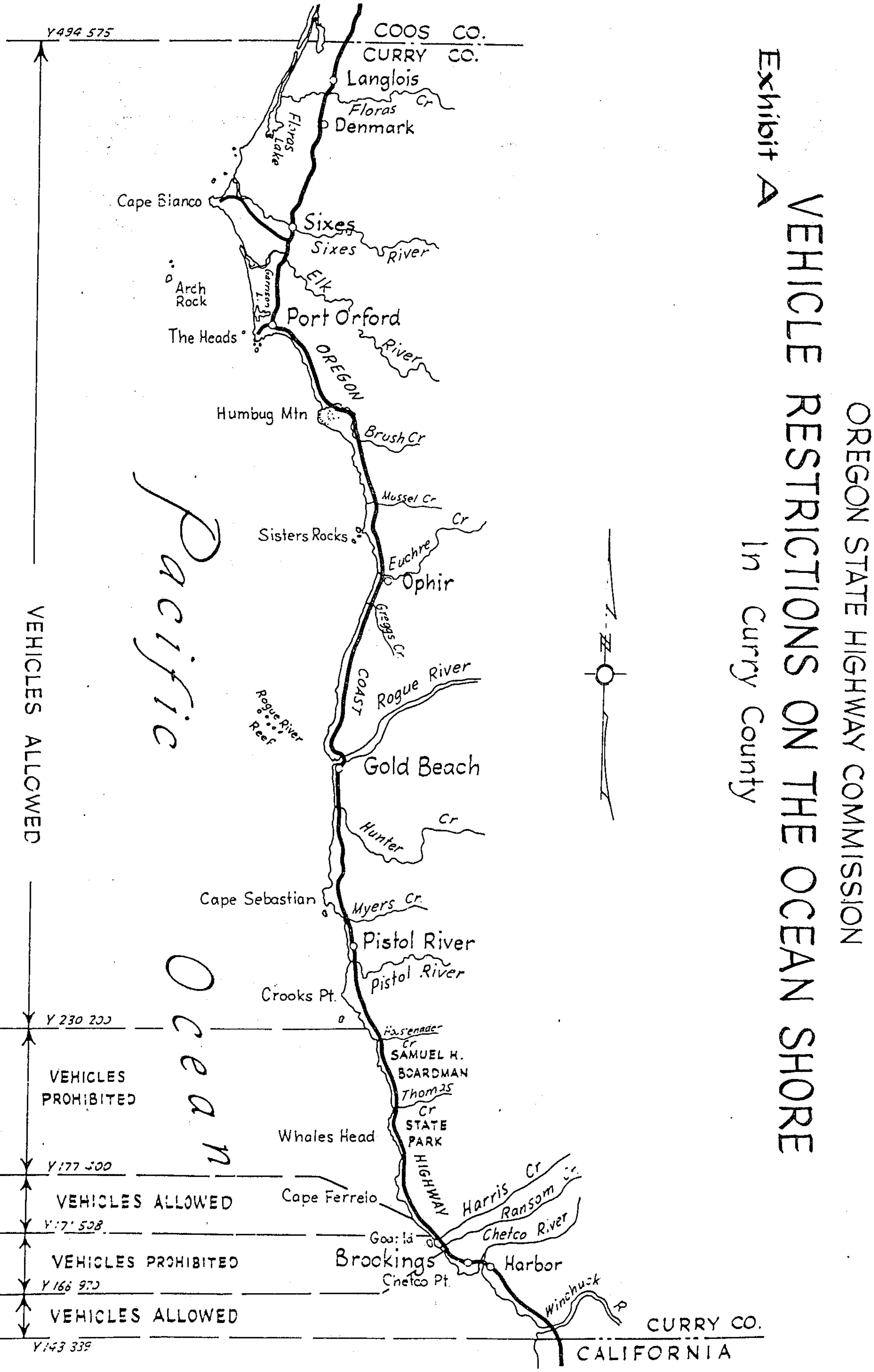
Map 19. Areas of ORV use and potential suitability in Coos County.



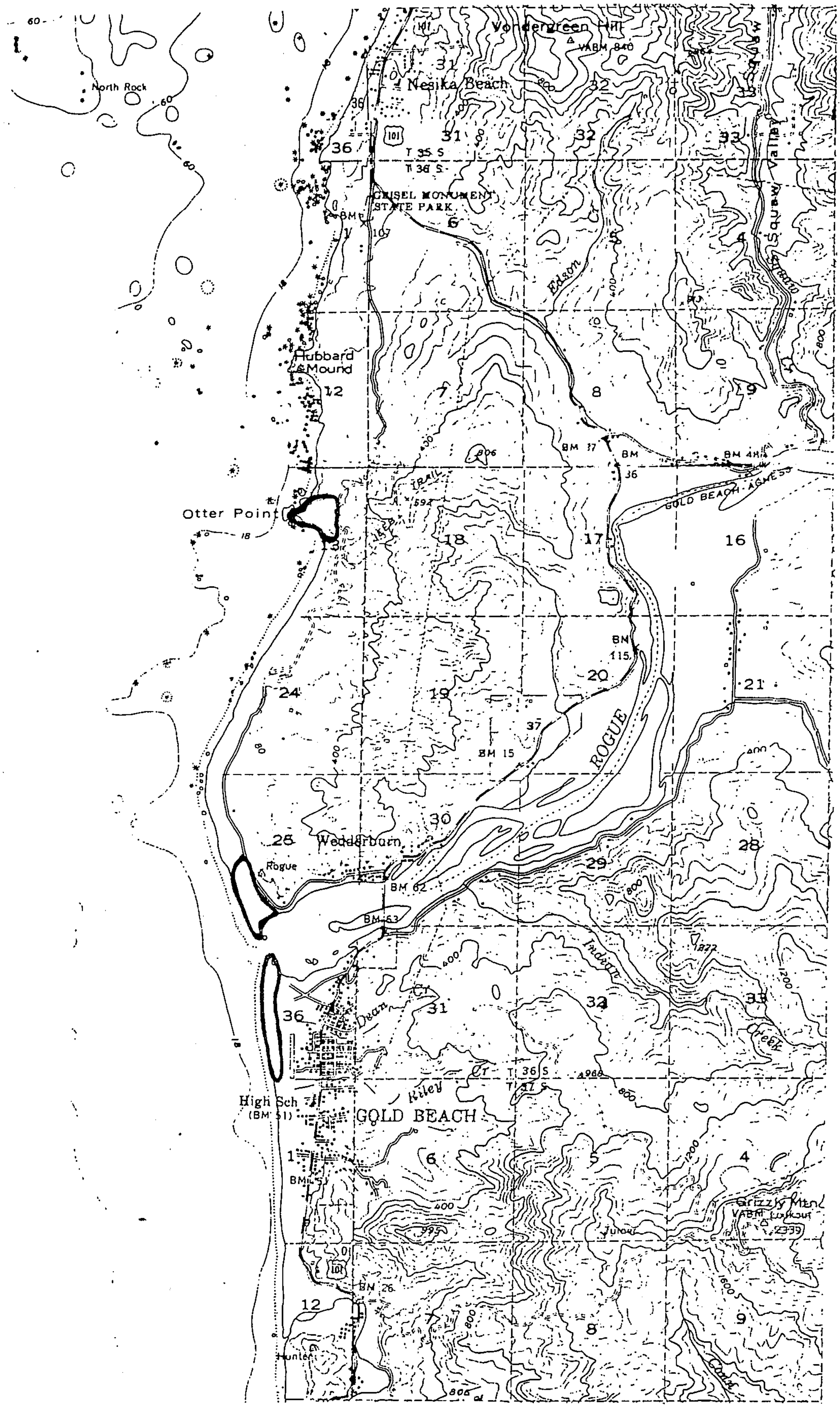
Map 20. ORV use in Coos County.



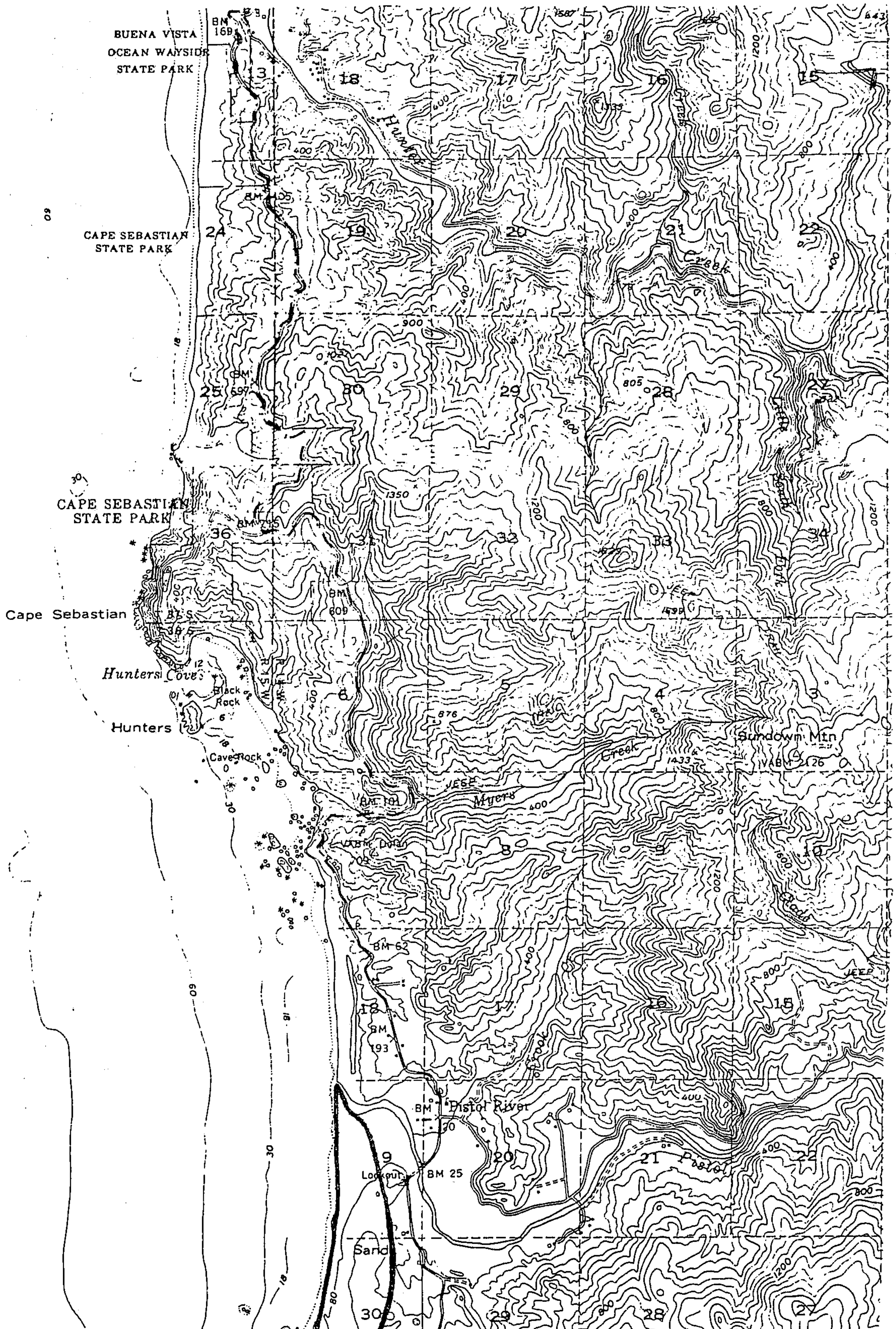
Map 21: ORV use in Coos County.



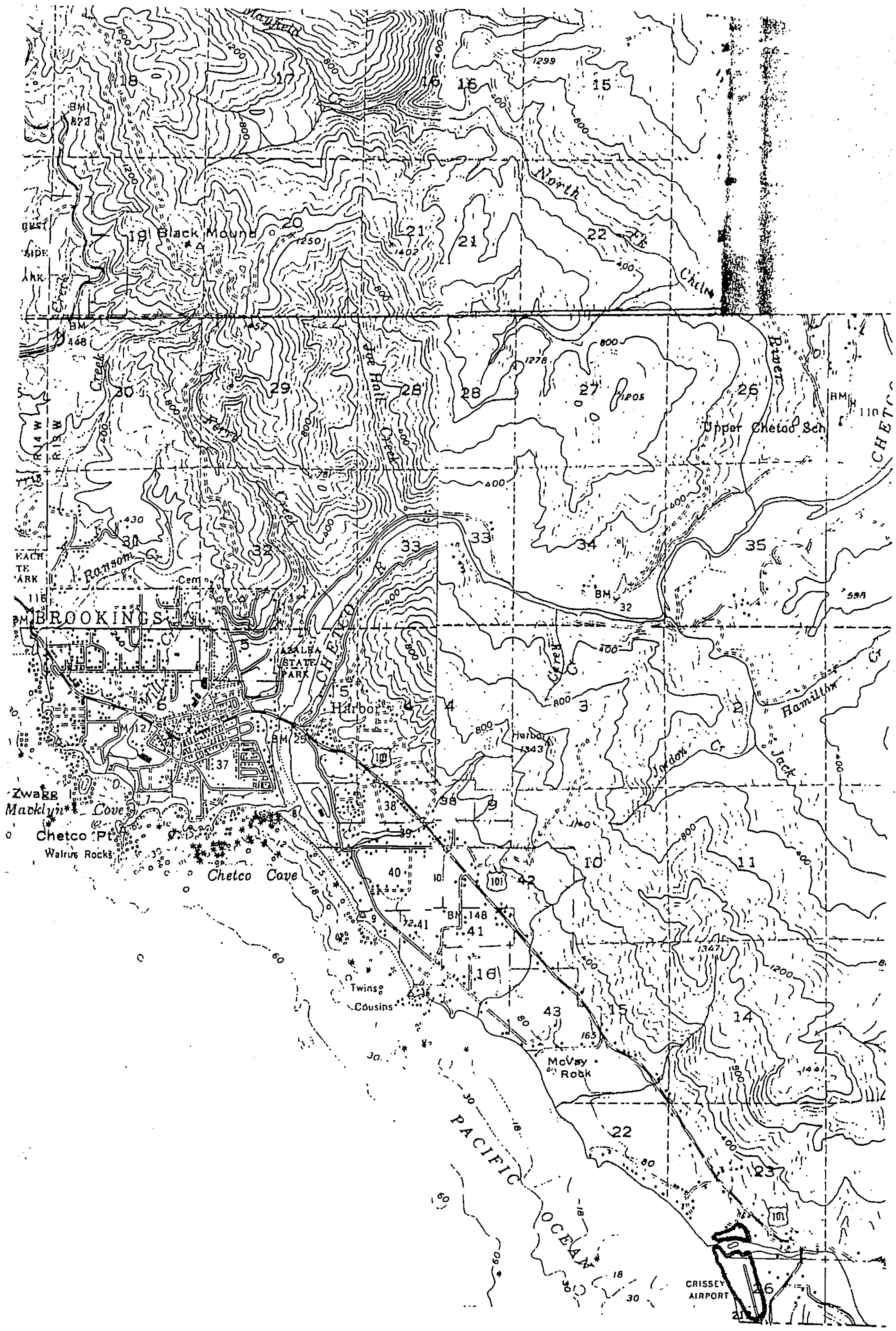
Map 22. Beach status in Curry County.



Map 23. ORV use in Curry County.



Map 24. ORV use in Curry County.



Map 25. ORV use in Curry County.

X. RECOMMENDATIONS AND RATIONALES

A. General

1. Off-Road Vehicle Advisory Councils should be established including ORV club representatives and individual participants, land managers, interested representatives from environmental groups, and park and recreation personnel on both a local and state level.

Such bodies would provide realistic and informed advice to develop and implement legislation. It could serve a similar function on a local level.

2. State legislation should be adopted which would comprehensively provide for and manage ORV recreation within Oregon. The legislation should:

It would provide for and manage an activity that presently exists.

a. Recognize ORV use as a legitimate form of recreation;

Acceptance of legitimate ORV use will promote more effective management of ORV activities.

b. Provide for ORV area development that would meet the needs of the ORV participant (such areas should be located in close proximity to the majority of the participants);

c. Restrict the use of ORVs to maintained roads and trails and areas designated for the various types of ORV activities;

d. Require establishment of environmental monitoring plans that suit an area's needs and the impacts of the ORV activity;

This would provide for ORV recreation and not necessarily reduce the areas open to ORVs. The benefits of limiting ORV use to designated areas would be to bring the multitude of management and environmental problems into a more reasonable realm. User conflict will be reduced. Hidden environmental impacts would be less likely to occur, and the impact that would occur in a designated area could be monitored and dealt with. Nuisance use would be minimized. Law enforcement would be facilitated since there would be no question whether an area was open or closed to ORV use. The need for management could be focused at a given area. *De facto* use would be reduced, for instance at South Beach and on Yaquina Head (hill-climbing on the slope east of the lighthouse by motorcycles and four-wheel drive vehicles). Providing good facilities for ORV recreation and stopping random use would increase the quality

<u>of the ORV experience, increase its compatibility, and reduce its environmental impacts</u>.

e. Register vehicles used off-roads that are not otherwise registered;

(1) this should include a fee which should be held accountable in a special ORV fund;
(2) the gas taxes from vehicle use off-road should be determined and placed in the ORV fund;
(3) the ORV funds should be expended for:

(a) provision of ORV areas and facilities,
(b) management and enforcement of ORV areas,
(c) environmental monitoring programs,
(d) ORV related research (environmental impacts, user needs, etc.),
(e) user education programs (which would be developed by ORV participants, land managers, etc. and include nature interpretation).
(f) local grants to develop ORV areas;

Registration would provide vital information on the number of ORVs and ORV users to better assess their needs. It would raise money specifically to provide ORV recreation.

f. Registration should require visible vehicle identification in some form;

Such markings would facilitate law enforcement. The mobility and anonymity of ORVs make enforcement difficult.

g. Give <u>state</u> ORV planning responsibilities to the Park and Recreation Branch;

Recognize ORVs as legitimate recreational activity.

h. Provide specific operating conditions regulating conduct and equipment;

Safety and resource protection would be promoted.

i. Provide that all law enforcement personnel from different agencies (federal, state, and

A broad approach is necessary to cover multi-jurisdictional areas and ORV mobility. Uniform local) have the power to enforce ORV regulations which should be coordinated and uniform.

regulations would be easier for people to comply with.

B. Specific

1. South Jetty Hill (within the NRA) should be closed to pedestrians by posting it as a vehicle play area. People should be informed and discouraged from entering such a hazardous area.

This would promote public safety. People unfamiliar with ORV use in the area should be informed of the potential hazard from vehicles.

2. A pedestrian corridor should be created from Cleawox Lake to the beach, and pedestrians should be warned they are entering a vehicle play area and to stay within the corridor. Vehicles should only be allowed to cross the pedestrian corridor in open sand areas of high visibility (east of the Goose Pasture).

Promotion of public safety.

3. ORV planning between the Oregon Dunes National Recreation Area, State, and local agencies should be coordinated.

Although the NRA is federal land, it can have a very direct effect on adjacent land. Any significant change in vehicle status within the NRA would have an impact on other areas.

4. To provide for ORV use on open sand, no additional substantial ORV closures should be implemented within the Oregon Dunes National Recreation Area.

The vast majority of open sand dunes on the Oregon coast are located within the Oregon Dunes National Recreation Area. Further closure of those areas open to ORVs would shift the use to smaller dune areas typically less suitable. Closures could result in the curtailment of some ORV use.

5. The north spit of the Coos River may be suitable for vehicle access corridor designations and perhaps a vehicle play designation. One access corridor might run down the beach or foredune with one or two crossovers to the bay side in the most appropriate places

The need for ORV areas in addition to the forty-seven per cent of the NRA is not considered here. Such a determination should be made by a community and the appropriate land holding agencies. There is no management available from the Corps of Engineers so an alternate (considering critical habitat and user interests). Vehicle play may be potentially suitable on the open sand dunes. These uses should be conditional upon: (1) development of a management plan including enforcement of the access corridor designations and the vehicle play area's boundaries, and (2) the performance of users and the effectiveness of the management plan. The latter conditions can be monitored by field observations and aerial photography. If the conditions are not met, then the vehicle designation would be inappropriate. A local ORV advisory council should be formed to develop a complete ORV plan including the South Coast Beach and Dune Recreationalists, the Corps of Engineers, the County, the private landholders involved, and any other appropriate parties.

source must be found if the area is to be suitable. The county and the ORV clubs may fill the management need. This could be a realistic chance for ORV recreationalists to demonstrate their capabilities of self-management.

6. A major ORV facility should be developed near the Portland area. The use of dredge spoils may facilitate this. Perhaps hills and other challenging topography could be formed. Potentially ORV funds could be used to help develop such a project.

This would provide for ORV recreation and increase the viability of restricted ORV use. It should relieve the user pressure at Sand Lake and allow for its eventual phase out regarding ORV use.

REFERENCES CITED

Baldwin, Malcolm R., and Dan H. Stoddard, Jr. 1973. The Off-Road Vehicle and Environmental Quality. 2nd Ed. The Conservation Foundation. Washington, D. C. 61 pp.

Bennett, Shaun. 1973. A Trail Rider's Guide to the Environment. The American Motorcycle Association. Westerville, Ohio. 60 pp.

Bess, Fred H. 1973. "The Effectiveness of Helmets for EAR Protection", Proceedings of the 1973 Snowmobile and Off The Road Vehicle Research Symposium. Donald F. Holecek, ed. Department of Parks and Recreation Resources Technical Report No. 9 (147-149), Michigan State University. 3 pp.

Blodget, Branford G. 1978. The Effect of Off-Road Vehicles on Least Terns and Other Shorebirds. National Park Service Cooperative Research Unit Report No. 26. University of Massachusetts, 79 pp.

Bury, Richard L., Robert C. Wendling, and Stephen McCool. 1976. Off-Road Recreation Vehicles-- A Research Summary, 1969-1975. MP-1277. Texas Agriculture Experiment Station. Texas A & M University. 84 pp.

Bush, George. 1976. "Soil Management Services Report--Sand Lake Recreation Area". USDA Forest Service, Siuslaw National Forest, Hebo Ranger District, Corvallis, Oregon. 16 pp.

California Department of Parks and Recreation. 1975. Pismo State Beach and Pismo Dunes State Vehicular Recreation Area--General Development Plan and Resource Management Plan. Sacramento, California. 83 pp.

California Department of Parks and Recreation. 1978. Off-Highway Vehicle Recreation in California. Sacramento, Calif. 96 pp.

Carter, James E. 1977. "Off-Road Vehicles on Public Lands", U. S. Presidential Executive Order 11989. Government Printing Office, Washington, D. C. 1 p.

Cooper, William S. 1958. Coastal Sand Dunes of Oregon and Washington. Geological Society of America Memoir 72. New York, N. Y. 169 pp.

Geological Society of America. 1977. "Impacts and Management of Off-Road Vehicles". Boulder, Colorado. 8 pp.

Godfrey, Paul J., Stephen P. Leatherman, and P. A. Buckely. 1978. "Impact of Off-Road Vehicles on Coastal Ecosystems", Coastal Zone '78 Symposium on Technical, Environmental, Socioeconomic and Regulatory Aspects of Coastal Zone Management, Volume II (581-600). American Society of Civil Engineers, New York, N. Y. 20 pp.

Harrison, Rob. 1973. "ORV Noise Effects and Measurements", Proceedings of the 1973 Snowmobile and Off The Road Vehicle Research Symposium. Donald F. Holecek, ed. Department of Parks and Recreation Resources Technical Report No. 9, (135-145), Michigan State University. 10 pp.

Komar, Paul. Personal Communication November 29, 1978, Newport, Oregon.

Lodico, Norma Jean. 1973. Environmental Effects of Off-Road Vehicles: A Review of the Literature. Bibliography Series No. 29. Office of Library Services, U. S. Department of the Interior. Washington, D. C. 112 pp.

McCool, Stephen F., and Joseph W. Roggenbuck. 1974. Off-Road Vehicles and Public Lands: A Problem Analysis. Department of Forestry and Outdoor Recreation and the Institute for the Study of Outdoor Recreation and Tourism, Utah State University, Logan. 109 pp.

McEwen, Douglas N. 1978. Turkey Bay Off-Road Vehicle Area at Land Between the Lakes: An Example of New Opportunities for Managers and Riders. Department of Recreation Research Report No. 1, Southern Illinois University, Carbondale. 28 pp.

Motorcycle Industry Council, Inc. 1978. 1978 Motorcycle Statistical Annual. Newport Beach, California. 46 pp.

Muntz, E. P., T. L. Deglow, and D. H. Campbell. 1972. "Public Lands and Off-Road Motorized Recreation". School of Engineering, Environmental Engineering Programs Bulletin 100. University of Southern California, Los Angeles. 18 pp.

Neidoroda, A. 1975. The Geomorphologic Effects on Off-Road Vehicles on Coastal Systems of Cape Cod, Massachusetts. National Park Service Cooperative Research Unit Report No. 17, University of Massachusetts. 100 pp.

Nixon, Richard M. 1972. "Use of Off-Road Vehicles on the Public Lands", U. S. Presidential Order 11644. Government Printing Office, Washington, D. C. 2pp.

Oregon Department of Environmental Quality. 1978. Handbook for Environmental Quality Elements of Oregon Local Comprehensive Land Use Plans, Noise. Portland, Oregon. 28 pp.

Oregon Department of Transportation, Parks and Recreation Branch. 1977. Oregon Outdoor Recreation Needs Bulletin, 1977. Technical Document III of the Statewide Comprehensive Outdoor Recreation Plan. Salem, Oregon. 183 pp.

Peine, John D. 1973. "Off-Road Vehicle Use in Tucson, Arizona". Proceedings of the 1973 Snowmobile and Off The Road Vehicle Research Symposium. Donald F. Holecek, ed. Department of Parks and Recreation Resources Technical Report No. 9 (9-33). Michigan State University. 24 pp.

Rasor, Robert. 1978. Five State Approaches to Trialbike Recreation Facilities and Their Management. American Motorcycle Association. Westerville, Ohio. 64 pp.

Stebbins, Robert C. 1974. "Off-Road Vehicles and the Fragile Desert". American Biology Teacher 36(5):294-304. 14 pp.

Stupay, Arthur M. 1971. "Growth of Powerized Vehicles in the 1970's". Proceedings of the 1971 Snowmobile and Off The Road Vehicle Research Symposium. Michael Chubb, ed. Department of Parks and Recreation Resources Technical Report No. 8. Michigan State University.

Ternyik, Wilbur E. Personal Communications, September-December, 1978, Newport, Oregon.

U. S. Department of Agriculture, Forest Service. 1976. "Travel Plan for Off-Road Vehicle Use--Siuslaw National Forest". Corvallis, Oregon. 4 pp. + Maps.

U. S. Department of Interior, Bureau of Land Management. 1970. Operation ORVAC: Recommendations and Guidelines for the Management of Off-Road Vehicles on Public Domain Lands in California. Sacramento, California. 40 pp.

Washington Department of Natural Resources. 1976. "Operating All-Terrain Vehicles in the State of Washington". Olympia, Washington. 14 pp.

APPENDIX A

Executive Orders 11644 and 11989

EXECUTIVE ORDER 11644 February 8, 1972

USE OF OFF-ROAD VEHICLES ON THE PUBLIC LANDS

An estimated 5 million off-road recreational vehicles--motorcycles, minibikes, trail bikes, snowmobiles, dune-buggies, all-terrain vehicles, and others--are in use in the United States today, and their popularity continues to increase rapidly. The widespread use of such vehicles on the public lands--often for legitimate purposes but also in frequent conflict with wise land and resource management practices, environmental values, and other types of recreational activity--has demonstrated the need for a unified Federal policy toward the use of such vehicles on the public lands.

NOW, THEREFORE, by virtue of the authority vested in me as President of the United States by the Constitution of the United States and in furtherance of the purpose and policy of the National Environmental Policy Act of 1969 (42 U.S.C. 4321), it is hereby ordered as follows:

Section 1. Purpose. It is the purpose of this order to establish policies and provide for procedures that will ensure that the use of off-road vehicles on public lands will be controlled and directed so as to protect the resources of those lands, to promote the safety of all users of those lands, and to minimize conflicts among the various uses of those lands.

Sec. 2. Definitions. As used in this order, the term:

(1) "public lands" means (A) all lands under the custody and control of the Secretary of the Interior and the Secretary of Agriculture, except Indian lands, (B) lands under the custody and control of the Tennessee Valley Authority that are situated in western Kentucky and Tennessee and are designated as "Land Between the Lakes", and (C) lands under the custody and control of the Secretary of Defense;

(2) "respective agency head" means the Secretary of the Interior, the Secretary of Defense, the Secretary of Agriculture, and the Board of Directors of the Tennessee Valley Authority, with respect to public lands under the custody and control of each;

(3) "off-road vehicle" means any motorized vehicle designed for or capable of cross-country travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other natural terrain; except that such term excludes (A) any registered motorboat, (B) any military, fire, emergency, or law enforcement vehicle when used for emergency purposes, and (C) any vehicle whose use i expressly authorized by the respective agency head under a permit, lease, license, or contract; and

(4) "official use" means use by an employee, agent, or designated representative of the Federal Government or one of its contractors in the course of his employment, agency, or representation.

Sec. 3. Zones of Use. (a) Each respective agency head shall develop and issue regulations and administrative instructions, within six months of the date of this order, to provide for administrative designation of the specific areas and trails on public lands on which the use of off-road vehicles may be permitted, and areas in which the use of off-road vehicles may not be permitted, and set a date by which such designation of all public lands shall be completed. Those regulations shall direct that the designation of such areas and trails will be based upon the protection of the resources of the public lands, promotion of the safety of all users of those lands, and minimization of conflicts among the various uses of those lands. The regulations shall further require that the designation of such areas and trails shall be in accordance with the following--

(1) Areas and trails shall be located to minimize damage to soil, watershed, vegetation, or other resources of the public lands.

(2) Areas and trails shall be located to minimize harassment of wildlife or significant disruption of wildlife habitats.

(3) Areas and trails shall be located to minimize conflicts between off-road vehicle use and other existing or proposed recreational uses of the same or neighboring public lands, and to ensure the compatibility of such uses with existing conditions in populated areas, taking into account noise and other factors.

(4) Areas and trails shall not be located in officially designated Wilderness Areas or Primitive Areas. Areas and trails shall be located in areas of the National Park system, Natural Areas, or National Wildlife Refuges and Game Ranges only if the respective agency head determines that off-road vehicle use in such locations will not adversely affect their natural, aesthetic, or scenic values.

(b) The respcetive agency head shall ensure adequate opportunity for public participation in the promulgation of such regulations and in the designation of areas and trails under this section.

(c) The limitations on off-road vehicle use imposed under this section shall not apply to official use.

Sec. 4. Operating Conditions. Each respective agency head shall develop and publish, within one year of the date of this order, regulations prescribing operating conditions for off-road vehicles on the public lands. These regulations shall be directed at protecting resource values, preserving public health, safety, and welfare, and minimizing use conflicts.

Sec. 5. Public Information. The respective agency head shall ensure that areas and trails where off-road vehicle use is permitted are well marked and shall provide for the publication and distribution of information, including maps, describing such areas and trails and explaining the conditions on vehicle use. He shall seek cooperation of relevant State agencies in the dissemination of this information.

Sec. 6. Enforcement. The respective agency head shall, where authorized by law, prescribe appropriate penalties for violation of regulations adopted pursuant to this order, and shall establish procedures for the enforcement of those regulations. To the extent permitted by law, he may enter into agreements with State or local governmental agencies for cooperative enforcement of laws and regulations relating to off-road vehicle use.

Sec. 7. Consultation. Before issuing the regulations or administrative instructions required by this order or designating areas or trails as required by this order and those regulations and administrative instructions, the Secretary of the Interior shall, as appropriate, consult with the Atomic Energy Commission.

Sec. 8. Monitoring of Effects and Review. (a) The respective agency head shall monitor the effects of use of off-road vehicles on lands under their jurisdictions. On the basis of the information gathered, they shall from time to time amend or rescind designations of areas or other actions taken pursuant to this order as necessary to further the policy of this order.

(b) The Council on Environmental Quality shall maintain a continuing review of the implementation of this order.

RICHARD NIXON

The White House,
February 8, 1972

EXECUTIVE ORDER 11989 May 24, 1977

OFF-ROAD VEHICLES ON PUBLIC LANDS

By virtue of the authority vested in me by the Constitution and statutes of the United States of America, and as President of the United States of America, in order to clarify agency authority to define zones of use by off-road vehicles on public lands, in furtherance of the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.), Executive Order No. 11644 of February 8, 1972, is hereby amended as follows:

Section 1. Clause (B) of Section 2(3) of Executive Order No. 11644, setting forth an exclusion from the definition of off-road vehicles, is amended to read "(B) any fire, military, emergency or law enforcement vehicle when used for emergency purposes, and any combat or combat support vehicle when used for national defense purposes, and".

Sec. 2. Add the following new Section to Executive Order No. 11644:

"Sec. 9. Special Protection of the Public Lands. (a) Notwithstanding the provisions of Section 3 of this Order, the respective agency head shall, whenever he determines that the use of off-road vehicles will cause or is causing considerable adverse effects on the soil, vegetation, wildlife, wildlife habitat or cultural or historic resources of particular areas or trails of the public lands, immediately close such areas or trails to the type of off-road vehicle causing such effects, until such time as he determines that such adverse effects have been eliminated and that measures have been implemented to prevent future recurrence.

"(b) Each respective agency head is authorized to adopt the policy that portions of the public lands within his jurisdiction shall be closed to use by off-road vehicles except those areas or trails which are suitable and specifically designated as open to such use pursuant to Section 3 of this Order.".

JIMMY CARTER

The White House
May 24, 1977.

APPENDIX B

Proposed Bureau of Land
Management Regulations

[4310-84]

DEPARTMENT OF THE INTERIOR

Bureau of Land Management

[43 CFR Part 6290]

OFF-ROAD VEHICLES

Use of Public Lands

AGENCY: Bureau of Land Management, Interior.

ACTION: Proposed rulemaking.

SUMMARY: This proposed rulemaking is developed to provide for management and control of off-road vehicle recreation on public lands. Concentrated off-road vehicle recreation on public lands has, in some areas, caused excessive damage to natural resources and disrupted more passive land uses. Management of off-road vehicle activities will provide for continuation of off-road vehicle recreation under conditions that will protect natural resources and other resource users and promote public safety.

DATE: Comments by September 5, 1978.

ADDRESS: Send comments to: Director (210), Bureau of Land Management, 1800 C Street NW., Washington, D.C. 20246. Comments will be available for public review in Room 5555 at the above address from 7:45 a.m.-4:15 p.m. on regular working days.

FOR FURTER INFORMATION CONTACT:

Larry Young, 202-343-9353.

SUPPLEMENTARY INFORMATION: On April 15, 1974, final rulemaking was published in the FEDERAL REGISTER (FR 13613) establishing regulations to control and direct the use of ORV's on public lands. By decision and order issued by the U.S. District Court for the District of Columbia on May 2, 1975, these regulations were declared to be in violation of Executive Order 11644 and to have been promulgated without adequate consideration of alternatives as required by the National Enviromental Policy Act. The court further ordered that after adequate consideration of alternatives, as required by the National Environmental Policy Act, regulations be issued which did meet the requirements of Executive Order 11644. Under the direction of the Bureau of Outdoor Recreation, the Off-Road Vehicle Environmental Impact Statement was revised to expand the alternatives as ordered by the court. A draft statement was made available to the public on July 19, 1976, and open to public comment until October 7, 1976. On July 28, 1976, proposed Off-Road Vehicle regulations were published in the FEDERAL REGISTER (FR 31518) and the public was given until October 7, 1976, to submit comments on this proposal.

More than 1,300 comments were received on the proposed rulemaking and 140 comments were received on the draft environmental impact statement. Based on careful consideration of the comments received a final Environmental Impact Statement has been prepared by the Heritage Conservation and Recreation Service, formerly the Bureau of Outdoor Recreation.

Of the more than 1,300 comments received on the proposed rulemaking approximately 830 were mailgrams and letters addressed to the President, later referred to the Bureau, asking that Executive Order 11644 be amended or rescinded. The Bureau does not have the authority to amend or rescind the Executive order but is in fact under order by the courts to issue regulations that will conform to the Executive order. However, the President has recently amended Executive Order 11644, and the regulations have been amended as appropriate to include provisions under the amended Executive order.

Of the remaining comments received, totalling more than 470, many commentors were generally opposed to the entire proposal and offered few, if any, suggested amendments. In addition to changes to include provisions of the amendments to Executive Order 11644, changes have been made in the proposed rulemaking in response to public comments received on the July 28, 1976, publication of proposed rulemaking. Public comments and suggestions are invited regarding the amended proposed rulemaking.

Final regulations will reflect any additional comments received on the amended proposed rules.

DISCUSSION OF MAJOR COMMENTS RECEIVED ON THE PROPOSED RULEMAKING OF JULY 28, 1976

PUBLIC PARTICIPATION AND INFORMATION

The need for improved public participation and dissemination of information was of major concern to many commentors. They felt the Bureau had not done an adequate job of informing the public and obtaining public input in the planning and management of the ORV program. Request was made to amend the proposed rules to insure that the public would be involved in the planning system and in the designation procedures. It was also suggested that designation notices be available in local Bureau Offices at all times and that maps and other information informing the public of designations and other conditions of use be readily available and widely distributed.

It has been the procedure of the Bureau to obtain public participation in its planning process. Guidelines for planning, which reflect the Bureau's planning process, have been signed into law with the passage of the Federal Land Policy and Management Act of 1976 (43 U.S.C. 1701 et seq.). The rulemaking has been amended to strengthen the provision for public participation. Comments also stressed the need for the Bureau to improve its public distribution of maps, brochures and other information concerning the location of public lands and ORV land use designations. The Bureau agrees with these suggestions and will strive to improve communication with the public during the land use planning phase as well as the use phase of the management cycle for a particular administrative unit.

PERMITS

The majority of the comments addressing the provisions for issuing permits requested that the 25 vehicle limit be eliminated or substantially increased, that family-type, non-commercial, and non-competitive events be exempt from permit requirements, and that the term "organized events" be deleted or amended to be less inclusive. A few commentors wanted permits for all ORV use. A permit system is felt to be necessary for management and control of ORV's. The permit provisions have been amended, removed from this part, and placed in part 6260 of this chapter. The provisions require permits for (1) commercial events (2) competitive events for which participants register, and (3) events involving 50 or more ORV's. The amendment also requires that applications for permits be submitted on forms approved by the Director and be made no less than 120 calendar days in advance of the intended use unless a shorter time is authorized by the authorized officer. The lead time is required for preparing the necessary environmental reports, statements and conditions of use, and to provide that the applicant receive an approved permit 30 days in advance of the use date.

CONDITIONS OF USE

Interest in the provisions relating to conditions governing use centered on the licensing and supervision provisions. Commentors asked that the requirement be deleted or modified. This provision has been amended to provide an exemption from the licensing and supervisions requirement for an individual who has been certified by an agency of State government as competent to drive an ORV as a result of successfully completing a State endorsed operators training program. The licensing and supervision requirement is also waived for areas in Alaska designated by the State Director for Alaska. Executive Order 11644 requires that the ORV regulations provide for safety provisions. Because many of the deaths and injuries associated with ORV use have occurred to younger drivers, the training, licensing and supervision provisions required for individuals under 18 years of age should provide for greater safety to users of the public lands.

Commentors also suggested that ORV use should be in harmony with other authorized uses of the public lands. The proposal has been amended to provide that ORV use be managed to minimize conflicts with other authorized uses of the public lands.

Comments suggested that the terms "reckless," "careless," and "negligent" were too broad and could be the basis of arbitrary decisions. These are terms that are commonly used in State vehicle operating requirements. They have been retained in the proposal. The terms have been used extensively enough that vehicle users have a general understanding as to what the terms mean and can use them as a guide in the operation of their vehicles.

Suggestion was made to improve the safety provisions relating to the use of headlights and taillights. A change was made in the proposal to require lighted headlights and taillights when operating during night hours from sunset to sunrise. This will reduce the possibility of an ORV operating in the dark without lights when coming to or going from an ORV use area.

DEFINITIONS

The definition section of the proposal prompted many comments. Of major interest was the definition of an "ORV." It was suggested that there be separate definitions for the different types of ORV's (snowmobiles, two-wheel, four-wheel, etc.). As the Department is under court order to conform its regulations to Executive Order 11644, the definition of ORV was amended only slightly. The changes made are the insertion of the word "motorized," the deletion of the words "deriving motive power from any source other than muscle," and deletion of the exception provision exempting as an ORV a vehicle operating under a special recreation permit issued in accordance with Part 6260 of 43 CFR. It was not the intent of this rulemaking to exclude, as an ORV, motorized vehicles permitted under the provisions thereof.

The term "authorized officer" was deleted because it is already defined in 43 CFR Part 1810. Several commentors expressed concern over the broad authorities of the authorized officer and wanted to know who he is and to whom he is subject. Bureau Order No. 701 is the official delegation document for the Bureau. Under section 3.9 of this Order all ORV actions have been delegated to the District Manager. Under section 3.1 of the Order the District Manager may redelegate his authority to Area Managers or the Chief, Division of Administration after first obtaining approval of such delegation from the State Director and after publicizing the delegation in the FEDERAL REGISTER.

As suggested in a comment, the word "designated" has been added to clarify the definitions of open, limited and closed areas and trails.

DESIGNATION—CRITERIA AND PROCEDURES

A great diversity of public concern was demonstrated in the comments dealing with designation. Many commentors were opposed to any designation while others wanted all lands closed to ORV use until designated. Some commentors wanted immediate closures not only on "wilderness" and "primitive" areas but also on "natural" areas, special cultural areas, and other areas having fragile or scenic values. Other commentors suggested keeping open to ORV use only those areas presently being used. Some commentors expressed strong disagreement with the designation deadline date of 1987. This date was felt to be too distant and allowed an unwarranted period of time to bring ORV use under adequate control and management.

The status of the public lands prior to designation in conformance with Executive Order 11644, under the terms of the District Court Order of May 5, 1975, is simply undesignated. This means that those areas which have previously been open, closed, or limited shall generally remain so until designated under E.O. 11644 or 11989. However, this does not preclude the use of other existing authorities to open, close, or limit areas as needed for reasons other than ORV use. Closures or limitations might be because of withdrawals for habitat preservation, public safety, resource protection, etc. Wilderness areas, big-game wintering areas, critical watersheds, etc., can be protected even though the Executive Order 11644 designations have not been made.

To correlate the management of the several resources uses of the public lands, the Bureau of Land Management uses a coordinated multiple use planning system approach. The designation of ORV areas must be accomplished in harmony with this planning system. Action necessary to make designations is beginning immediately. All areas will be designated by 1987. It is estimated that 40 percent of the total designation process will be accomplished by 1981. This 40 percent will cover 60 percent of the major ORV use areas. For example, the Federal Land Policy and Management Act of 1976 designated the California Desert Conservation Area and directed that a comprehensive management plan be completed and implemented by September 30, 1980. This Conservation Area presently sustains about half of the total ORV use occurring on the public lands administered by the Bureau. Other major ORV use areas are also receiving timely planning and management attention.

Executive Order 11644 directed that officially designated wilderness and primitive areas be closed to ORV use and need not be designated under the three ORV designations defined in this part. Additional closures may be justified through the Bureau planning system. The Federal Land Policy and Management Act of 1976 has directed that by October 21, 1991, the Secretary shall review those roadless areas of 5,000 acres or more and roadless islands of the public lands identified during the inventory required by the Federal Land Policy and Management Act as having wilderness characteristics as described in the Wilderness Act (16 U.S.C. 1131 et seq.). Once identified, these areas having wilderness characteristics shall continue to be managed during the review period so as not to impair the suitability of such areas for preservation as wilderness, subject, however, "to the continuation of existing mining and grazing uses and mineral leasing in the manner and degree in which the same was being conducted on the date of approval" of the Federal Land Policy and Management Act. The ORV designations of lands identified as potential wilderness areas are being made consistent with these provisions of the Federal Land Policy and Management Act.

Request was made to clarify the status of current ORV designations. Designations made to date under 43 CFR Part 6290 are null and void. United States District Court, District of Columbia Court Order 74-1215, dated May 2, 1975, declared 43 CFR Part 6290 in violation of Executive Order 11644. Therefore, any designations made under those regulations also were in violation of the Executive Order. ORV closures and conditions of uses made under subpart 6221—Primitive Areas, § 6010.4—Closure of lands and subpart 6261—Rules for Visitor Use of Developed Recreation Sites, remain valid and in effect.

As suggested in the comments, the provision for monitoring ORV use has been clarified by stating that the authorized officer or his delegate shall monitor the effects of ORV use. The types of temporary designation changes have been expanded by adding that temporary designations may also "open" areas previously closed. The paragraph dealing with withdrawals has been deleted since the withdrawal procedures referred to do not comply with the provisions of the Federal Land Policy and Management Act of 1976.

VEHICLE STANDARDS

Commentors suggested reducing the required level of vehicle operating standards as required in the proposal, feeling that the standards were excessive. Snowmobile interests as well as other ORV groups wanted the spark arrester requirement removed. Request was made to delete the requirements for having brakes in good working condition as no one would operate an ORV without good brakes. The provision of the proposal covering noise standards appeared to some commentors as excessive since the Environmental Protection Agency did not have established noise standards. Some commentors read the proposal as saying that all ORV's required lights. Some commentors suggested that state standards be followed in lieu of Federal standards. The provision requiring minimum vehicle standards was retained because it is felt that basic vehicle standards are necessary. Even though states may have vehicle standards there is a lack of consistency of standards among states. The broad standards in the regulations are the minimum standards and will prevail where State law and regulations do not exist or are less stringent.

The proposal requires that an ORV have a spark arrester only when the authorized officer requires it. The proposal has been amended to waive the spark arrester requirement where three or more inches of snow are on the ground. The provision on noise standards has been amended to require compliance with Environmental Protection Agency standards when they are established and become available to the public. The requirement for lights on ORV's was apparently misunderstood. It requires ORV's operating during night hours from sunset to sunrise to be equipped with and use lights. Vehicles operated only during daylight hours are not required to have lights.

OTHER COMMENTS

The law enforcement provision drew several comments that the Bureau lacked both personnel and the authority to conduct law enforcement activities. The proposal used as the authority the act of September 15, 1960, as amended (16 U.S.C. 670 et seq.), sometimes referred to as the Sikes Act. This act provides authority to enforce the regulations issued to control ORV use on those specific designated areas of public land within a State on which conservation and rehabilitation programs are to be implemented. The other authority on which the law enforcement provisions was based was the Land and Water Conservation Fund Act (16 U.S.C. 460 1-6a) which provides for enforcing the collection of fees and permit requirements.

After this proposed rulemaking was printed in the FEDERAL REGISTER on July 28, 1976, the Federal Land Policy and Management Act of 1976 was enacted. This law provides the Bureau of Land Management with broad law enforcement authority. Not only may BLM personnel be given law enforcement responsibilities, but the act provides for the use of local law enforcement personnel through compensation by the Bureau.

A few commentors wanted limits established for temporary designations. Generally, such designations would be for a season—for deviation from normal wildlife use patterns, climatic conditions, public safety, etc., which most often would not exceed a year in duration.

Some commentors expressed concern that the proposed regulations would hinder access to isolated tracts of State or private lands within large blocks of public lands. The Bureau does not intend to hinder lawful and proper ingress and egress to such lands. Owners of such lands who desire access to their lands may work with local Bureau officials to arrive at solutions to their access needs. A number of commentors, including many who have mineral interests and holders of rights of way permits, suggested the proposed regulations be amended to specifically allow for the use of motorized vehicles in exploring and prospecting for minerals and for inspection and maintenance of rights-of-way. The definition of an "off-road vehicle" specifically excludes vehicles expressly authorized by the authorized officer or otherwise officially approved. Examples of situations where authorized and approved use of motorized vehicles would be excluded from the definition of an ORV are: the specific conditions of motorized vehicle use contained in a right-of-way permit, an approved plan of operation as described in the proposed regulations dealing with the surface management of public lands under the U.S. mining laws as published in the FEDERAL REGISTER on December 9, 1976, or a condition of use in a grazing license.

PRINCIPAL AUTHOR

Larry Young of the Bureau of Land Management, Washington Office, Division of Recreation Management.

INFLATION IMPACT STATEMENT

The Department of the Interior has determined that this document does not contain a major proposal requiring preparation of an Economic Impact Analysis under Executive Order 11821 and OMB Circular A-107.

It is proposed to amend 43 CFR Part 6290 as set forth below.

Dated: June 28, 1978.

GUY R. MARTIN,
Assistant Secretary of the Interior.

1. Part 6290 is revised to read as follows:

PART 6290—OFF-ROAD VEHICLES

Subpart 6290—General

AUTHORITY: 43 U.S.C. 1201, National Environmental Policy Act of 1969, 42 U.S.C. 4321; 43 U.S.C. 2, 1201; and Executive Order 11644 (37 FR 2877); Executive Order 11989 (42 FR 26959) (43 U.S.C. 1701 et. seq.)

Subpart 6290—General

§ 6290.0-1 Purpose.

The purpose of this part is to establish criteria for designating public lands as open, limited or closed to the use of off-road vehicles and for establishing controls governing the use and operation of off-road vehicles in such areas.

§ 6290.0-2 Objectives.

The objectives of these regulations are to protect the resources of the public lands, to promote the safety of all users of those lands, and to minimize conflicts among the various uses of those lands.

§ 6290.0-3 Authority.

The provisions of this part are issued under the Federal Land Policy and Management Act of 1976 (90 Stat. 2743; 43 U.S.C. 1701 et seq.); the Taylor Grazing Act (43 U.S.C. 315a); the National Environmental Policy Act (42 U.S.C. 4321 et seq.); the Endangered Species Act (16 U.S.C. 1531 et seq.); the Wild and Scenic Rivers Act (16 U.S.C. 1281c); the act of September 15, 1960, as amended (16 U.S.C. 670 et seq.); the Land and Water Conservation Fund Act (16 U.S.C. 460 1-6a); the National Trails System Act (16 U.S.C. 1241 et seq.) and E.O. 11644 (Use of Off-Road Vehicles on the Public Lands), 37 FR 2877, 3 CFR 74, 332, as amended by E.O. 11989 42 FR 26959 (May 25, 1977).

§ 6290.0-5 Definitions.

As used in this part:

(a) "Off-Road Vehicle" means any motorized vehicle capable of, or de-their natural, esthetic, or scenic values.

§ 6292.2 Designation procedures.

(a) *Public participation.* The authorized officer shall, to the extent practical, designate and redesignate areas and trails in conjunction with the Bureau planning system for the formulation of multiple-use management plans. Plans shall consider current and potential impacts of specific vehicle types on all resources and users in the region of the area under consideration. Prior to making designations or redesignations, the authorized officer shall consult with interested user groups, Federal, State, county, and local agencies, local landowners, and other parties in a manner that provides an opportunity for the public to express itself and have those views taken into account.

(b) *Identification of designated areas and trails.* The authorized officer shall take action by posting and other appropriate measures to identify designated areas and trails so that the public will be aware of locations and limitations applicable thereto. Public notice of designations or redesignations shall be given at the time of designation or redesignation through publication in the FEDERAL REGISTER and local news media. Copies of such notices shall be available to the public in local Bureau offices. The authorized officer will make available to the public other information material as may be appropriate.

§ 6292.3 Designation changes.

(a) *Monitoring use.* The authorized officer shall monitor effects of the use of off-road vehicles. On the basis of information so obtained, and whenever the authorized officer deems it necessary to carry out the objectives of the part, designations may be amended, revised, revoked, or other actions taken pursuant to the regulations in this part.

(b) *Temporary action.* The authorized officer may temporarily open, close, or limit public use and travel in accordance with the provisions of § 6010.4 of this chapter as to public lands which have been designated or redesignated in accordance with this subpart, and as to public lands which have not been designated.

Subpart 6293—Vehicle Operations

§ 6293.1 Standards.

(a) No off-road vehicle may be operated on public lands unless equipped with brakes in good working condition.

(b) No off-road vehicle equipped with a muffler cutout, bypass, or similar device, or producing excessive noise exceeding Environmental Protection Agency standards, when established, may be operated on public lands.

(c) The authorized officer may, by posting appropriate signs or by marking a map which shall be available for public inspection at local Bureau offices, indicate those public lands upon which no off-road vehicle may be operated unless equipped with a properly installed spark arrester that meets and is qualified to either the U.S. Department of Agriculture—Forest Service Standard 5100-1a, or the 80-percent efficiency level when determined by the appropriate Society of Automotive Engineers (SAE) Recommended Practices J335 or J350, which standards include the requirement that such spark arrester shall have an efficiency to retain or destroy at least 80 percent of carbon particles for all flow rates, and which includes a requirement that such spark arrestor has been warranted by its manufacturer as meeting such requirement for at least 1,000 hours subject to normal use, with maintenance and mounting in accordance with the manufacturer's recommendation. A spark arrester is not required when an off-road vehicle is being operated in an area which has 3 or more inches of snow on the ground.

(d) Vehicles operating during the time specified in § 6291.1(g)(5) shall comply with the following: (1) Headlights shall be of sufficient power to illuminate an object at 300 feet at night under normal, clear atmospheric conditions. Two- or three-wheeled vehicles or single-tracked vehicles will have a minimum of one headlight. Vehicles having four or more wheels or more than a single track will have a minimum of two headlights, except double tracked snowmachines with a maximum capacity of two people may have only one headlight. (2) Red taillights, capable of being seen at a distance of 500 feet from the rear at night under normal, clear atmospheric conditions, are required on vehicles in the same numbers as headlights.

Supart 6294—Permits

§ 6294.1 Permit requirements.

Permits are required for certain types of ORV use and shall be issued in accordance with the special recreation permit procedures under part 6260 of this chapter.

[FR Doc. 78-18478 Filed 7-6-78; 8:45 am]

APPENDIX C

Applicable (36 CFR 295);
(36 CFR 261.13) and revoked
(36 CFR 295.6-295.8) Forest
Service regulations.

PART 295—USE OF OFF-ROAD VEHICLES

AUTHORITY: 30 Stat. 35, as amended; 16 U.S.C. 551; 50 Stat. 525, as amended; 7 U.S.C. 1011; 83 Stat. 852; E.O. 11644.

SOURCE: 38 FR 26723, Sept. 25, 1973, unless otherwise noted.

§ 295.1 Applicability.

The regulations in this part pertain to administrative designation of specific areas and trails of National Forest System lands on which the use of off-road vehicles shall be allowed, restricted, or prohibited and establishing controls governing the use of off-road vehicles on such areas. The use of off-road vehicles in National Forest Wilderness and Primitive Areas is governed by §§ 293.1 through 293.17 of this Title.

§ 295.2 Definitions.

(a) "Off-road vehicles" means any motorized vehicles designed for or capable of cross country travel on or immediately over land, water, sand, snow, ice, marsh, swampland, or other terrain which would include, but not be limited to, such vehicles as four wheel drive, motorcycle, snowmobile, amphibious, and air cushion vehicles; except that such term excludes (1) any registered motorboat, (2) any military, fire, emergency or law enforcement vehicle when used for official or emergency purposes, and (3) any vehicle whose use is expressly authorized by the Chief, Forest Service, under a permit, lease, license, or contract.

(b) "National Forest System lands" means National Forests, National Grasslands, and other lands and interests in land administered by the Forest Service.

(c) "Official use" means an employee, agent, or designated representative of the Federal Government or one of its contractors in the course of his employment, agency, or representation.

(d) "Trail" means a designated path or way of varying width which is commonly used by and maintained for hikers, horsemen, snow travelers, bicyclists or for motorized vehicles with a total width of 40 inches or less.

§ 295.3 Planning designation of areas and trails.

On National Forest System lands the continuing resource planning process will provide for designation of specific areas and trails for off-road vehicle use, use restrictions, and closures to any or all types of such use. This process will include coordination with appropriate Federal, State, and local agencies. The planning process will analyze and evaluate alternatives to enable decisions which best provide for the protection of the natural and historic resources, promotion of safety for all users, minimization of use conflicts, and accomplishment of all of the other resource objectives for National Forest System lands. Analysis and evaluation of off-road vehicles uses will take into consideration factors such as noise, safety, quality of the various recreational experiences provided, protential impacts on soil, watershed, vegetation, fish, wildlife, fish and wildlife habitat, and existing or proposed recreational uses of the same or neighboring lands. Regional Foresters and Forest Supervisors are authorized to designate areas and trails for off-road vehicles use, use restrictions, and closures to any or all types of such use.

[38 FR 26723, Sept. 25, 1973, as amended at 39 FR 10431, Mar. 20, 1974]

§ 295.4 Public participation.

The public shall be provided an opportunity to participate in the designation of areas and trails relating to off-road vehicle use. Advance notice will be given to allow review by the public of proposed designations or revisions of designations of any areas or trails for off-road vehicle use, for restrictions, or for closures to such use. Adequate time will be allowed for public response prior to any designations or revisions. In emergency situations, designation or revision of designation may be made without public participation to protect natural resources and to provide for public safety.

§ 295.5 Public information.

Areas and trails may be marked with appropriate signs to control off-road vehicle use. All notices issued concerning the regulation of off-road vehicles shall be posted so as to reasonably bring them to the attention of the public, and a copy of the notice shall be kept available to the public in the offices of the District Rangers and Forest Supervisors. Information and maps will be published and distributed describing the conditions of use and the time periods when areas and trails are: (a) Open to off-road vehicle use, (b) restricted to certain types of off-road vehicle use, (c) closed to off-road vehicle use.

§§ 295.6—295.8 [Reserved]

§ 295.9 Monitoring effects of off-road vehicle use.

The effects of off-road vehicle use on National Forest System lands will be monitored by the Forest Service. Designation, use restrictions, and operating conditions will be revised as needed to meet changing conditions.

PARTS 296–299 [RESERVED]

295.6 Operating conditions.

The following acts are prohibited when off-road vehicles are operated on areas or trails of National Forest System lands:

(a) Operation without a valid operator's license or learner's permit if required by the laws of the State in which the vehicle is being operated for that particular type of off-road vehicle;

(b) Operation by an unlicensed person under 18 years of age unless accompanied by or within the sight of a responsible adult who has a valid operators license if a license is required by the State for the type of vehicle being operated;

(c) Operation in a manner disregarding the rights and safety of others, or so as to endanger, or be likely to endanger, any person or property;

(d) Operation in excess of established speed limits;

(e) Operation while the operator is under the influence of alcohol or drugs;

(f) Operation in a manner creating excessive damage or disturbance of the land, wildlife, or vegetative resources;

(g) Operation not in conformance with applicable State laws and regulation requirements established for off-road vehicles;

(h) Operation when an internal combustion engine is not equipped with a properly installed muffler in good working condition;

(i) Operation when an internal or external conbustion engine is not equipped with a properly installed spark arrester, provided that such equipment is specified when an area or trail is designated for use by off-road vehicles. Such spark arrester shall meet and be qualified to either the Department of Agriculture, Forest Service Standard 5100-1a, or the 80 percent efficiency level when determined in accordance with the appropriate Society of Automotive Engineers (SAE) Recommended Practices J335 or J350. Qualification or spark arresters to either the Forest Service Standard of SAE Recommended Practices shall be determined by the Forest Service;

(j) Operation without an operable braking system;

(k) Operation from one-half hour after sunset to one-half hour before sunrise without working headlights and taillight;

(l) Operation which does not comply with:

(1) Any applicable noise emission standard established by the Administrator, Environmental Protection Agency, under authority of section 6 of the Noise Control Act of 1972 (PL 92-574);

(2) Any applicable U. S. Department of Agriculture or State standards for permissible levels of environmental noise. In case of overlapping standards, the most stringent standards will govern.

[39 FR 10431, Mar. 20, 1974]

295.7 Restricted and prohibited use.

Except as provided in 295.8, and except for use in connection with mining activities under the provisions of the General Mining Act of 1872, the use of off-road vehicles is prohibited in areas and trails on National Forest System lands during any period when such areas and trails have been closed to vehicles or certain types of vehicles pursuant to these regulations.

295.8 Off-road vehicle permits.

Use of off-road vehicles on National Forest System lands where the use of off-road vehicles is prohibited may be allowed for official use or with prior authorization by means of an Off-Road Vehicle permit. Off-Road Vehicle permits may be issued by the Chief or authorized official of the Forest Service, and such permits shall be revocable for violation of the rules and regulations governing the National Forests.

PART 261—PROHIBITIONS

Subpart A—General Prohibitions

§ 261.13 Use of vehicles off roads.

It is prohibited to operate any vehicle off Forest Development, State or County roads:

(a) Without a valid license as required by State law.

(b) Without an operable braking system.

(c) From one-half hour after sunset to one-half hour before sunrise unless equipped with working head and tail lights.

(d) In violation of any applicable noise emission standard established by any Federal or State agency.

(e) While under the influence of alcohol or other drug;

(f) Creating excessive or unusual smoke;

(g) Carelessly, recklessly, or without regard for the safety of any person, or in a manner that endangers, or is likely to endanger, any person or property.

APPENDIX D

Oregon Revised Statutes that apply to off-road vehicles and snowmobiles.

OFF-ROAD VEHICLES

483.833 Definitions for ORS 483.833 to 483.847. As used in ORS 483.833 to 483.847, "off-road vehicle" means any motorized vehicle designed for or capable of cross-country travel on or immediately over land, water, sand, snow, ice, marsh, swampland or other natural terrain.
[1975 c.89 §2]

483.835 [1973 c.580 §5; 1975 c.287 §6; renumbered 487.755]

483.837 Equipment requirements when operated on certain public lands. Except as provided in ORS 483.847, an off-road vehicle is not in violation of laws governing equipment on motor vehicles if the off-road vehicle complies with the requirements of ORS 483.839 and 483.843 and is operated within the Oregon Dunes National Recreational Area on:

(1) Lands and roads under the custody and control of the Secretary of the United States Department of Agriculture; or

(2) That portion of the ocean shore open to vehicular traffic.
[1975 c.89 §3]

483.839 Required equipment. (1) Every off-road vehicle operating in an area specified in ORS 483.837 shall be equipped with:

(a) A muffler which permits the vehicle to meet standards for noise emissions adopted by the Environmental Quality Commission.

(b) Brakes of a type specified by the Administrator of the Motor Vehicles Division.

(c) A windshield wiper if the off-road vehicle is equipped with a windshield.

(d) A flag of a type specified by the administrator of the division when the off-road vehicle is operated on sand.

(e) Such other safety equipment as is required by rule adopted by the administrator.

(2) Paragraphs (c) and (d) of subsection (1) of this section shall not apply to motorcycles.
[1975 c.89 §4]

483.840 [1973 c.580 §6; repealed by 1975 c.451 §291]

483.843 Headlight and taillight requirements. Every off-road vehicle operating in an area specified in ORS 483.837 at any time from one-half hour after sunset to one-half hour after sunrise shall be equipped with and display headlights and taillights.
[1975 c.89 §5]

483.845 [1973 c.580 §7; repealed by 1975 c.451 §291]

483.847 Operation without required equipment. Operation of an off-road vehicle in an area specified in ORS 483.837 in violation of ORS 483.839 or 483.843 or any rule adopted pursuant to ORS 483.839 is a Class C misdemeanor.
[1975 c.89 §6]

483.850 [1973 c.580 §8; repealed by 1975 c.451 §291]

483.855 [1973 c.580 §9; repealed by 1975 c.451 §291]

483.860 [1973 c.580 §10; 1975 c.287 §8; repealed by 1975 c.451 §291]

483.865 [1973 c.580 §11; 1975 c.451 §127; renumbered 487.775]

483.870 [1973 c.580 §12; 1975 c.451 §129; renumbered 487.785]

SNOWMOBILES

483.705 [1969 c.598 §9; repealed by 1971 c.618 §28]

483.710 Operation of snowmobile to hunt; while under the influence of liquor or drugs; "dangerous drugs" defined. (1) No person shall operate a snowmobile in a manner so as to run down, harass, chase or annoy any game animals or birds or domestic animals. No person shall hunt from a snowmobile. This subsection does not apply to officers of the State Fish and Wildlife Commission, to persons under contract to the commission in the performance of their official duties or to individuals who have secured a permit from the commission for purposes of research and study.

(2) No owner or other person having charge or control of a snowmobile shall knowingly authorize or permit any person to operate the snowmobile across a highway who is incapable by reason of age, physical or mental disability or who is under the influence of intoxicating liquor or controlled substances.

(3) As used in ORS 483.730, "dangerous drugs" means any drug designated a controlled substance by the Committee on Controlled Substances.
[1969 c.598 §§10, 13; 1971 c.618 §23; 1977 c.745 §50]

Note: The amendments to 483.710 by section 50, chapter 745, Oregon Laws 1977, take effect July 1, 1978. See section 56, chapter 745, Oregon Laws 1977.

483.715 [1969 c.598 §11; repealed by 1971 c.618 §28]

483.725 Operator's license or certification required; age limit for operators; snowmobile safety education courses. (1) No person shall operate a snowmobile unless:

(a) He has an operator's license issued under ORS chapter 482 or has been certified, as provided by subsection (3) of this section, as qualified to operate a snowmobile; and

(b) He has on his person at the time he is operating the snowmobile his license or evidence of such certification.

(2) No person under 12 years of age shall operate a snowmobile on or across a highway or a railroad right of way.

(3) A person who does not have an operator's license issued under ORS chapter 482 may operate a snowmobile if he has taken a snowmobile safety education course and been certified as qualified to operate a snowmobile. The course shall be one given by an instructor designated by the division as qualified to conduct such a course and issue such a certificate. The division shall adopt regulations to provide for the designation of instructors and the issuance of certificates. The division shall by regulation prescribe reasonable fees to be collected in the administration of the program. Notwithstanding subsection (1) of this section, a person may operate a snowmobile while taking such a course from an instructor.
[1971 c.618 §18]

483.730 Prohibited acts. It shall be unlawful for any person to operate any snowmobile:

(1) At a rate of speed greater than reasonable and proper under the existing conditions.

(2) While under the influence of intoxicating liquor, dangerous drugs or narcotic drugs.

(3) In a negligent manner so as to endanger the person or property of another, or to cause injury or damage to either.

(4) Without a lighted headlight and taillight.

(5) Without an adequate braking device which may be operated either by hand or foot.

(6) Without an adequate and operating muffling device which shall effectively blend the exhaust and motor noise in such a manner so as to preclude excessive or unusual noise and, on snowmobiles manufactured after January 4, 1973, which shall effectively maintain such noise at a level of 82 decibels or below on the "A" scale at 100 feet under testing procedures established by the Department of State Police; however, snowmobiles used in organized racing events in an area designated for that purpose may use a bypass or cutout device.

(7) Upon the paved portion or upon the shoulder or inside bank or slope of any highway, or upon the median of any divided highway or upon any portion of a highway right of way under construction, except as provided in ORS 483.735 and 483.740.

(8) On or across a railroad right of way, except as provided by ORS 483.735 and 483.740; however, this subsection does not apply to snowmobiles being operated by officers or employes or authorized contractors or agents of a railroad in the course of their employment.

(9) In any area or in such a manner so as to expose the underlying soil or vegetation, or to injure, damage or destroy trees or growing crops.

(10) With a firearm in his possession, unless the firearm is unloaded, or with a bow, unless the bow is unstrung.

(11) A person who violates subsection (1) or subsections (3) to (10) of this section commits a Class B traffic infraction.

(12) A person who violates subsection (2) of this section commits a Class A traffic infraction.
[1971 c.618 §15; 1977 c.882 §26]

483.735 Crossing two or three lane highways. It shall be lawful to drive or operate a snowmobile across a two or three lane highway or a railroad right of way when:

(1) The crossing is made at an angle of approximately 90 degrees to the direction of the highway or railroad right of way and at a place where no obstruction prevents a quick and safe crossing;

(2) The snowmobile is brought to a complete stop before entering the highway or railroad right of way;

(3) The operator of the snowmobile yields the right of way to vehicles using the highway or equipment using the railroad tracks; and

(4) The crossing is made at an established public railroad crossing or at a place that is greater than 100 feet from any highway intersection.

(5) A person who violates this section commits a Class C traffic infraction.
[1971 c.618 §16; 1977 c.882 §27]

483.740 Operation of snowmobile upon highway or railroad right of way. (1) Notwithstanding subsection (2) of ORS 483.725 and ORS 483.735, it shall be lawful to operate a snowmobile upon a highway:

(a) Where the highway is completely covered with snow or ice and has been closed to motor vehicle traffic during the winter months;

(b) For the purpose of loading or unloading when such operation is performed with safety and without causing a hazard to vehicular traffic approaching from either direction on the highway;

(c) Where the highway is posted to permit snowmobiles;

(d) In an emergency during the period of time when and at locations where snow upon the highway renders travel by automobile impractical; or

(e) When traveling along a designated snowmobile trail.

(2) Notwithstanding subsection (2) of ORS 483.725 and ORS 483.735, it shall be lawful to operate a snowmobile upon a railroad right of way:

(a) Where the right of way is posted to permit snowmobiles; or

(b) In an emergency.

(3) A person who violates this section commits a Class C traffic infraction.
[1971 c.618 §17; 1977 c.882 §28]

483.745 Accident reports required. The operator of a snowmobile involved in any accident resulting in injury to or death of any person, or property damage in the estimated amount of $200 or more, or a person acting for the operator or the owner of the snowmobile having knowledge of the accident, should the operator of the snowmobile be unknown, shall submit such reports as are required under ORS 483.602 to 483.614, and ORS 483.602 to 483.612 are applicable to such reports when submitted.
[1971 c.618 §19; 1975 c.451 §269d]

483.750 Enforcement of ORS 483.725 to 483.740. ORS 483.725 to 483.740 shall be enforced by all police officers, game wardens and all other state law enforcement officers within their respective jurisdictions.
[1971 c.618 §20]

483.755 Regulation of snowmobiles by cities, counties, political subdivisions and state agencies. Notwithstanding any of the provisions of ORS 483.725 to 483.740 and subsection (3) of 483.991, any city, county or other political subdivision, or any state agency, may regulate the operation of snowmobiles on public lands, waters and other properties under its jurisdiction, and on streets or highways within its boundaries by adopting regulations or ordinances of its governing body, if such regulations are not inconsistent with ORS 483.725 to 483.740 and subsection (3) of 483.991.
[1971 c.618 §22; 1977 c.475 §6]

APPENDIX E

Oregon Revised Statutes and administrative rules relating to ORV noise.

467.010 Legislative findings and policy. The Legislative Assembly finds that the increasing incidence of noise emissions in this state at unreasonable levels is as much a threat to the environmental quality of life in this state and the health, safety and welfare of the people of this state as is pollution of the air and waters of this state. To provide protection of the health, safety and welfare of Oregon citizens from the hazards and deterioration of the quality of life imposed by excessive noise emissions, it is hereby declared that the State of Oregon has an interest in the control of such pollution, and that a program of protection should be initiated. To carry out this purpose, it is desirable to centralize in the Environmental Quality Commission the authority to adopt reasonable state-wide standards for noise emissions permitted within this state and to implement and enforce compliance with such standards.
[1971 c.452 §1]

467.020 Emission of noise in excess of prescribed levels prohibited. No person may emit, cause the emission of, or permit the emission of noise in excess of the levels fixed therefor by the Environmental Quality Commission purusant to ORS 467.030.
[1971 c.452 §3]

467.030 Adoption of noise control rules, levels and standards. (1) In accordance with the applicable provisions of ORS chapter 183, the Environmental Quality Commission shall adopt rules relating to the control of levels of noise emitted into the environment of this state and including the following:

(a) Categories of noise emission sources, including the categories of motor vehicles and aircraft.

(b) Requirements and specifications for equipment to be used in the monitoring of noise emissions.

(c) Procedures for the collection, reporting, interpretations and use of data obtained from noise monitoring activities.

(2) The Environmental Quality Commission shall investigate and, after appropriate public notice and hearing, shall establish maximum permissible levels of noise emission for each category established, as well as the method of measurement of the levels of noise emission.

(3) The Environmental Quality Commission shall adopt, after appropriate public notice and hearing, standards for the control of noise emissions which shall be enforceable by order of the commission.
[1971 c.452 §2; 1973 c.107 §1; 1973 c.835 §159]

467.100 Local regulation of noise sources. (1) Pursuant to this chapter, in order to protect the health, safety and welfare of its citizens, a city or county may adopt and enforce noise ordinances or noise standards otherwise permitted by law. A city or county may also adopt such standards for a class of activity exempted by the commission or noise emission sources not regulated by the commission.

(2) The commission may by rule withdraw from enforcement any or all of its rules or standards adopted pursuant to this chapter within the boundaries of any city or county, if the commission finds such city or county:

(a) Has adopted noise standards that are at least as stringent as and no less protective than those standards adopted by the state; and

(b) Has a program of active enforcement of such standards which, in the commission's view, is at least as protective of the public health, safety and welfare as would be the enforcement provided by the department.

(3) The commission may modify or repeal such a rule as is made in accordance with subsection (2) of this section with regard to any particular city or county if it finds material change in any of the circumstances relied upon by the commission in making such rule. Such rulemaking shall be in conformance with the provisions of ORS chapter 183.

(4) Nothing in this section is intended to preclude contractual arrangements between a city or county and a state agency for services provided for the enforcement of state or local noise emission control standards.
[1977 c.511 §4]

467.990 Penalties. Violation of any provision of this chapter or rules or orders made under the provisions of this chapter is a Class B misdemeanor. Each day of violation shall be considered a separate offense.
[1971 c.452 §6; 1973 c.835 §161]

Department of Environmental Quality

Chapter 340, Oregon Administrative Rules

Division 35

Noise Control Regulations

Amended March 1, 1978

General

35-005 POLICY. In the interest of public health and welfare, and in accordance with ORS 467.010, it is declared to be the public policy of the State of Oregon:

(1) to provide a coordinated state-wide program of noise control to protect the health, safety, and welfare of Oregon citizens from the hazards and deterioration of the quality of life imposed by excessive noise emissions;

(2) to facilitate cooperation among units of state and local governments in establishing and supporting noise control programs consistent with the State program and to encourage the enforcement of viable local noise control regulations by the appropriate local jurisdiction;

(3) to develop a program for the control of excessive noise sources which shall be undertaken in a progressive manner, and each of its objectives shall be accomplished by cooperation among all parties concerned.

....

35-015 DEFINITIONS. As used in this Division:

(1) "Ambient Noise" means the all-encompassing noise associated with a given environment, being usually a composite of sounds from many sources near and far.

....

(11) "In-Use Motor Vehicle" means any Motor Vehicle which is not a New Motor Vehicle.

....

(14) "Motorcycle" means any Motor Vehicle, except Farm Tractors, designed to travel on not more than three wheels which are in contact with the ground.

(15) "Motor Vehicle" means any vehicle which is, or is designed to be self-propelled or is designed or used for transporting persons or property. This definition excludes, airplanes, but includes water craft.

....

(18) "Noise Level" means weighted Sound Pressure Level measured by use of a metering characteristic with an "A" frequency weighting network and reporting as dBA.

(19) "Noise Sensitive Property" means real property on, or in, which people normally sleep, or on which exist facilities normally used by people as schools, churches, or public libraries. Property used in industrial or agricultural activities is not defined to be Noise Sensitive Property unless it meets the above criteria in more than an incidental manner.

....

(21) "Off-Road Recreational Vehicle" means any Motor Vehicle, including water craft, used off Public Roads for recreational purposes. When a Road Vehicle is operated off-road, the vehicle shall be considered an Off-Road Recreational Vehicle if it is being operated for recreational purposes.

....

(26) "Propulsion Noise" means that noise created in the propulsion of a Motor Vehicle. This includes, but is not limited to, exhaust system noise, induction system noise, tire noise, cooling system noise, aerodynamic noise and, where appropriate in the test procedure, braking system noise. This does not include noise created by Road Vehicle Auxiliary Equipment such as power take-offs and compressors.

(27) "Public Roads" means any street, alley, road, highway, freeway, thoroughfare, or section thereof in this state used by the public or dedicated or appropriated to public use.

(28) "Quiet Area" means any land or facility designated by the Commission as an appropriate area where the qualities of serenity, tranquility, and quiet are of extraordinary significance and serve an important public need, such as, without being limited to, a wilderness area, national park, state park, game reserve, wildlife breeding area or amphitheater. The Department shall submit areas suggested by the public as Quiet Areas, to the Commission, with the Department's recommendation.

(29) "Racing Events" means any competition using Motor Vehicles, conducted under a permit issued by the governmental authority having jurisdiction or, if such permit is not required, under the auspices of a recognized sanctioning body. This definition includes, but is not limited to, events on the surface of land and water.

(30) "Racing Vehicle" means any Motor Vehicle that is designed to be used exclusively in Racing Events.

(31) "Road Vehicle" means any Motor Vehicle registered for use on Public Roads, including any attached trailing vehicles.

....

(33) "Sound Pressure Level" (SPL) means 20 times the logarithm to the base 10 of the ratio of the root-mean-square pressure of the sound to the reference pressure. SPL is given in decibels (dB). The reference pressure is 20 micropascals (20 micronewtons per square meter).

....

35-030 NOISE CONTROL REGULATIONS FOR IN-USE MOTOR VEHICLES

(1) Standards and Regulations:

....

(b) Off-Road Recreational Vehicles.

(A) No person shall operate any off-road recreational vehicle which exceeds the noise level limits specified in Table D.

(B) No person shall operate an off-road recreational vehicle with any of the following defects:

(i) no muffler

(ii) leaks in the exhaust system

(iii) pinched outlet pipe

....

(d) Ambient Noise Limits

(A) No person shall cause, allow, permit, or fail to control the operation of motor vehicles, including motorcycles, on property which he owns or controls, nor shall any person operate any such motor vehicle if the operation thereof increases the ambient noise level such that the appropriate noise level specified in Table E is exceeded as measured from either of the following points, if located within 1000 feet (305 meters) of the motor vehicle:

(i) noise sensitive property, or

(ii) the boundary of a quiet area.

(B) Exempt from the requirements of this subsection shall be:

(i) motor vehicles operating in racing events;

(ii) motor vehicles initially entering or leaving property which is more than 1000 feet (305 meters) from the nearest noise sensitive property or boundary of a quiet area.

(iii) motor vehicles operating on public roads; and

(iv) Motor vehicles operating off-road for non-recreational purposes.

....

TABLE D

Off-Road Recreational Vehicle Standards

Allowable Noise Limits

Vehicle Type	Model Year	Maximum Noise Level (dBA) and Distance from Vehicle to Measurement Point: Stationary Test 20 Inches (1/2 Meter)	Moving Test at 50 Feet (15.2 Meters)
Motorcycles	1975 and Before	102	
	After 1975	99	
Snowmobiles	1971 and Before		86
	1972-1975		84
	1976-1978		80
	After 1978		77
Boats			
Underwater Exhaust	All		84
Atmosphere Exhaust	All	100	84
All Others			
Front Engine	All	95	
Mid and Rear Engines	All	97	

TABLE E

Ambient Standards for Vehicles Operated Near Noise Sensitive Property

Allowable Noise Limits

Time	Maximum Noise Level, dBA
7 a.m. - 10 p.m.	60
10 p.m. - 7 a.m.	55

APPENDIX G

Cooperative agreement between Tillamook County and the U. S. Forest Service.

COOPERATIVE AGREEMENT

BETWEEN

TILLAMOOK COUNTY SHERIFF'S DEPARTMENT
TILLAMOOK, OREGON

AND

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
SIUSLAW NATIONAL FOREST
P. O. BOX 1148
CORVALLIS, OREGON

Under the Act of August 10, 1971 (P. L. 92-82).

Whereas, the Forest Service, hereinafter referred to as the Service, has the responsibility for the enforcement of the Federal laws and regulations relative to the National Forest System, and other lands administered by the Forest Service, and,

Whereas, the Service recognizes that public use of such lands, which are usually located in remote or sparsely populated areas, are attracting large numbers of visitors, and,

Whereas, the Tillamook County Sheriff's Department, hereafter referred to as the Cooperator, has the authority to enforce the State and local laws for Tillamook County on such lands, and,

Whereas, the Siuslaw National Forest is partially located in Tillamook County for which the cooperator has the responsibility of enforcement of State and local laws, and,

Whereas, the cooperator is limited by level of financing as to the amount of protection, patrol and investigation that can be provided at the more remote areas within Tillamook County,

Now therefore, the parties hereby mutually agree that it is desirable to cooperate in better utilizing the resources of both agencies while providing for more adequate protection of persons and property as follows:

A. The Tillamook County Sheriff's Department agrees:

1. To continue to enforce the civil and criminal laws of the State and/or county on lands within or a part of any unit of the National Forest System within the normal scope of its duty without reimbursement by the Service.

2. Upon specific request of the Service, to provide special services beyond those provided under Clause A-1 for the enforcement of State or local laws relating to the protection of persons and their property in accordance with the operating and financial plan.

3. To furnish the Service at intervals mutually agreed upon itemized statements of expenditures incurred.

4. To maintain accounting and performance records of the reimburseable expenses in a manner that will facilitate an examination by officials of the Service or other Federal officials who may be required to examine such records. Such records will be retained for a period of three years following the year the expenditures were incurred, unless disposition is otherwise agreed to in writing.

5. That all officers assigned to fulfill the services under this agreement will meet the same standards of training required of other officers in his jurisdiction or where State Peace Officer Standards of Training (P.O.S.T.) exist, will meet those standards.

6. When Forest Service radio frequencies are utilized, acquire Federal Communication Commission licenses.

B. The Service agrees, within availability of funds and established Service regulations and policies:

1. To enforce the Federal laws and regulations relating to the National Forest System.

2. To provide support and cooperation to the Tillamook County Sheriff's Department in enforcement of State and local laws on lands within or a part of any unit of the National Forest System.

3. To reimburse the Tillamook County Sheriff's Department for the special or support services provided under Clause A-1 and A-2 at the rates established in Clause B-2.

4. Obtain required licenses for operating radio on cooperator frequencies.

C. The parties mutually agree:

1. To provide the maximum cooperation possible, within the availability of funds and established laws, regulations, and policies governing the respective agencies that will assure the protection of persons and their property on land within or a part of any unit of the National Forest System.

2. To prepare and/or update annually an Operating and Financial Plan specifying the cooperation on behalf of both parties and the terms for reimbursement for the services referred to. This plan when signed by both parties is attached to and made a part of this agreement. Each party will designate in the plan a specific individual and alternate(s) to make or receive requests for special services under this agreement.

3. That officers of the Tillamook County Sheriff's Department performing services under this agreement in enforcing State and local laws are, and will remain under the supervision, authority, and responsibility of the Tillamook County Sheriff. Such services provided by the cooperator and its employees shall not be considered as coming within the scope of Federal employment and none of the benefits of Federal employment will be conferred under this agreement.

4. In connection with the performance of work under this agreement, the provisions of Form AD-369, Equal Opportunity, attached, are hereby included as a part of this agreement. On Form AD-369, "Contractor" means "Cooperator." "Contracting Officer" and "Contracting Agency" mean "Forest Service."

5. No member of, or delegate to, Congress, or Resident Commissioner, shall be admitted to any share or part of this agreement or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

6. The period of this agreement shall be from the date of execution until terminated by mutual agreement, or on 30 days' written notice from either party to the other.

7. Any changes in the provisions of this agreement which are necessary and proper will be made by formal amendment.

COOPERATOR		FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE	
Chas D Bailey	3/29/78	[signature]	4/5/78
Chairman, Board of Commissioners Tillamook County	Date	Forest Supervisor Siuslaw national Forest	Date

Approved Dori O Wilson — 3-30-78

Sheriff, Tillamook County — Date

APPENDIX H

Agreement between Tillamook County and Northwest Trail and Dune Association.

BEFORE THE BOARD OF COUNTY COMMISSIONERS

FOR TILLAMOOK COUNTY, OREGON

SPECIAL USE LICENSE

Permission is hereby granted to NORTHWEST TRAIL AND DUNE ASSOCIATION of 1150 Iris Lane N.W., Salem, Oregon 97304, hereinafter called the Licensee, to use the property shown on the attached map marked "Exhibit A" and made a part hereof to the same extent as if set forth in full. This license is issued for the purpose of allowing the Licensee to stage seven (7) drag races only between April 1 and October 15 each year for the duration of the license, and is subject to and contingent upon compliance with the conditions set forth below.

1. In consideration for this use, the Licensee shall pay to Tillamook County, Oregon the sum of One thosuand dollars ($1,000.) per year for the duration of this license, said first year sum payable upon execution of this agreement. Subsequent yearly payments shall be payable on or before the 31st day of March each year.

2. Development Plans: layout or construction plans for this area must be approved in advance and in writing by the Chairman of the Board of County Commissioners or his designee. Trees, shrubs, and other plants may be planted in such manner and in such places about the premises as may be approved by the Chairman of the Board of County Commissioners or his designee.

3. The Licensee shall maintain the improvements and premises to Tillamook County standards of repair, orderliness, neatness, sanitation, and safety acceptable to the Chairman of the Board of County Commissioners or his designee.

4. The Licensee shall provide necessary fencing in accordance with and under the direction of Siuslaw National Forest and including the licensed area of Tillamook County.

5. The Licensee, in exercising the privileges granted by this license, shall comply with the regulations of the Department of Agriculture and all Federal, State, county, and municipal laws, ordinances, or regulations which are applicable to the area or operations covered by this license.

6. The Licensee shall take all reasonable precautions to prevent and suppress forest fires. No material shall be disposed of by burning in open fires during the closed season established by law or regulation without a written permit from the Chairman of the Board of County Commissioners or his designee.

7. The Licensee shall exercise diligence in protecting from damage the land and property of Tillamook County covered by and used in connection with this license, and shall pay Tillamook County for any damage resulting from negligence or from the violation of the terms of this license, or of any law or regulation applicable to County lands by the Licensee, or by any agents or employe's of the Licensee acting within the scope of their agency or employment.

8. The Licensee shall fully repair all damage, other than ordinary wear and tear, to roads and trails caused by the Licensee in the exercise of the privilege granted by this license.

9. Upon abandonment, termination, revocation, or cancellation of this license, the Licensee shall remove within a reasonable time all stuctures or improvements, and shall restore the site, unless otherwise agreed upon in writing or in this license. If the Licensee fails to remove all such structures or improvements within a reasonable period, they shall become the property of Tillamook County, but that will not relieve the Licensee of liability for the cost of their removal and restoration of the site.

10. This license is not transferable. If the Licensee through voluntary sale or transfer, or through enforcement of contract, foreclosure, tax sale, or other valid legal proceeding shall cease to be the owner of the physical improvements other than those owned by Tillamook County situated on the land described in this license and is unable to furnish adequate proof of ability to redeem or otherwise reestablish title to said improvements, this license shall be subject to cancellation. But if the person to whom title to said improvements shall have been transferred in either manner provided is qualified as a Licensee and is willing that his future occupancy of the premises shall be subject to such new conditions and stipulations as existing or prospective circumstances may warrant, his continued occupancy or the premises may be authorized by license to him if, in the opinion of the issuing officer or his successor, issuance of a license is desirable and in the public interest.

11. In case of change of address, the Licensee shall immediately notify the Board of County Commissioners of Tillamook County, Oregon.

12. This license may be terminated upon breach of any of the conditions herein or at the discretion of the Board of County Commissioners, Tillamook County, Oregon.

13. In the event of any conflict between any of the preceding printed clauses or any provisions thereof and any of the following clauses or any provisions thereof, the following clauses will control.

14. The Licensee shall protect the scenic aesthetic values of the area under this license, and the adjacent land, as far as possible with the authorized use, during construction, operation and maintenance of the improvements.

15. This license is issued with the understanding and on the condition that, unless sooner terminated or revoked for cause, it will expire on October 15, 1983 and all structures and improvements, except those owned by Tillamook County, shall be moved in accordance with Clause 9 of this license. For the purpose of this license, two months after termination of the license will be considered a reasonable period in which to remove the structure and improvements. This termination date shall not be extended.

No additional improvements shall be constructed without prior written approval of the Board of County Commissioners of Tillamook County, Oregon.

This is strictly a license for the period hereinbefore designated only.

16. Licensee shall not cause, permit, or allow alcoholic beverages or illegal drugs to be sold, used or kept on the premises.

17. During the term of this license, the Licensee agrees:

a. In connection with the performance of work under this license, including maintenance and operation of the facility, the Licensee shall not discriminate against any employee or applicant for employment because of race, color, religion, sex or national origin.

b. The Licensee and his employe's shall not discriminate by segregation or otherwise against any person on the basis of race, color, religion, sex or national origin by curtailing or refusing to furnish accomodation, facilities, services, or use privileges offered to the public generally.

c. The Licensee shall include and require compliance with the above non-discrimination provisions in any subcontract made with respect to the operations under this license.

d. Signs setting forth this policy of non-discrimination will be conspicuously displayed at the public entrance to the premises.

18. The Licensee shall have in force public liability insurance covering: (1) property damage in the amount of Five thousand dollars ($5,000.), and (2) damage to persons in the minimum amount of One hundred thousand dollars ($100,000.) in the event of death or injury to more than one individual. The coverage shall extend to property damage, bodily injury, or death arising out of the Licensee's activities under the license including, but not limited to, the occupancy or use of the land and the construction, maintenance, and operation of the structures, facilities, or equipment authorized by this license. Such insurance shall also name the County of Tillamook as a co-insured and provide for specific coverage of the Licensee's contractually assumed obligation to indemnify the County of Tillamook. The Licensee shall require the insurance company to send an authenticated copy of its insurance policy to Tillamook County immediately upon issuance of the policy. The policy shall also contain a specific provision or rider to the effect that the policy will not be cancelled or its provisions changed or deleted before thirty (30) days written notice to the County Clerk of Tillamook County, Oregon.

19. The operation and maintenance of all sanitation, food service, and water-supply methods, systems and facilities shall comply with the standards of the local department of health and the United States Public Health Service.

The Licensee shall dispose of all garbage and refuse in a place outside of the Sand Beach area.

20. The Licensee agrees to take all reasonable precaution to avoid damage to property and resources of Tillamook County, and diligently to undertake suppression action in the event of fire resulting from the exercise of the privileges herein granted.

21. No fireworks or explosives of any kind or nature shall be stored or used on the land covered by this license, or in the stuctures thereon.

22. The Licensee shall restrict all parking to areas approved by the Tillamook County Board of Commissioners, and comply with the traffic control requirements on National Forest land as outlined in the Forest Service Special Use Permit.

23. No signs or advertising devices, except as required by paragraph 17, item D, shall be erected on the area covered by this license, or highways leading thereto, without prior approval by the Tillamook County Board of Commissioners as to location, design, size, color and message. Erected signs shall be maintained or renewed as

as necessary to neat and presentable standards.

24. The Licensee or designated representative shall be present on the premises at all times when the facilities are open to the public. The Licensee will notify Tillamook County Board of Commissioners in writing who the representative will be.

25. To provide for public safety, resource protection, orderliness, neatness, and sanitation acceptable to Tillamook County, the following plan is hereby made a part of the License:

PUBLIC SAFETY AND ORDERLINESS

a. RACE COURSES: Staging area (pits) will be staked and delineated by rope or other like substance and flagged to warn spectators and to keep them out. Size of area to be staked shall be based upon 200 square feet for each vehicle registered for competition.

b. DRAG STRIP: The entire racing area including starting line, finish line, and deceleration area will be roped off so as to restrict access by those vehicles not racing. A return route to the pits will be marked by flags or some like means.

c. MUFFLERS: Vehicles must have adequate mufflers installed unless they are operating in the pit area, of the race course.

d. PUBLIC INFORMATION: By use of the public address system or other suitable means, the Licensee shall, at least every two hours, inform the public and participants of the following:

1. Vehicle travel is restricted to open sand areas.

2. Fire danger is high in beach grass. Be careful with fire.

3. Mufflers are required for all non-contest vehicles.

4. Deposit litter in bags and cans.

e. COURSE POLICING: The Licensee will take steps to assure that straying vehicles or people are not on the race course while a competitor is racing. This will include barring non-racing traffic from the course for periods of time, up to 1/2 hour.

f. All events will be held in open sand areas. No clearing of vegetation is permitted except in areas designated and approved by the Board of County Commissioners.

g. The construction of permanent structures will not be permitted.

h. SANITATION:

1. At least four (4) chemical toilets shall be available for public use adjacent to the spectators or other locations deemed more feasible by the Chairman of the Board of Commissioners of Tillamook County, Oregon.

2. Large plastic bags shall be well distributed in the spectator and pit areas for the purpose of collecting litter, and other garbage and rubbish. The Licensee shall also pick up all remaining litter, garbage, and refuse following the close of each day's events within the permit area.

i. PARKING FOR DAY USE: Licensee shall furnish security for the parking lot and control entry to race vehicles or participants. Control can be accomplished by use of barricades or like devices. Signs informing the general public that the area is under license to the NORTHWEST TRAIL AND DUNE ASSOCIATION will be displayed on the barricades.

j. TRAFFIC CONTROL: Traffic control will be the responsibility of the Licensee who will supply a man at the road junction of the campground and beach road on Sundays, one (1) hour before the race until 4:00 p.m. If additional time is needed, it will be on a request basis by the Chairman of the Board of County Commissioners of Tillamook County.

26. Tillamook County designates the Chairman of the Board of County Commissioners of Tillamook County as supervisor and contact person pertaining to all matters under this License, whose address is P.O. Box 152, Tillamook, Oregon 97141.

DATED this 31st day of March, 1978.

LICENSEE:

Myke L. Holmes
Myke L. Holmes
President
Northwest Trail and Dunes Association

BOARD OF COUNTY COMMISSIONERS
FOR TILLAMOOK COUNTY, OREGON

Chas D Bailey
Chairman, Chas. D. Bailey

F E Knight
F.E. Knight

Granville Simmons
Granville Simmons

EXHIBIT I

Grievances associated with off-road vehicle use in the Sand Lake area, Tillamook County, Oregon.

May 31, 1976

This memorandum is being submitted so that there will be a documentation on file in your records of the property owners' complaints..

The Forest Setvice has created a monster on the sand dunes at Sand Lake that is a menace to the property and possibly the lives of those who live in this area.

The following list of complaints indicates the seriousness of the problem.

Tearing up of pasture land.
Pulling up fence posts.
Cutting trees and stealing wood.
Dumping sanitary bags and garbage on property.
Using private property for bathrooms.
Urinating in front of homes..
Tearing down "No Trespassing" signs.
Building fires in private woods, thus putting forests and homes in jeopard
Camping on private property.
Threatening personal injury and property damage when asked to get off of property.
All-night running without mufflers.
Exceeding the speed limit on county roads.
Creating sanitary hazards to private water systems.
Tearing up the sand stabilizing cover.
Endangering a child's life.
Threatening future damage to person and property.
No Forest Service or police patrol on the Derrick Road during the 3-day holiday.

What the property owners want to know is this: Does the Forest Service plan to take action to protect the property and lives of the residents of this area?

Signed by eleven local residents on the front of this page and eight on the back of it.

This list of grievances was submitted to the author December 15, 1978, with a cover letter dated December 9, 1978, reiterating their concerns. The letter was signed by eleven area residents and is on file at the OCZMA office in Newport, Oregon.

This intern report was read and accepted by a staff member at:

Agency: Oregon Coastal Zone Management Association, Inc.

Address: 132 West Olive
Newport, Oregon 97365

This report was completed by a WICHE intern. This intern's project was part of the Resources Development Internship Program administered by the Western Interstate Commission for Higher Education (WICHE).

The purpose of the internship program is to bring organizations involved in community and economic development, environmental problems and their students in the West for the benefit of all.

For these organizations, the intern program provides the problem-solving talents of student manpower while making the resources of universities and colleges more available. For institutions of higher education, the program provides relevant field education for their students while building their capacity for problem-solving.

WICHE is an organization in the West uniquely suited for sponsoring such a program. It is an interstate agency formed by the thirteen western states for the specific purpose of relating the resources of higher education to the needs of western citizens. WICHE has been concerned with a broad range of community needs in the West for some time, insofar as they bear directly on the well-being of western peoples and the future of higher education in the West. WICHE feels that the internship program is one method for meeting its obligations within the thirteen western states. In its efforts to achieve these objectives, WICHE appreciates having received the generous support and assistance of the National Endowment for the Humanities, the Economic Development Administration and by more than one hundred and fifty community agencies throughout the West.

For further information, write Resources Development Internship Program, WICHE, P. O. Drawer 'P', Boulder, Colorado 80302 or call (303) 443-6144.

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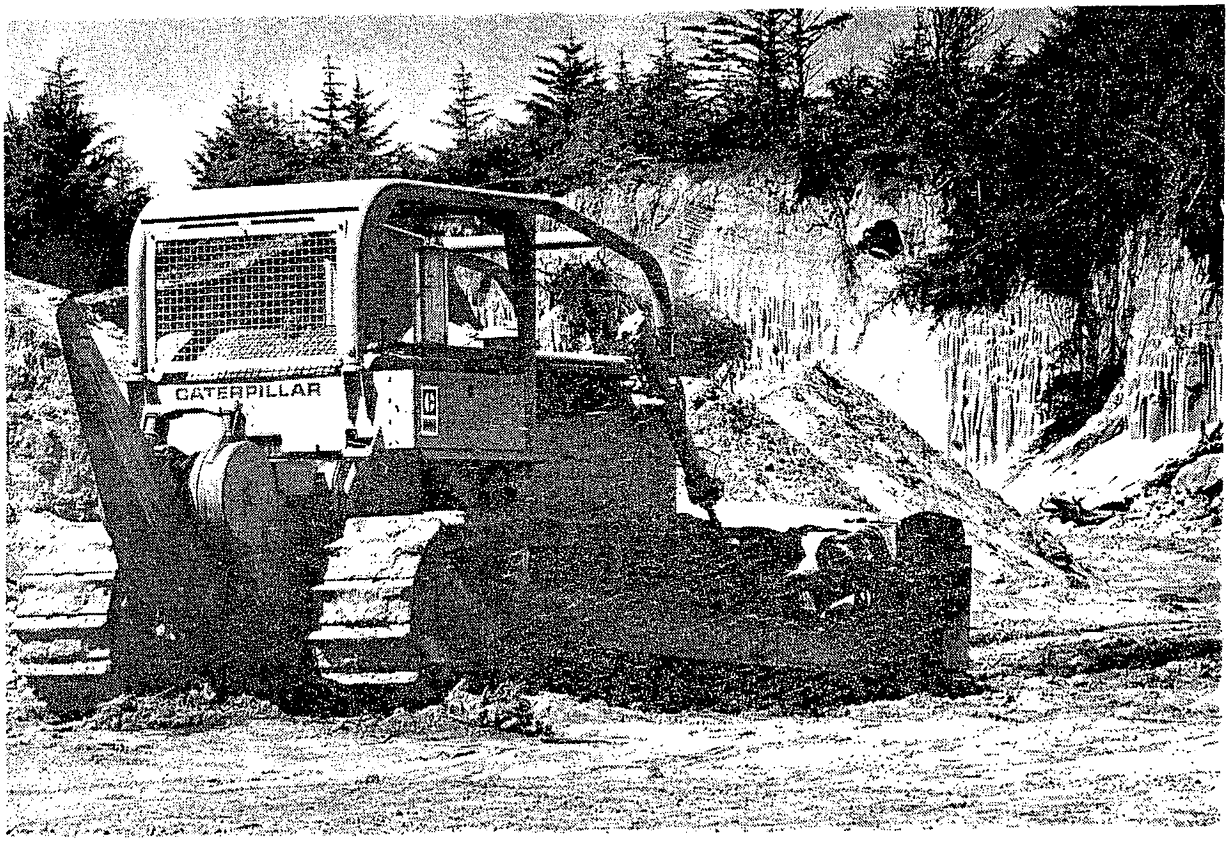
Sand Removal
Planning & Management Considerations
For The Oregon Coast



Oregon Coastal Zone Management Association, Inc.

This report was prepared as part of a larger document addressing various beach and dune planning and management considerations and techniques. Other segments of the document and additional materials are:

I. BACKGROUND ON BEACH AND DUNE PLANNING:

Background of the Study

An Introduction to Beach and Dune Physical and Biological Processes

Beach and Dune Planning and Management on the Oregon Coast: A Summary of the State-of-the-Arts

II. BEACH AND DUNE IDENTIFICATION:

A System of Classifying and Identifying Oregon's Coastal Beaches and Dunes

III. PHYSICAL AND BIOLOGICAL CONSIDERATIONS:

Physical Processes and Geologic Hazards on the Oregon Coast

Critical Species and Habitats of Oregon's Coastal Beaches and Dunes

IV. MANAGEMENT CONSIDERATIONS:

Dune Groundwater Planning and Management Considerations for the Oregon Coast

Off-road Vehicle Planning and Management on the Oregon Coast

Sand Removal Planning and Management Considerations for the Oregon Coast

Oregon's Coastal Beaches and Dunes: Uses, Impacts and Management Considerations

Dune Stabilization and Restoration: Methods and Criteria

V. IMPLEMENTATION TECHNIQUES:

Beach and Dune Implementation Techniques: Findings-of-Fact

Beach and Dune Implementation Techniques: Site Investigation Reports

*Beach and Dune Implementation Techniques: Model Ordinances**

VI. ANNOTATED BIBLIOGRAPHY:

Beach and Dune Planning and Management: An Annotated Bibliography

VII. EDUCATIONAL MATERIALS:

Slide show: *Managing Oregon's Beaches and Dunes*

Brochure: *Planning and Managing Oregon's Coastal Beaches and Dunes*

*Prepared under separate contract between Oregon Department of Land Conservation and Development and the Bureau of Governmental Research, Eugene,

Cover photo by Jay Rasmussen, Toledo, Oregon; cover design by Arlys Bernard, Newport, Oregon.

SAND REMOVAL
PLANNING AND MANAGEMENT CONSIDERATIONS
FOR THE OREGON COAST

by
Carl A. Lindberg
Project Director
Beaches and Dunes Study Team

Kathy Bridges Fitzpatrick
Editor and Project Administrator

Oregon Coastal Zone Management Association, Inc.
313 S.W. 2nd Street, Suite C   P.O. Box 1033
Newport, Oregon - 97365

June, 1979

Funding for this study was provided by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, under Section 306 of the Coastal Zone Management Act through the Oregon Department of Land Conservation and Development.

PREFACE

The following report presents the results of an in-depth analysis of beach and dune sand removal on the Oregon Coast conducted by the Oregon Coastal Zone Management Association, Inc. This report constitutes one element of an overall analysis of planning for and managing beaches and dunes as required by Oregon's Beaches and Dunes Goal.

This report was prepared by Carl Lindberg, OCZMA Beaches and Dunes Project Director, with assistance from other Study Team members composed of Christianna Crook, Research Associate, Wilbur Ternyik, Project Coordinator, Arlys Bernard, Project Secretary, and Kathy Fitzpatrick, Project Administrator.

In addition, valuable review and comments were made by the Beaches and Dunes Steering Committee composed of:

R. A. Corthell, U.S. Soil Conservation Service
Steve Stevens, U.S. Army Corps of Engineers
Sam Allison, Oregon Department of Water Resources
Peter Bond and John Phillips, Oregon Department of Transportation, Parks and Recreation Division
Bob Cortright, Oregon Department of Land Conservation and Development
Jim Lauman, Oregon Department of Fish and Wildlife
Jim Stembridge, Oregon Department of Soil and Water Conservation
Steve Felkins, Port of Coos Bay
Rainmar Bartl, Clatsop-Tillamook Intergovernmental Council
Gary Darnielle, Lane Council of Governments
Cathy Mecone, Coos-Curry Council of Governments
Marilyn Adkins, City of Florence Planning Department
Phil Bredesen, Lane County Planning Department
Steve Goeckritz, Tillamook County Planning Department
Oscar Granger, Lincoln County Planning Department
Curt Schneider, Clatsop County Planning Department

Additionally, OCZMA extends special appreciation to Peter Bond, Parks Planner, Parks and Recreation Branch of the Oregon Department of Transportation, and Stan Ausmus, Administrator, Mineland Reclamation Division, for their valuable review of and significant contributions to this report.

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I. INTRODUCTION

Sand removal as used in this report is a term identifying a wide range of man-made actions including the mining of sand for the extraction of ores and for use in the production of glass, concrete and ceramics, for sand blasting or for fill material. Additionally, sand is oftentimes removed from one location during excavation of a building site, to improve a view, or to protect a natural or man-made environment from inundation by migrating sand dunes.

There exists little in the way of published data on the topic of sand removal from beach and dunes areas, especially within the context of Oregon's Beaches and Dunes Goal. One researcher who has produced several reports over the years on the environmental geology of the Oregon coast has noted that only recent concerns have brought the topic into the fore (Beaulieu, 1979). Only one article was identified that comprehensively addressed sand removal from a beach or dune situation (Magoon, et al., 1972). This article addressed the commercial mining of sand in Northern California and identified two major uses for such sand--aggregate for concrete and fill, and speciality purposes (glassmaking - 65%, sandblasting - 13%, and grinding and polishing - 6%). In their conclusion the authors note two problems associated with the activity of sand removal--a depletion of the sand resource and a conflict with the recreational use of coastal sand areas.

One authority on shoreline processes, while noting that mining activities in shore areas is an important industry in some specific areas, does state a similar observation to that of Komar, (1978); Rea, (1977), and Magoon, et al., (1972), in that:

> "Mining of beach and dune sands has further depleted this source, while the entrapment of coastal materials by harbors, groins, and jetties has placed sand in short supply on beaches where it provides an essential element of protection of the coast from the erosive action of waves. Further, sand is a valuable recreational asset that is now in very short supply." (Inman, 1978, p. 2269).

Although little written information on sand removal is available, the issue was brought into focus when it was first mentioned as a concern in beach and dune areas in the January 1975 Progress Report published by the Oregon Coastal Conservation and Development Commission (OCCDC, 1975, p. 53). This same concern was carried over into the first draft of the Coastal Goals proposed by the Oregon Department of Land Conservation and Development which stated that:

> "d. Removal of sand from sand areas should be permitted only when it is necessary to protect private or public property from sand damage or when such removal will not adversely affect the environment or the stability of adjacent areas as determined by a site investigation." (DLCD, 1975, p. 5).

In its final form, the adopted Beaches and Dunes Goal (#18) does not specifically require such a comprehensive examination of sand removal proposals and their impacts, but rather focuses on protection of life and property, which would necessitate a review of sand removal impacts.

II. SAND REMOVAL ON THE OREGON COAST

A. Historical Sand Removal Activities

Along the Oregon coast, sand has typically been removed for four major reasons: industrial purposes, construction activities, site alteration, and protection of structures, property and/or habitats.

1. Industrial processes

The sand or mineral(s) within the sand have been used in some industrial process. Such processes include the extraction of chromite, zircon, platinum, gold, etc. (von Bernewitz, 1930; Dasher, et. al., 1942; Beaulieu and Hughes, 1975), and the use of sand for ceramics, container glass, foundry molding, and sand blasting (Sterrett, 1958; Carter, et. al., 1962 and 1964; Beaulieu and Hughes, 1975; Gray, 1978).

Most of the mineral bearing sands are found in Coos and Curry Counties on Oregon's South Coast. Figure 1 illustrates the general locations of these and other minerals found on the Oregon coast. In these southern counties, beginning with "black sand" mining at Whiskey Run Creek in 1852, a series of surface mining operations was carried out until the end of World War II. These sands were mined generally for their chrome and gold content. Depending on future prices and availabilities, some of these sites may again become viable for production within the future.

2. Construction activities

The sand has been used in construction activities such as fill and concrete (Ketchum, 1972; Beaulieu and Hughes, 1975; Gray, 1978). The removal of sand for construction purposes has occurred at scattered locations up and down the coast as has the ad hoc removal of a bucket or pickup load of sand. The most publicized removal for this purpose was at School House Creek in the Gleneden Beach area of Lincoln County. This operation did not have its beach sand removal permit renewed when it was found to possibly be related to the coastal erosion immediately to the north at Salishan Spit (Gray, 1978; Komar, 1978). This sand removal project was estimated to have removed between 43% to 75% (112,000 to 196,000 cubic meters) of the new sand being supplied to this area of the beach, (Rea, 1974, p. 74).

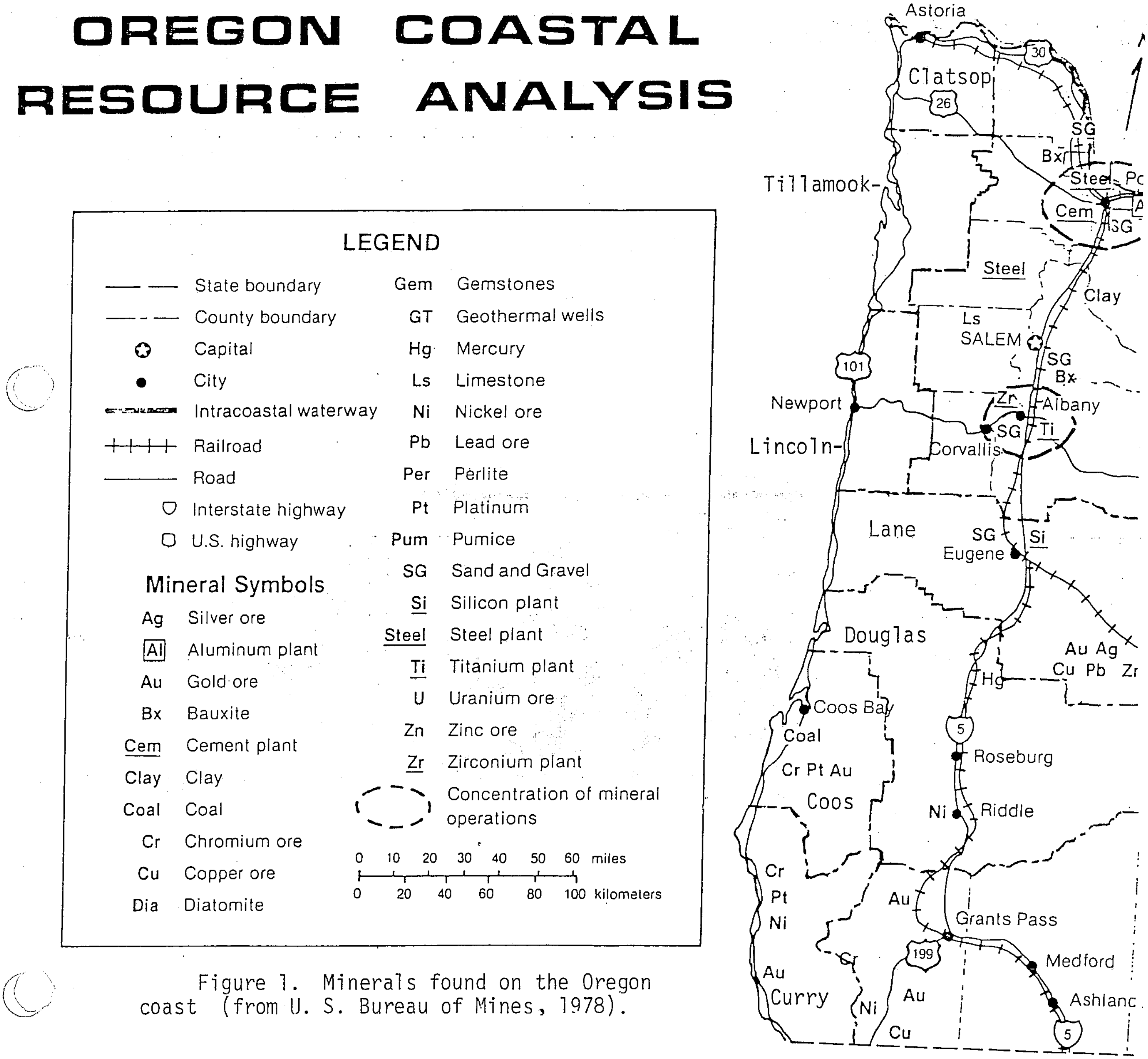

Figure 1. Minerals found on the Oregon coast (from U. S. Bureau of Mines, 1978).

3. Site alteration

Sand has been removed to alter a site prior to construction or to improve a view that is continually blocked by blowing and accumulating sand (Gray, 1978; Ternyik, 1978). This activity of site alteration goes on continually with each new structure erected and later, in some cases, to maintain a view. Removal related to construction should be reviewed in the future to ensure that it meets the goal requirements. Removal related to view protection should be analyzed to determine if such removal is necessary, the degree of hazard involved, and if it can be better treated by a stabilization program.

4. Protection of structures, property and/or habitats

Sand has been removed to protect man-made and natural environments from in-migrating sand (U.S. Soil Conservation Service, 1975; Brown, 1978; Ternyik, 1978). Protecting man-made and natural environments from in-migrating sand has been going on for some time. A massive program, coupled with plantings for stabilization, was carried out in the Clatsop Plains area in the 1930's (see Figure 2). Since then, there have been many cases of sand removal to protect highways and roads (Highway 101

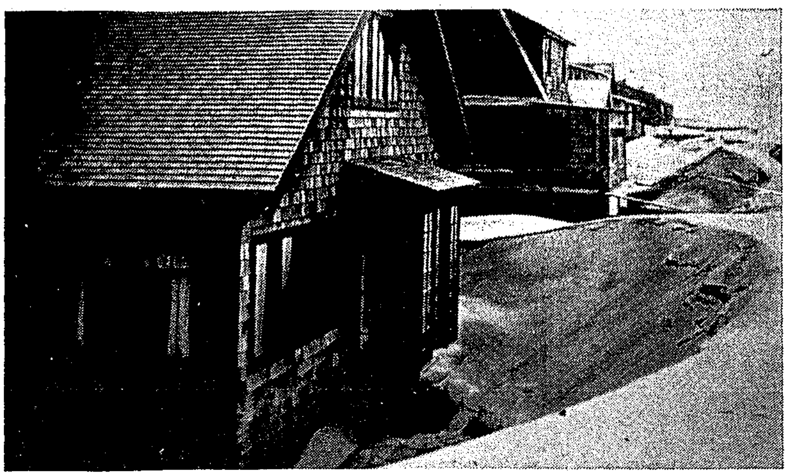

Figure 2. Blowing sand caused problems for Gearhart property owners in 1935 when sand piled up to the second floor of many residences. Removing sand, sometimes several times a year, proved expensive (from Warrenton Dune Soil and Water Conservation District, 1966).

at Humbug Canyon, seven miles south of Port Orford, along Highway 101 between Glenada and Dunes City, about one mile north of Woods, along Highway 101 near Rockaway and Arch Cape, and within Cannon Beach and Seaside), to protect parking lots (Del Ray Beach State Wayside north of Gearhart), to protect buildings (at a dune tour concession in the Oregon Dunes National Recreation Area), and to protect railroad lines (about one mile south of Menasha on the north slough of Coos Bay), (Brown, 1978; Ternyik, 1978), (see Figures 3-5). It is suggested that provisions for such necessary protective actions be included in local plans and ordinances.

Figure 3. Sand being removed just west of Highway 101 between Glenada and Dunes City. Throughout this stretch of Highway 101, migrating dunes are within several hundred feet of the pavement.

Herb Schlicker, an engineering geologist with the State of Oregon's Department of Geology and Mineral Industries notes: "Removal of sand provides only a temporary solution and may have to be repeated frequently at considerable expense" (Schlicker, 1972, p. 68). In areas which are known to experience sand accumulation problems, it might be wiser to either establish a stabilization program or to limit the location of permanent structures and roads.

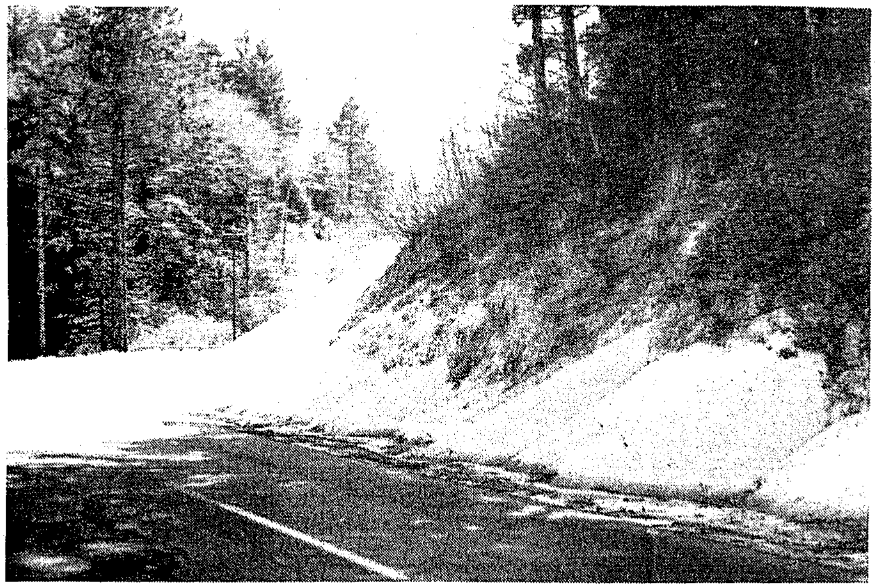

Figure 4. This migrating sand dune is constantly spilling onto the highway just north of Woods in Tillamook County.

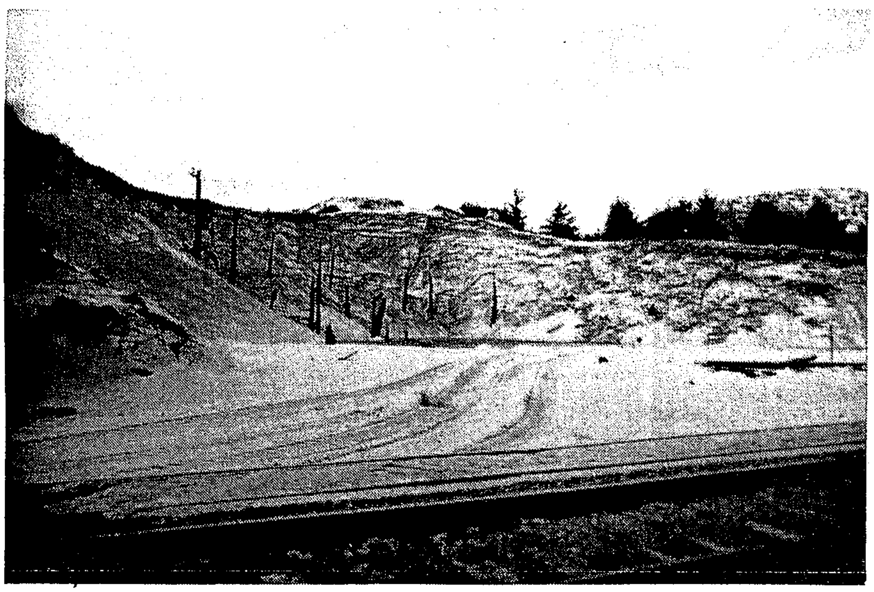

Figure 5. Sand removal activity along the Southern Pacific Railroad Line on the north slough of Coos Bay. Notice the layers of sand and the exposed trees that were buried by this in-migrating dune.

B. Historical Controls on Sand Removal

1. Local controls

Historically, there has been an interest in having some control or standards for sand removal activities on the Oregon coast. For example, in 1910 the coastal City of Newport adopted an ordinance prohibiting the removal of sand and gravel from its ocean beaches. Later in 1928, Newport repealed this ordinance in spite of the following State Attorney General's opinion:

> "The City of Newport may by ordinance regulate or forbid the taking of sand and gravel from the ocean beach on the grounds that such taking interferes with the safety, order and general welfare of the inhabitants of the City", (13 OR. Op. A.G. 515 [1928]).

The interest in such standards arose again in 1938 when the City Attorney of Newport was asked for an opinion on the City's ability to adopt a sand removal ordinance. The City Attorney's advice was affirmative, and later that year the editor of The Mineralogist, a national magazine, sent a letter to the City Council with stated concerns about sand and gravel operations on Newport's beaches, (Marsters, 1938; Dake, 1938).

More recently, the City of Florence adopted Ordinance #464 in January of 1968. Section VIII, "Securing Loose, Open or Raw Sand" of that ordinance states:

> "No person, firm, or corporation shall make any excavation or remove any natural or planted ground cover, trees and shrubs or grass, or any existing building or structure when any such action will expose loose, open, or raw sand which would be susceptible to movement or displacement onto any public way or public or private land, by the action of wind or running water unless provisions are made to prevent such movement or displacement."

The above ordinance seeks to maintain stability at the site of any activity within a sand area. Similarly, in August of 1978, the City of Seaside authorized their Public Works Department to remove sand that had been accreting on the beach and blowing inland onto yards and public rights-of-way, (The Daily Astorian, 1978).

2. State controls

Generally speaking, sand removal from beaches and dunes is not permitted in most states (The Conservation Foundation, 1975, p. 107; U. S. Army Corps of Engineers, 1975, pp. 1-21). However, on the West Coast, the State of Washington has recognized the importance of commercial sand and gravel mining "as a necessary industry" and calls for careful management (Washington Department of Ecology, 1971, pp. 31-32). Under the general guidelines of the Washington Shoreline Management Act, the state's two southern coastal counties, where a large amount of accretion is taking place, allow the removal of beach sand (to eighteen inches depth in Pacific County and to twelve inches depth in Grays Harbor County), however, much of this removal is related to the local cranberry bog operations (Ruef, 1979).

Within Oregon, three agencies are involved in sand removal activities and issue permits allowing such actions. The Oregon Department of Geology and Mineral Industries under the surface mining regulations of Chapter 517 is given the duty to issue permits for certain surface mining activities and set standards for reclamation. Such activities can take place in sand areas, but require a permit if:

(1) they remove more than 2500 cubic yards of minerals per year, and/or
(2) they affect at least one acre of land within a period of twelve consecutive months; and
(3) the material is not used on-site for construction purposes.

When an applicant applies for the surface mining permit, he must also include a "Reclamation and Development Plan" pursuant to ORS 517. 750-517.990. This plan is to include site plans, cross sections, aerial photos, and any other drawing necessary to illustrate the present and proposed final configuration of the site. The Department also requires a performance bond not to exceed $500.00 per acre, and a permit fee of $265.00. Copies of Chapter 517.750-.990, Reclamation Plan Guidelines, and the Application for Operating Permits or Grant Exemption under ORS 517 are included in Appendix A. Table 1 lists sites of known sand removal and current permits issued by the Oregon Department of Geology and Mineral Industries.

Another state agency having permit authority over sand removal on the coast is the Parks and Recreation Branch of the Oregon Department of Transportation. Chapter 390 of the Oregon Revised Statutes requires permits for removal of products along the ocean shore (west of the state's surveyed "zone line"). Except for exemptions for fish, wildlife, agates or souvenirs, no other natural mineral or animal product can be taken from the state controlled beach area without the expressed permission of the Department of Transportation. Furthermore, state law (ORS 390.725) requires that such permission be granted only after consultation with the State Fish and Wildlife Commission, the State Department of Geology and Mineral Industries, and the Division of State Lands. Approval of the permit must contain any necessary provisions to protect the areas from any use, activity or practice adverse to the conservation of natural resources or public recreation. Copies of the most applicable provisions of the state statute and of the Permit Application for Removal of Sand, Rock, Minerals, Marine Growths, or Other Natural Products of the Ocean Shore are included in Appendix B. Table 2 lists those permits issued by the Oregon Parks and Recreation Brach pursuant to ORS 390.

Table 1. Sites registered or under permits issued by the Oregon Department of Geology and Mineral Industries pursuant to ORS 517.750-.990*

Location	Amount	Permittee	Purpose
Clatsop			
Sec 8 T8NR10W	up to 2500/yr	Individual (TE-04-0040)	Construction material**
NW 1/4 Sec 19 T8NR6W	unlimited	Oregon Portland Cement (LE-04-0012)	Sandstone quarry
Sec 3 T7NR10W	unlimited	Individual (SMP-04-0024)	Construction material
Tillamook			
SW 1/4 18 T4SR10W NW 1/4 19	unlimited	Federal Hwy. Adm. (SMP-29-0060)	Construction material
Sec 6 T3NR10W	unlimited	Individual (LE-29-0036)	Sandstone and Rock quarry
Sec 18 T4SR10W	unlimited	Individual (SMP29-0066)	Construction material
Lincoln			
SE 1/4 sec 22 T7SR11W	unlimited	Oceanlake Sand and Gravel Co. (LE-21-0011)	Construction material
Sec 27 T7SR11W	IN VIOLATION	Ford, Frank & Lewis (21-0036)	Construction material
Lane			
Sec 15 T18SR12W	unlimited	Individual (LE-20-0068)	Construction material

Table 1. continued

Location	Amount	Permittee	Purpose
Coos			
Sec 34 T24SR13W	unlimited	CooSand Corp. (SMP-06-0007)	Construction material

*from Ausmus, 1979.
**construction material--includes fill material, concrete, etc.

TE-total exemption--activity does not fall within the permitting purview of DOGAMI (e.g. less than 2,500 cu yd/yr, etc.)

LE-limited exemption--activity initiated prior to reclamation requirement reclamation plan not required.

SMP-surface mining permit--activity falls within DOGAMI's permitting authority; reclamation plan required.

Table 2. Sand removal permits issued by the Oregon Parks and Recreation branch of the Oregon Department of Transportation pursuant to ORS 390.725*

Date	Location	Amount	Permittee	Purpose
1970	Brookings, Curry County	Not stipulated	Individual	Removal for construction and fill purposes
1970	Brookings, Curry County	10,000 cu. yd.	Port of Brookings	Removal of sand to clear channel
1973	Beaver Creek at Ona Beach State Park, Lincoln County	4,800 cu. yd.	Lincoln County	Rechannelization of mouth of Beaver Creek

*from Bond, 1979.

Under ORS 541.605-665, the Oregon Division of State Lands maintains permit authority for fill and removal activities within waters of the state. Pursuant to this statute, the Division coordinates with the Parks and Recreation Branch on removal activities within beach areas. Additionally, the Division of State Lands is charged with administering the transfer of dredge spoils with proceeds from such sales going to the common school fund. Inquiries regarding use of dredge spoils and negotiation of fees, should be directed to the Division (Johnson, 1979).

Local governments should arrange to review and comment on all applications filed under these state programs within, or adjacent to, their jurisdictional boundaries. However, it should be noted that many sand removal activities that should be addressed under the provisions of Goal #18 do not fall under the jurisdictional provisions of these two state agencies. Therefore, local governments should require a site investigation report for most sand removal activities. Those minor activities exempted from the site investigation report requirement could be specifically listed with a blanket finding to support their exemption.

3. Federal controls

The major federally controlled beach and dune area is the forty-one mile long Oregon Dunes National Recreation Area on Oregon's central coast. This sand area of large migrating sand dunes was made a national recreation area by an act of Congress on March 23, 1972. The Siuslaw National Forest of the U.S. Forest Service maintains the administration of this unique area.

According to the Final Environmental Impact Statement concerning the Oregon Dunes National Recreation Area Management Plan (January, 1977), the sand removal policy is:

"J. Minerals

> The sand within the Oregon Dunes National Recreation Area is of high enough quality for making some varieties of glass. In recent years, an individual filed thirty-five mining claims covering 4,640 acres of this sand. Of these claims, twenty-five involving 3,160 acres were subsequently declared invalid, since the claimant had not established a market for this sand. Although the claimant had not established a market for the sand on the remaining ten claims prior to the effective date of the NRA Act, the validity proceedings are in progress, but have not been completed at this time. Since then, all lands within the NRA have been withdrawn from entry under both the mining and mineral leasing laws, subject to valid existing rights." (U. S. Forest Service, 1977, pp. 22-23)

The Environmental Impact Statement suggests that although private lands within the NRA have not been withdrawn from mineral entry, this potential activity is not considered a threat. Section 7 of PL 92-260 provides for industrial or commercial purposes that are proposed for private lands after December 31, 1970, to be certified as being compatible with or furthering the purposes of the Act, if the property owner is to retain his protection from condemnation. However, sand mining is incompatible with the purposes of the Act since it would negatively impact one of the elements that makes the Oregon Dunes NRA unique--the sand dunes.

The Impact Statement notes further that while "the NRA Act provides for no consequences should the state or counties decide to allow sand removal for glass manufacturing purposes, a cooperative relationship is expected to prevent this from happening." (U. S. Forest Service, 1977, p. 55).

Within the Oregon Dunes National Recreation Area there exists only one sand removal project. It is a mining operation, removing the sand for glass, foundry molding and traction sand[1]. The NRA management position is to use stabilization instead of removal in situations where potential inundation poses hazardous conditions. However, when sand migrates off NRA lands, it is no longer within the jurisdictional realm of the U. S. Forest Service. Thus, future removal or stabilization would be up to adjacent property owners, such as the Oregon Department of Transportation, when removing sand from Highway 101 just north of Siltcoos (Czmerys, 1979).

4. Intergovernmental coordination

The maintenance of open sand by various jurisdictional parties and the public can lead to a variety of planning and management conflicts. It is vital that adjacent property owners participate in the planning and management of dune forms to ensure the compatibility of management approaches and techniques. Local, state and federal jurisdictions would do well indeed to work cooperatively and jointly in coordinating their planning and management of beach and dune areas. A cooperative regional planning approach specific to shoreland areas has been developed by the National Parks Service and is included in Appendix C as an aid to coastal jurisdictions involved in a coordinated approach to beach and dune planning and management. Indeed, the federal consistency provisions of the Coastal Zone Management Act, coupled with Oregon's state coordination program, ensure that local jurisdictions have ample opportunity to coordinate their planning needs and efforts with state and federal agencies.

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[1]Traction sand - sand placed in front of the driving wheels of railroad locomotives for improved traction.

III. SAND REMOVAL ACTIVITIES AND POTENTIAL IMPACTS

There are six major concerns related to the activity of sand removal in beach and dune areas. These areas of concern are the impact(s) of a proposed sand removal activity on sand flow patterns, sand-formed lakes, groundwater supplies, aesthetics, wildlife habitats and adjacent property and associated structures.

A. Sand Flow Patterns

The removal of sand from the beach and dune area may lead to erosion of neighboring landforms either down the littoral drift system of the beach or in areas leeward of the removal activity. The energy levels and directions of wind, tide and currents are constantly impacting on the beach. A reservoir of sand, especially the beach and foredune, is needed to ensure that a supply of sand is available to maintain a buffer between land and sea (U. S. Army Corps of Engineers, 1975, pp. 5-21).

> "The key to the natural protective quality of the beachfront is the sand held in storage and yielded to the storm waves to dissipate the forces of their attack on the beachfront. Whenever the total volume of sand held in storage is reduced, the ability of the beachfront to absorb the energy of the storm waves is reduced. If the forces of a storm exceed the restorative capabilities of the beach, then extensive long-term erosion and alteration of the [beach] profile are likely results." (The Conservation Foundation, 1977, p. 103).

Decision-makers should review the sand budget of an area to determine if an historic surplus of sand exists before permitting sand removal. Removal should be conducted in such a manner as to minimize the interference with the free movement of sand or which would adversely affect the vegetative cover or modify the landscape topography in a manner which promotes erosion, unwanted sand migration, an over-steepened slope situation, alterations in driftwood accumulation patterns, or breaches in the foredune. Such considerations should be addressed within a site investigation report.

B. Sand-formed Lakes

Sand-formed, or dune-dammed lakes as they are sometimes called, are most commonly exposed areas of the water table in dune areas. As such, the main concern to their viability is the encroachment on them by in-migrating dunes. At Cleawox Lake, such migration is so rapid that in a period of several years the lake depth at a narrow section went from twenty feet to five feet (Ternyik, 1978). The importance of these lakes for wildlife habitat, recreation and aesthetics should mandate protection and restoration measures including sand removal and dune stabilization.

In as much as these lakes are commonly exposed areas of the water table, the considerations mentioned below for the groundwater should also be reviewed when planning and managing such coastal lakes.

C. Groundwater Supplies

Sand removal excavations may intersect the local groundwater table. If a removal project is large enough, it may lower the local water table. Chemicals such as fuel and lubricating oil from heavy equipment may be introduced into the groundwater if the groundwater table is exposed during the removal project.

D. Aesthetics

The major resource study relating to Oregon coastal aesthetics is Visual Resource Analysis of the Oregon Coastal Zone produced by a firm of landscape architects under contract with the Oregon Coastal Conservation and Development Commission in 1974. While this study categorizes typical coastal landscapes as they relate to the land-water interface, it does not provide decision-makers with specific standards in this highly subjective area. "Shoreline Site Planning and Design" by Roy Mann is an excellent source of information on this subject (Clark, 1977).

Relying somewhat on the two sources mentioned above the following factors for the evaluation of a proposed sand removal project from an aesthetic standpoint include:

(1) the character of the sand features to be altered. (Is it representative of a typical or common landscape, or is it an obviously unique and important feature?);

(2) the size of the landform. (Would it be possible to remove a portion of the feature without altering its aesthetic value(s)?);

(3) impact of the removal on the site and the surrounding area. (Would the proposed sand removal be a detrimental, neutral or positive action to the general aesthetic values of the site and surrounding area?); and,

(4) other land use goals and planning objectives. (Would the removal be consistent with local plans and other land use objectives such as those expressed in Goal #5, Open Space, Scenic and Historic Areas and Natural Resources?).

E. Wildlife Habitats

The beach and dune system provides a living environment for a large number of plants and animals, the sensitivity of which varies under various habitat conditions. The scale and intensity of sand removal envisioned under existing constraints, in comparison with the total sand area, does not appear to pose any significant threat to the general habitat picture. Site investigations should give special attention to identified critical habitat areas and species. In fact, through a program of sound management, such as vegetation, restoration and sand removal (to protect habitats), improvement in the quality of habitat may be realized. In the past, largely due to a lack of beach and dune management on the coast, several wildlife habitats, including lakes and wetlands, have been smothered by migrating dunes such as at Cleawox Lake. Local decision-makers should be aware of local wildlife needs when reviewing proposals for sand removal to ensure that local key areas are not adversely affected, or to direct removal to areas where habitats may be restored.

F. Adjacent Property and Associated Structures

Other than the obvious impacts of noise, dust, fumes and traffic on adjoining properties, the dangers of eliminating lateral support[1] and the inundation of such properties by reactivated sand migrating downwind from the site of the removal project are also present. Local decision-makers should thus ensure that all such problems are considered within the site investigation report.

After a sand removal project has been terminated there are two future alternatives. First is to attempt to return the site to a somewhat natural setting for rural land uses by the re-introduction of native vegetation. The second alternative is the development of the site for other urban land uses. Several helpful studies have been produced by the National Sand and Gravel Association which address reclamation:

(1) "Site Utilization and Rehabilitation Practices," by Shellie and Rogier;

(2) "Simultaneous Excavation and Rehabilitation of Sand and Gravel Sites," by Bauer; and

(3) "Practical Operating Procedures for Progressive Rehabilitation of Sand and Gravel Sites," by Johnson.

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[1]Lateral support-the general support offered a parcel of ground by that land immediately surrounding it; a very important feature considering the unconsolidated nature of the sand.

IV. PLANNING AND MANAGING SAND REMOVAL ACTIVITIES

The beach and dune system consists of dynamic and fragile landforms in various stages of stability. Because of this variability of stability and the inherent possibility of adverse impact on the beach and dune system by sand removal projects, most sand removal projects should be accompanied by a site investigation report to be evaluated and considered before a final decision is made. This report should clearly identify impacts and suggest techniques and modifications to the original proposal designed to eliminate the adversities as much as possible, or to mitigate the impacts if circumstances warrant.

Site investigation reports for proposed sand removal projects should demonstrate by reliable and probative evidence that:

(1) the beach and dune system is capable of supporting the proposed removal activity including impacts associated with transportation, noise, site devegetation and disturbance, alteration of groundwater levels, contamination of surface and groundwater, erosion, and destruction of wildlife habitat;

(2) the proposed sand removal activity is compatible with existing or proposed use of the site or contiguous areas and structures including impacts associated with lateral support, noise, dust, blowing sand, traffic and aesthetic qualities; and,

(3) the proposed sand removal activity is compatible with all applicable local, state and federal plans, regulations or ordinances, and standards including local comprehensive plans and implementing ordinances.

Additionally, it is suggested that volumes of sand may be redistributed from one area to an adjacent area during the alteration of a particular site with the approval of the local jurisdiction if all of the following conditions are met:

(1) all involved property owners (those involved with the proposal) are in written agreement;

(2) the sand mass on one property is so great that existing development is threatened or that construction of future development would be prohibitive without some reduction of the sand mass; and

(3) the action as proposed would not weaken the overall dune system and that consideration be given to the resulting topography and stabilizing factors.

Finally, restrictions should be developed for excavations in sand areas to prevent:

(1) moisture loss and root damage to plants in the surrounding area;

(2) exposing sand areas to prolonged erosion; and

(3) creating or causing slope instability. (That is, no slope should be left unattended that could fail and cause serious injury or death; all such areas should be posted.)

At the same time, however, local decision-makers should heed and consider the following observation by ensuring the opportunity for future sand removal activities as needs and demands dictate.

> "Although the land use planning and coastal zone management programs provide for mineral development, they have been criticized for not stressing adequately the importance of minerals in over-all planning for future population growth and as to national interests. The result is that current investigations of mineral deposits are discouraged by doubts about future development and mining restrictions." (U. S. Bureau of Mines, 1978, p. 14).

Given the importance of sand in the natural coastal zone processes, as well as its importance to the developing coastal economy, other sources and approaches to management must be explored by policy makers. The use of dredge spoils for fill material or beach nourishment is one area needing further consideration. Additionally, studies currently under way by the Portland District Corps of Engineers and by the Department of Civil Engineering at Oregon State University, Corvallis, may shed further light on the need and uses for coastal sand including dredge spoils.

V. IDENTIFICATION OF AREAS SUITABLE FOR SAND REMOVAL

It is difficult to comprehensively identify areas suitable for sand removal because the associated impacts are dependent upon the landform type, historic sand supply, recent erosion or accretion patterns, the surrounding natural and man-made environment(s) and the extent of the sand removal operation.

Three general types of circumstances may at times allow or necessitate the removal of sand; they are areas where:

(1) in-migrating sand is posing a threat to structures, habitat and/or property;

(2) significant accretion is known to occur (however, due to a possible zero net littoral drift and limited sources of new

sand supplied to Oregon's beaches, removal of sand even from areas of historic accretion is not generally recommended.) and;

(3) dredge spoils have been deposited or stored.

Jurisdictions should allow sand removal from ocean beach and sand dune areas only when the following factors are addressed by the developer:

(1) the removal is necessary to protect life or property;

(2) a site investigation report demonstrates that the removal will have minimal adverse impact on the environment and adjacent land uses, and

(3) attention is given to anticipated potential impacts and subsequent rehabilitation of the site.

While it is important for jurisdictions to recognize the necessity or importance of sand removal activities for mineral extraction, industrial processes, construction, and protection of property, local plans should not attempt to specifically identify sites having sand removal potential. Rather it is suggested that jurisdictions act upon sand removal applications following a review of all facts included in a site investigation report and rehabilitation program. Following such review, and given local input, sand removal proposals can be modified as necessary to satisfy the objectives of both the developer and local citizenry.

Presently, few coastal jurisdictions are in a position whereby they can affect sand removal proposals, with the exception of those projects requiring state agency permit(s). As a result of Oregon's land use program, state coordination, and the federal consistency provisions of the Coastal Zone Management Act, coastal jurisdictions are now afforded an opportunity to comment on sand removal proposals in their locale. It is strongly recommended, however, that those jurisdictions containing areas of beach and dune landforms adopt ordinances allowing them review authority of sand removal proposals falling outside the realm of state purview.

Because local governments are called upon to fill the void between state regulation of sand removal and areas not covered by state statutes, it is incumbent upon jurisdictions to adopt reasonable standards and policies to ensure that future sand removal activities are designed in a manner which meets local economic, social and environmental demands while complying with the intent of the Beaches and Dunes Goal.

REFERENCES CITED

Ausmus, Stan. Personal Communication. 1979. Administrator, Mineland Reclamation Division, Oregon Department of Geology and Mineral Industries.

Bauer, Anthony M. 1965. "Simultaneous Excavation and Rehabilitation of Sand and Gravel Sites." National Sand and Gravel Association, Silver Springs, Maryland. 80 pp.

Beaulieu, John D. Personal Communication. 1979. Deputy State Geologist, Oregon Department of Geology and Mineral Industries.

Beaulieu, John D. and Paul W. Hughes. 1975. Environmental Geology of Western Coos and Douglas Counties, Oregon. Department of Geology and Mineral Industries, Portland, Oregon. 148 pp.

Bernewitz, M. W. von. 1930. "Treatment and Sale of Black Sands." Information Circular 7000. U.S. Department of Interior, Washington, D. C. 21 pp.

Bond, Peter. Personal Communication. 1979. Parks Planner, Parks and Recreation Branch, Oregon Department of Transportation.

Brown, B. E. Personal Communication. 1978 District Engineer, Oregon State Highway Division.

Carter, George J., H. M. Harris and K. G. Strandberg. 1964. "Beneficiation Studies of the Oregon Coastal Dune Sands For Use as Glass Sand." RI 6484 U. S. Department of the Interior, Bureau of Mines, Washington, D.C. 21 pp.

Carter, George, Hal J. Kelly and E. W. Parsons. 1962. "Industrial Silica Deposits of the Pacific Northwest." Information Circular No. 8112. U. S. Department of the Interior, Bureau of Mines, Washington, D.C. 57 pp.

Czmerys, John. Personal Communication. 1979. NRA Wildlife Specialist.

Dake, H. C. 1938. Letter to City Council of Newport, Oregon, November 23, 1938. 2 pp.

Dasher, John, Foster Frass and Alton Gabriel. 1942. "Mineral Dressing of Oregon Beach Sands: Concentration of Chromite, Zircon, Garnet, and Illmerite." RI 3668. U.S. Department of the Interior, Bureau of Mines, Washington, D.C. 19 pp.

Erickson, Robert, et al. 1974. Visual Resource Analysis of the Oregon Coastal Zone: Experimental Qualities of Oregon Coastal Environments. The Oregon Coastal Conservation and Development Commission, Florence, Oregon. 135 pp.

Gray, Jerry. Personal Communication. 1978. Geologist, Oregon Department of Geology and Mineral Industries.

Inman, Douglas L. 1978. "The Impact of Coastal Structures on Shorelines." Proceedings of Coastal Zone 78. American Society of Civil Engineers, New York, New York. pp. 2265-2272. 8 pp.

Johnson, Craig. 1966. "Practical Operating Procedures for Progressive Rehabilitation of Sand and Gravel Sites." National Sand and Gravel Association, Silver Springs, Maryland. 75 pp.

Johnson, Earl. Personal Communication. 1979. Oregon Division of State Lands.

Ketchum, Bostwick H., ed. 1972. The Water's Edge. MIT Press, Cambridge, Massachusetts. 393 pp.

Komar, Paul D. 1976. Beach Processes and Sedimentation. Prentice-Hall, Inc., Englewood, N. J. 429 pp.

Komar, Paul D. Personal Communication. 1978. Professor of Oceanography, Oregon State University, Corvallis, Oregon.

Magoon, Orville T., John C. Haugen and Robert L. Sloan. 1972. "Coastal Sand Mining in Northern California, U.S.A." Proceedings of the 13th Coastal Engineering Conference. American Society of Civil Engineers, New York, New York. pp. 1571-1595. 25 pp.

Mann, Roy. 1977. "Shoreline Site Planning and Design." John Clark, Ed. Coastal Ecosystem Management: A Technical Manual for the Conservation of Coastal Zone Resources. John Wiley and Sons, New York, New York. 928 pp.

Marsters, C. L. 1938. Letter to City Council of Newport, Oregon, November 23, 1938. 2 pp.

Oregon Land Conservation and Development Commission. 1975. "Draft Regional Land Use Planning Goals and Guidelines for the Coastal Zone." Oregon Land Conservation and Development Commission, Salem, Oregon. 8 pp.

Rea, Campbell. 1974. "The Erosion of Siletz Spit, Oregon." Unpublished MA Thesis, School of Oceanography, Oregon State University, Corvallis, Oregon. 105 pp.

Reuef, Michael. Personal Communication. 1979. Shorelines Division, Washington State Department of Ecology.

Schlicker, Herbert G., et al. 1972. Environmental Geology of the Coastal Region of Tillamook and Clatsop Counties, Oregon. Bulletin 74, Oregon Department of Geology and Mineral Industries, Portland, Oregon 164 pp.

Shellie, Kenneth L. and David A. Rogier. 1963. "Site Utilization and Rehabilitation Practices." National Sand and Gravel Association, Silver Springs, Maryland. 80 pp.

Sterrett, Chester K. 1958. "Industrial Silica for Pacific Northwest Industries." Resource Report No. 1, Raw Materials Survey, Inc., Portland, Oregon. 14 pp.

Ternyik, Wilbur. Personal Communication. 1978. Owner, Wave Beach Grass Nursery, Florence, Oregon.

The Conservation Foundation. 1977. Physical Management of Coastal Floodplains: Guidelines for Hazards and Ecosystems Management. The Council on Environmental Quality, Washington, D.C. 179 pp.

The Daily Astorian. 1978. "Seaside Approves Land-use Plan Changes." September 13, 1978. Astoria, Oregon.

U. S. Army Corps of Engineers. 1975. Shore Protection Manual, Volume I. Second edition. U. S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia. 508 pp.

U. S. Department of Agriculture, Forest Service. 1977. Final Environmental Statement, Oregon Dunes National Recreation Area. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Portland, Oregon. 200 pp.

U. S. Department of Agriculture, Soil Conservation Service and Oregon Coastal Conservation and Development Commission. 1975. Beaches and Dunes of the Oregon Coast. U. S. Department of Agriculture, Soil Conservation Service, Portland, Oregon. 161 pp.

U. S. Department of the Interior, Bureau of Mines. 1978. "Minerals in the Economy of Oregon." SMP-21. U. S. Department of the Interior, Bureau of Mines, Washington, D.C. 14 pp.

U. S. Department of the Interior, National Park Service. 1978. Management Policies. U. S. Department of the Interior, National Parks Service, Washington, D. C. 175 pp.

Warrenton Dune Soil and Water Conservation District, Clatsop County, Oregon. 1966. "Thirty-one Years of Progress, 1935-1966." Warrenton Dune Soil and Water Conservation District, Astoria, Oregon. 17 pp.

APPENDIX A

ORS 517.750 - .990
Reclamation of Mining Lands

Application for Operating
Permit or Grant of Exemption

Reclamation Plan Guideline

RECLAMATION OF MINING LANDS

517.750 Definitions for ORS 517.750 to 517.900. As used in ORS 517.750 to 517.900 and subsection (4) of 517.990, unless the context requires otherwise:

(1) "Abandonment of surface mining" means a cessation of surface mining operation that was not set forth in a permittee's plan of operation or similar written notice extending:

(a) For more than 24 consecutive months; or

(b) For a period of less than 24 consecutive months in length, determined by the department to be sufficient to characterize such cessation of the surface mining operation as an abandonment of surface mining and where the permittee fails to submit sufficient evidence to the department that such operation has not been abandoned within 30 days after his receipt of written notification from the department of its intention to declare the operation abandoned.

(2) "Board" means the governing board of the State Department of Geology and Mineral Industries..

(3) "Completion" means termination of surface mining activities including reclamation of the surface-mined land in accordance with the approved reclamation plan and operating permit.

(4) "Department" means the State Department of Geology and Mineral Industries.

(5) "Landowner" means the person possessing fee title to the natural mineral deposit being surface mined.

(6) "Minerals" includes soil, coal, clay, stone, sand, gravel, metallic ore and any other solid material or substance excavated for commercial, industrial or construction use from natural deposits situated within or upon lands in this state.

(7) "Operator" means any individual, public or private corporation, political subdivision, agency, board or department of this state, any municipality, partnership, association, firm, trust, estate or any other legal entity whatsoever that is engaged in surface mining operations.

(8) "Overburden" means the soil, rock and similar materials that lie above natural deposits of minerals.

(9) "Reclamation" means the employment in a surface mining operation of procedures, reasonably designed to minimize as much as practicable the disruption from the surface mining operation and to provide for the rehabilitation of any such surface resources adversely affected by such surface mining operations through the rehabilitation of plant cover, soil stability, water resources and other measures appropriate to the subsequent

beneficial use of such mined and reclaimed lands.

(10) "Reclamation plan" means a written proposal, submitted to the department as required by ORS 517.750 to 517.900 and subsection (4) of 517.990 and subsequently approved by the department as provided in ORS 517.750 to 517.900 and subsection (4) of 517.990, for the reclamation of the land area adversely affected by a surface mining operation and including, but not limited to the following information:

(a) Proposed measures to be undertaken by the operator in protecting the natural resources of adjacent lands.

(b) Proposed measures for the rehabilitation of the surface-mined lands and the procedures to be applied.

(c) The procedures to be applied in the surface mining operation to control the discharge of contaminants and the disposal of surface mining refuse.

(d) The procedures to be applied in the surface mining operation in the rehabilitation of affected stream channels and stream banks to a condition minimizing erosion, sedimentation and other factors of pollution.

(e) The map required by paragraph (e) of subsection (1) of ORS 517.790 and such other maps and supporting documents as may be requested by the department.

(f) A proposed time schedule for the completion of reclamation operations.

(11) "Spoil bank" means a deposit of excavated overburden or mining refuse.

(12) "Surface mining" includes all or any part of the process of mining minerals by the removal of overburden and the extraction of natural mineral deposits thereby exposed by any method by which more than 2,500 cubic yards of minerals are extracted or by which at least one acre of land is affected within a period of 12 consecutive calendar months, including open-pit mining operations, auger mining operations, production of surface mining refuse, the construction of adjacent or off-site borrow pits (except those constructed for use as access roads), and prospecting and exploration activities coming within the quantity or area specifications set forth herein or when such activities affect more than one acre of land for each eight acres of land prospected or explored; but excluding excavations of sand, gravel, clay, rock or other similar materials conducted by the landowner or tenant for the primary purpose of construction, reconstruction or maintenance of access roads and excavation or grading operations conducted in the process of farming or cemetery operations, onsite road construction or other onsite construction, or underground mines; and also excluding rock, gravel, sand, silt or other similar substances removed from the beds or banks of any waters of this state pursuant to permit issued under ORS 541.605 to 541.660.

(13) "Surface mining refuse" means all waste materials, soil, rock, mineral, liquid, vegetation and other materials resulting from or displaced by surface mining operations within the operating permit area, including all waste materials deposited in or upon lands within such operating permit area.
[1971 c.719 §2; 1975 c.724 §1; 1977 c.59 §1]

517.755 Mining operations affecting more than five acres. Notwithstanding the yard and acre limitations of subsection (11) of ORS 517.750, as soon as any mining operation begun after July 1, 1975, affects more than five acres of land the provisions of ORS 517.750 to 517.900 and subsection (4) of 517.990 apply to the mining operation.
[1975 c.724 §1a]

Note: 517.755 was enacted into law by the Legislative Assembly but was not added to or made a part of ORS chapter 517 or any series therein by legislative action. See the Preface to Oregon Revised Statutes for further explanation.

517.760 Policy. (1) The Legislative Assembly finds and declares that:

(a) The extraction of minerals by surface mining operations is a basic and essential activity making an important contribution to the economic well-being of the state and nation.

(b) Proper reclamation of surface-mined lands is necessary to prevent undesirable land and water conditions that would be detrimental to the general welfare, health, safety and property rights of the citizens of this state.

(c) Surface mining takes place in diverse areas where the geologic, topographic, climatic, biological and social conditions are significantly different and that reclamation operations and the specifications therefor must vary accordingly.

(d) It is not practical to extract minerals required by our society without disturbing the surface of the earth and producing waste materials and that the very character of many types of surface mining operations precludes complete restoration of the affected lands to their original condition.

(e) Reclamation of surface-mined lands as provided by ORS 517.750 to 517.900 and subsection (4) of 517.990 will allow the mining of valuable minerals in a manner designed for the protection and subsequent beneficial use of the mined and reclaimed lands.

(2) The Legislative Assembly, therefore, declares that the purposes of ORS 517.750 to 517.900 and subsection (4) of 517.990 are:

(a) To provide that the usefulness, productivity and scenic values of all lands and water resources affected by surface mining operations within this state shall receive the greatest practical degree of protection and reclamation necessary for their intended subsequent use.

(b) To provide for cooperation between private and governmental entities in carrying out the purposes of ORS 517.750 to 517.900 and subsection (4) of 517.990.
[1971 c.719 §1]

517.770 Application of ORS 517.750 to 517.900. (1) Nothing in ORS 517.750 to 517.900 and subsection (4) of 517.990 applies to:

(a) The reclamation of lands within the surfaces and contours of surface mines as of July 1, 1972, or to vertical extensions of those surfaces and contours. The surfaces and contours of surface mines shall not include those areas over which the mining operator merely leveled terrain or cleared vegetative cover.

(b) Dredging operations conducted pursuant to ORS 517.611 to 517.700.

(c) A landowner or operator who, on July 1, 1972, is a party to a valid contract, in existence on January 1, 1971, to surface mine; but this exemption will not apply to existing contracts upon expiration, or in instances where a fiduciary relationship exists between the contracting parties, and in no case will the exemption continue after January 1, 1981.

(2) Notwithstanding paragraph (a) of subsection (1) of this section, if in the judgment of the department meaningful reclamation cannot be accomplished the department may waive the permit and reclamation requirements of ORS 517.750 to 517.900 and subsection (4) of 517.990 even though the mine surfaces and contours as of July 1, 1972, have been extended horizontally.
[1971 c.719 §15; 1973 c.709 §1; 1975 c.724 §2]

517.775 Permit fee for certain landowners and operators. Notwithstanding the provisions of subsections (1) and (3) of ORS 517.770, any landowner or operator conducting surface mining on July 1, 1972, shall pay the permit fee as provided in ORS 517.800.
[1971 c.719 §17]

517.780 Effect on local zoning laws or ordinances; local reclamation permit and fee in lieu of state permit and fee; certain operations exempt. (1) The provisions of ORS 517.750 to 517.900 and subsection (4) of 517.990 and the rules and regulations adopted thereunder shall not supersede any zoning laws or ordinances in effect on July 1, 1972; however, if such zoning laws or ordinances are repealed on or after July 1, 1972, the provisions of ORS 517.750 to 517.900 and subsection (4) of 517.990 and the rules and regulations adopted thereunder shall be controlling. The department may adopt rules and regulations with respect to matters presently covered by such zoning laws and ordinances.

(2) In lieu of the permit required by ORS 517.790, an operator may conduct surface mining provided such surface mining is done pursuant to a valid permit issued by the appropriate authority of a city or county in which the mining is taking place, if such authority has adopted an ordinance, approved by the department, requiring reclamation of land that has been surface mined.

(3) City or county operated surface mining operations which sell less than 2,500 cubic yards of minerals within a period of 12 consecutive calendar months, are exempt from the provisions of ORS 517.750, 517.755, 517.770, 517.810, 517.830, 517.860, 517.865 and this section provided the city or county adopts an ordinance which shall include a general reclamation scheme for all surface mining within the boundaries of the city or county, which shall provide for the means and methods whereby reclamation is to be achieved.

(4) A city or county may determine and collect fees for any function performed pursuant to subsection (2) of this section. However, no such fee shall exceed the amounts prescribed in ORS 517.800. A city or county shall issue a permit for each regulated surface mining activity within its jurisdiction, and all such permittees are subject to the payment of any fee charged by the city or county. However, those activities described in ORS 517.770 are not required to comply with mined land reclamation plans. City or county fees shall be in lieu of any surface mining permit fees assessed by the department.
[1971 c.719 §16; 1975 c.724 §3; 1977 c.524 §1]

517.790 Operating permit required for surface mining on certain lands; application for permit; proposed reclamation plans. (1) Except as otherwise provided by subsection (2) of ORS 517.780, after July 1, 1972, no landowner or operator shall permit or engage in surface mining on land not surface mined on July 1, 1972, without having first applied for and received an operating permit from the department for such surface mining operation. A separate permit shall be required for each separate surface mining operation. Prior to receiving an operating permit from the department the landowner or operator must submit an application on a form provided by the department that contains information considered by the department to be pertinent in its review of the application, including but not limited to:

(a) The name and address of the landowner and the operator and the names and addresses of any persons designated by them as their agents for the service of process.

(b) The materials for which the surface mining operation is to be conducted.

(c) The type of surface mining to be employed in such operation.

(d) The proposed date for the initiation of such operation.

(e) The size and legal description of the lands that will be affected by such operation, and, if more than 10 acres of land will be affected by such operation and if the department considers the conditions to warrant it, a map of the lands to be surface mined that shall include the boundaries of the affected lands, topographic details of such lands, the location and names of all streams, roads, railroads and utility facilities within or adjacent to such lands, the location of all proposed access roads to be constructed in conducting such operation and the names and addresses of the owners of all surface and mineral interests of the lands included within the surface mining area.

(f) If economically practicable, a plan for visual screening by vegetation or otherwise that will be established and maintained on the lands within such operation for the purpose of screening such operation from the view of persons using adjacent public highways, public parks and residential areas.

(2) The application referred to in subsection (1) of this section must also contain a proposed reclamation plan that is acceptable to and approved by the department.
[1971 c.719 §4; 1973 c.709 §2]

517.800 Fees. (1) Each application for an operating permit under ORS 517.750 to 517.900 and subsection (4) of 517.990 shall be accompanied by a fee of $265.

(2) Annually on the anniversary date of each such operating permit, each holder of an operating permit shall pay to the department a fee of $165.
[1971 c.719 §7; 1973 c.709 §3; 1977 c.524 §2]

517.810 Bond or security deposit required of applicant; public and governmental bodies exempt; other security in lieu of bond from landowner. (1) Before issuing or reissuing an operating permit for any surface mining operation, the department shall require that the applicant for such permit file with it a bond or security deposit, conditioned upon the faithful performance of the reclamation plan and of the other requirements of ORS 517.750 to 517.900 and subsection (4) of 517.990 and the rules and regulations adopted thereunder in a sum equal to the estimated cost of the completion of the reclamation work. The applicant may deposit with the department, in lieu of a bond, cash or other security in a sum satisfactory to the department. In no event shall such bond or deposit of cash or security exceed the sum of $500 per acre of land to be surface mined under the terms of the operating permit therefor. The amount of the bond shall be determined by the department.

(2) Nothing in this section shall apply to any public or governmental agency.

(3) In lieu of the bond or other security required of the applicant in subsection (1) of this section, the department may accept a similar security from the landowner, including a mortgage or trust deed equal to the estimated cost of reclamation as determined by the department, not to exceed $500 per acre. The cost of title or mortgage insurance, or costs for title searches or examinations necessary to insure the department's security shall be the responsibility of the applicant.
[1971 c.719 §8; 1975 c.724 §4]

517.820 Extensions of time for submission of proposed reclamation plans; time limit for reclamation completion; consultation with state agencies. (1) Upon good cause shown, the department may grant reasonable extensions of time for the completion by the landowner or operator and his submission to the department of a proposed reclamation plan required by subsection (2) of ORS 517.790. Each reclamation plan submitted to the department must provide that all reclamation activities shall be completed within three years after the termination of mineral extraction from the surface mining operation conducted within each separate area for which an operating permit is requested. Each such reclamation plan shall be approved by the department if it adequately provides for the reclamation of surface-mined lands.

(2) The department, prior to approving a proposed reclamation plan, shall consult with all other interested state agencies and appropriate local planning authorities.
[1971 c.719 §5; 1977 c.59 §2]

517.830 Inspection of operating site; approval of application for operating permit; effect of failure to approve or refusal to approve reclamation plan; appeal from denial of plan; transfer of permittee's interest. (1) Upon receipt of an application for an operating permit, the department shall cause the operating site described therein to be inspected. Within 30 days after the date on which such application is received and upon receipt of the required permit fee, the department shall issue the operating permit applied for or, if it considers such application incomplete, return the application to the applicant for correction of the deficiencies indicated by the department.

(2) Failure by the department to act upon the reclamation plan submitted with an application for an operating permit within the 30-day period referred to in subsection (1) of this section shall not be considered a denial by the department of the operating permit applied for. The department, pending final approval of a reclamation plan, may issue a provisional permit subject to reasonable limitations that may be prescribed by the department and conditioned upon the applicant's compliance with the bond and security requirements established by ORS 517.810. For all operations ongoing as of July 1, 1972, a provisional permit shall be issued except in those instances where there is reason to believe that a reclamation plan will not be approved and the operating permit ultimately denied.

(3) If the department refuses to approve a reclamation plan in the form submitted by the applicant, it shall notify the applicant, in writing, of its reasons for the refusal to approve such reclamation plan, including additional requirements as may be prescribed by the department for inclusion in such reclamation plan. Within 60 days after the receipt of such notice, the applicant shall comply with the additional requirements prescribed by the department for such reclamation plan or file with the department a notice of appeal from the decision of the department with respect to such reclamation plan. If a notice of appeal is filed with the department by the applicant, the department may issue a provisional permit to such applicant.

(4) An operating permit issued by the department under this section shall be granted for the period required to mine the land described in such permit and shall be valid, subject to payment of the renewal fee, until the surface mining operation described in the operating permit is completed or abandoned. Each such operating permit shall provide that the reclamation plan described therein may be modified upon agreement between the department and the permittee to change the reclamation plan included within the operating permit.

(5) When a person succeeds to the interest of a permittee in any uncompleted surface mining operation by sale, assignment, lease or other means, the department shall release the permittee from the duties imposed upon him under his operating permit if his successor assumes fully the duties of the former permittee with respect to the reclamation of the surface-mined lands. Upon the assumption by such person of the duties of the permittee as provided in this subsection, the department shall transfer the operating permit to the successor upon the approval of such successor's bond or security deposit as required under ORS 517.750 to 517.900 and subsection (4) of 517.990.
[1971 c.719 §6; 1975 c.724 §5]

517.840 Administration and enforcement of ORS 517.750 to 517.900. The board shall administer and enforce the provisions of ORS 517.750 to 517.900 and subsection (4) of 517.990 and may:

(1) Conduct or cause to be conducted investigations, research, experiments and demonstrations and may collect and disseminate information related to surface mining and the reclamation of surface-mined lands.

(2) Cooperate with other governmental and private agencies of this state or of other states and with agencies of the Federal Government, including the reimbursement for any services provided by such agencies to the department at its request.

(3) Apply for, accept and expend public and private funds made available for the reclamation of lands affected by surface mining in accordance with the purposes of

ORS 517.750 to 517.900 and subsection (4) of 517.990.

(4) In accordance with the applicable provisions of ORS chapter 183, adopt rules and regulations considered by the board to be necessary in carrying out the provisions of ORS 517.750 to 517.900 and subsection (4) of 517.990. However, such rules and regulations shall be subject to existing rights under any permit, license, lease or other valid authorization granted or issued by a governmental entity.
[1971 c.719 §3]

517.850 Inspection of permit area. At such reasonable times as the department may elect, the department, after reasonable advance notice has been given to the permittee, may cause the permit area to be inspected to determine if the permittee has complied with the reclamation plan and the rules and regulations of the department.
[1971 c.719 §9]

517.860 Failure to comply with reclamation plan; notice of noncompliance; performance period; extension; department may perform work and assess costs against permittee or landowner. (1) If from inspections conducted pursuant to ORS 517.850, or from any other source the department shall determine that the permittee has not or is not complying with the reclamation plan or the rules and regulations of the department, it shall give written notice thereof to the permittee, specifically outlining the deficiencies. Within 30 days thereafter, the permittee shall commence action to rectify those deficiencies and diligently shall proceed until they are all corrected. However, the department may extend performance periods for delays occasioned for causes beyond the permittee's control, but only when the permittee is, in the opinion of the department, making a reasonable effort to comply.

(2) (a) If the permittee has not commenced action to rectify the deficiencies within said period of time, and after notification by the department, or

(b) If the permittee has commenced such action and fails to diligently pursue it, or

(c) If reclamation is not properly completed in conformance with the reclamation plan within three years after surface mining on any segment of the permit area has terminated, or

(d) If reclamation is not properly completed in conformance with the reclamation plan upon determination by the department that abandonment of surface mining has occurred on any segment of the permit area,

the department may perform the reclamation required by the reclamation plan, complete such reclamation and give written notice that the amount of the reasonably necessary costs and expenses so incurred is due and payable to the department by the permittee. In performing the reclamation under this subsection the department shall be limited to expending funds to complete the reclamation plan, but in no event shall the expenditure exceed $500 per acre. If the amount specified in the notice is not paid within 30 days following such notice the Attorney General, upon request of the department, shall institute proceedings to recover the amount specified in the notice.

(3) If the landowner has given security as provided in subsection (3) of ORS 517.810 and the permittee is in default as specified in subsection (2) of this section, the landowner shall be held responsible for complying with the reclamation plan of the permitee. The department shall furnish written notice of the default to the landowner and require the landowner to complete the reclamation as specified in the permittee's reclamation plan acceptable to the department. If the landowner has not commenced action to rectify the deficiencies within 30 days after receiving notice, or if he fails to diligently pursue reclamation in conformance with the plan, the department may complete the reclamation and otherwise proceed as provided in subsection (2) of this section, or the department may bring suit to compel the landowner to complete the reclamation plan.
[1971 c.719 §10; 1975 c.724 §6; 1977 c.59 §3]

517.865 Failure to faithfully perform reclamation; insufficient bond; lien; notice; priority; foreclosure. (1) If a permittee fails to faithfully perform the reclamation required by his reclamation plan and if the bond or security deposit required by ORS 517.810 is not sufficient to compensate the department for all reasonably necessary costs and expenses incurred by it in performing the reclamation required by the reclamation plan, the amount due, not to exceed $500 per acre, shall be a lien in favor of the department upon all property, whether real or personal, belonging to the permittee.

(2) The lien shall attach upon the filing of a notice of claim of lien with the county clerk of the county in which the property is located. The notice of lien claim shall contain a true statement of the demand, the insufficiency of the bond or security deposit to compensate the

department and the failure of the permittee to perform the reclamation required.

(3) The lien created by this section is prior to all other liens and encumbrances, except that the lien shall have equal priority with tax liens.

(4) The lien created by this section may be foreclosed by a suit in the circuit court in the manner provided by law for the foreclosure of other liens on real or personal property.
[1975 c.724 §8]

517.870 Adjustment of bond or security deposit of permittee upon satisfactory completion of reclamation work. Upon request of the permittee, and when in the judgment of the department the reclamation has been completed in accordance with the reclamation plan, the permittee shall be notified that the work has been found to be satisfactorily performed and is acceptable and his bond or security deposit shall be adjusted accordingly.
[1971 c.719 §11]

517.880 Order for suspension of surface mining operation operating without required permit; enjoining operation upon failure of operator to comply; completion of reclamation by department. When the department finds that an operator is conducting a surface mining operation for which an operating permit is required by ORS 517.750 to 517.900 and subsection (4) of 517.990, but has not been issued by the department under the provisions of ORS 517.750 to 517.900 and subsection (4) of 517.990 or by the rules and regulations adopted thereunder, it may order such operator to suspend such operation until an operating permit has been issued by the department for such surface mining operation or until such time as the department is assured that such operator will comply therewith. If the operator fails or refuses to comply with such order, the Attorney General at the request of the department shall initiate any necessary legal proceeding to enjoin such surface mining operation and to provide for the completion of the reclamation of the lands affected by such operation.
[1971 c.719 §12]

517.890 Appeals. Appeals from determinations made by the department in carrying out the provisions of ORS 517.750 to 517.900 and subsection (4) of 517.990 and the rules and regulations adopted thereunder shall be conducted in the manner provided by the applicable provisions of ORS chapter 183 for appeals from orders in contested cases.
[1971 c.719 §13]

517.900 Information submitted by operators and landowners is confidential. Operators' reports and other information submitted by operators and landowners as required under ORS 517.750 to 517.900 and subsection (4) of 517.990, with the exception of the reclamation plan as approved by the department, shall be confidential.
[1971 c.719 §14]

PENALTIES

517.990 Penalties. (1) A person who violates ORS 517.450 shall be guilty of theft and punished as provided in ORS 164.045 or 164.055.

(2) Violation of any rules, regulations and orders made pursuant to subsection (4) of ORS 517.540 is punishable, upon conviction, by a fine of not less than $25 nor more than $250, or by imprisonment in the county jail for not more than 60 days, or both.

(3) Any person conducting a dredging operation in violation of the provisions of ORS 517.611 to 517.700 is guilty of a misdemeanor.

(4) Any landowner or operator who shall conduct a surface mining operation, for which a permit is required by ORS 517.750 to 517.900 and this subsection, without a valid operating permit therefor shall be punished, upon conviction, by a fine of not more than $1,000.
[Amended by 1953 c.188 §2; subsection (3) enacted as 1957 c.580 §11; 1971 c.743 §398; subsection (4) enacted as 1971 c.719 §18]

STATE DEPARTMENT OF GEOLOGY
AND MINERAL INDUSTRIES
1129 SE South Santiam Road
Albany, Oregon 97321
Telephone: 967-2039

Identification No.________
Office Use Only ________

APPLICATION FOR OPERATING PERMIT OR GRANT OF EXEMPTION UNDER ORS 517.750 - 990

1. Responsible Parties
   A. Operator
      Name________
      Street or Box No.________
      City________ State________
      Zip________ Telephone________
   B. Landowner (if other than operator)
      Name________
      Street or Box No.________
      City________ State________
      Zip________ Telephone________

3. MINERAL DEPOSIT CHARACTERISTICS
   A. Description
      Type of overburden________
      Approximate depth of overburden________
      Approximate depth of mine________
      Primary mineral to be removed________
      * Estimated quantity of mineral (yards)________
   B. Size
      Size in acres of any areas presently affected by surface mining________
      How much of the above was affected before 7/1/72________
      before 7/1/75________
      Has any of the above area been reclaimed?________
      If yes, how much and when?________
      Approximate acreage to be affected by surface mining during the ensuing 12 months________
   C. Volume
      * Total cubic yards excavated 7/1/72 to date________
      * During ensuing permit year, what is the scheduled total cubic yards to be excavated________
   D. Status
      ☐ Active   Date mining began ________
      ☐ Inactive   Date mining will begin ________
      ☐ New

2. Identification of Site
   A. ¼Sec. Section Township Range County
   ____
   Distance in miles / Direction from / Nearest Community
   ____
   Type of site: (Check all that apply)
   ☐ 1. Pit ☐ 5. Prospect
   ☐ 2. Stockpile ☐ 6. Refuse Disposal
   ☐ 3. Plant ☐ 7. Other
   ☐ 4. Quarry

4. Application is hereby made for: (complete only one - see instructions)
   A. Operating permit - operator claims no exemptions________
      I apply for a surface mining operating permit under ORS517.790________ date________
      (signature) Title________
   B. Grant of limited exemption based on: (check one or both)
      ☐ Prior mined (ORS 517.770-1a)
      ☐ Valid contract (ORS 517.770-1c)
      I apply for a grant of limited exemption from the requirement for a reclamation plan and bond, but not the fees Signature________
      Date________ Title________
   C. Grant of total exemption.
      I apply for a grant of total exemption from the requirements of a reclamation plan, bond, and the fees under ORS 517.750(12) and 517.770 (2) because:
      ☐ 1. All mining activity takes place between the banks of a stream. (The vegetation line defines the bank).
      ☐ 2. Access road's borrow pit or quarry.
      ☐ 3. On-site construction.
      ☐ 4. The site is less than one acre, and
      ☐ 5. a total of less than 2,500 cubic yards of material have been, or will be, removed.
      ☐ 6. The site is inactive.
      ☐ 7. Other
      ________ date________
      (signature) Title________
   D. Even though entitled to exemptions as shown above, a reclamation plan is submitted voluntarily.
      Yes. No.

NOTICE

If more than 50 cubic yards of material are to be removed or placed in fill within the bed and banks of a natural waterway, a permit from the Division of State Lands, 1445 State Street, Salem, Oregon 97310, telephone: 378-3805, is required.

*INFORMATION TO BE CONSIDERED CONFIDENTIAL (ORS 517.900)

INSTRUCTIONS FOR COMPLETING THIS FORM ARE ON THE REVERSE SIDE

DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
MINED LAND RECLAMATION DIVISION

RECLAMATION PLAN GUIDELINE

A. NAME, ADDRESS AND TELEPHONE NUMBER OF THE OPERATOR OR HIS AGENT:

B. NAME AND ADDRESS OF LANDOWNER:

C. LIST OF KNOWN MATERIALS FOR WHICH THE OPERATION IS TO BE CONDUCTED:

1. PROPOSED STARTING DATE:
2. PROPOSED ENDING DATE (IF KNOWN):

D. OPERATIONAL PLAN:

1. METHOD TO BE EMPLOYED:

   a. SINGLE BENCH   c. DREDGE

   b. MULTIPLE BENCH   d. OTHER ________________

2. TYPES OF EQUIPMENT TO BE USED:

3. DISPOSITION OF OVERBURDEN:

E. WHAT WILL BE THE PLANNED SUBSEQUENT "BENEFICIAL USE" OF THE PERMIT AREA? THIS CAN INCLUDE, BUT IS NOT LIMITED TO, CONSTRUCTION SITE, SANITARY LAND FILL, PARK, WATER IMPOUNDMENT, AGRICULTURAL USE (BE SPECIFIC, EXAMPLE: GRAZING LAND, CROP TO BE PLANTED, ETC.), FOREST LAND.

F.1. (a) Reclamation will begin ________ days following completion of mining.
(b) Reclamation will be concurrent with mining. ______ yes ______ no

F. 2. PROVISION FOR RECLAIMING MINED LANDS ON A CONTINUING BASIS WHERE FEASIBLE.

G. RECLAMATION PROCEDURES

1. WHAT WILL YOU DO TO INSURE GROUND STABILITY?

2. PROVISION FOR REVEGETATION. (Minimal survival rate is 75% uniformly distributed.)

(a) HOW WILL YOU SAVE AND STORE TOPSOIL?

(b) WHAT MEASURES WILL YOU TAKE TO PREVENT EITHER WIND OR WATER EROSION OF TOPSOIL DURING STORAGE?

(c) WHAT WILL BE THE AVERAGE DEPTH OF TOPSOIL REPLACED ON THE AREA TO BE RECLAIMED.

(d) HOW WILL YOU PREPARE SEED BED PRIOR TO PLANTING?

(e) WHAT TYPES AND AMOUNTS OF GRASS SEED WILL YOU USE PER ACRE AND HOW WILL THIS BE PLANTED?

(f) WHAT TYPES AND AMOUNTS OF FERTILIZER, MULCH, AND LIME WILL YOU USE?

(g) WHAT TYPES AND AMOUNTS OF SEEDLINGS AND SHRUBS WILL YOU PLANT?

(h) WHEN WILL SEEDING AND PLANTING TAKE PLACE? (SEASON OF YEAR)

H. WATER AND DRAINAGE

(a) WHAT PROVISION WILL YOU TAKE TO INSURE PROPER DRAINAGE?

(b) WHAT PROVISION HAS BEEN TAKEN FOR SILT CONTROL?

(c) IF WATER IMPOUNDMENT IS TO BE LEFT, SEE PAGE 6.

I. VISUAL SCREENING

(a) WILL YOU EMPLOY VISUAL SCREENING? (IF NO, EXPLAIN)

(b) WHAT TYPES AND AMOUNTS OF PLANTS WILL YOU USE?

(c) WHAT WILL BE THE SPACING BETWEEN PLANTS?

J. PROVISION FOR REMOVING STRUCTURES, EQUIPMENT, AND REFUSE FROM THE PERMIT AREA IN ACCORDANCE WITH THE RECLAMATION PLAN.

K. MAP OF AERIAL PHOTO REQUIREMENTS

(a) WILL AREA PHOTO BE SUBMITTED? YES ______ NO ______

SCALE ______

(b) MAP(S) REQUIREMENTS. THE MAP SHOULD SHOW, BUT IS NOT LIMITED TO:

(1) SCALE: (1" = 400' to 600')

(2) NORTH SHALL BE INDICATED

(3) QUARTER SECTION, SECTION, TOWNSHIP AND RANGE

(4) DISTANCE AND DIRECTION TO NEAREST MUNICIPALITY

(5) LOCATIONS AND NAMES OF ALL STREAMS, ROADS, RAILROADS, UTILITIES

(6) LOCATION AND NAMES OF ADJACENT LANDOWNERS

(7) ALL OCCUPIED HOUSES WITHIN 500 FEET

(8) LOCATION OF ALL PROPOSED ACCESS ROADS

(9) LOCATION OF PLANT, OFFICE AND MAINTENANCE FACILITIES

(10) SHOW BOUNDARIES OF AREA TO BE PERMITTED

(11) TYPICAL CROSS-SECTION OF PRESENT GROUND LINE AND PROJECTED GROUND LINE AFTER RECLAMATION

(12) CONTOUR INTERVAL, DATE OF MAP PREPARATION, NAME OF PERSON PREPARING MAP.

(13) AREA FOR TOPSOIL STORAGE, WASTE DISPOSAL

(14) A SEPARATE MAP SHOWING GENERAL LOCATION OF THE OPERATING AREA (NOT LARGER THAN 8½" x 11")

(c) A REVISED MAP MAY BE REQUIRED ANNUALLY

L. IF APPLICABLE, WHAT PROVISIONS HAVE BEEN MADE FOR STREAM CHANNEL, BANK STABILIZATION AND REHABILITATION?

M. EVIDENCE, IN WRITTEN FORM, STATING THAT ALL OWNERS OF A LEGAL, EQUITABLE, FIDUCIARY OR POSSESSORY INTEREST IN THE LAND CONCUR WITH THE PROPOSED SUBSEQUENT USE FOR ANY MINING OPERATION COMMENCING SUBSEQUENT TO JULY 1, 1972.

N. OTHER PERMITS IF APPLICABLE:

DIVISION OF STATE LANDS	NO. ____________	DATE ____________
DEPARTMENT OF ENVIRONMENTAL QUALITY	NO. ____________	DATE ____________
COUNTY USE PERMIT	NO. ____________	DATE ____________
OTHER (IDENTIFY)	____________	

O. OTHER COMMENTS:

____

(SIGNATURE OF APPLICANT)

TITLE ____________________ DATE ______________

WATER IMPOUNDMENTS

(1) HOW LARGE WILL THE SURFACE AREA BE, IN ACRES? ____________________

(2) WHAT PROVISIONS HAVE BEEN MADE FOR PUBLIC SAFETY?

(3) WHAT PROVISIONS HAVE YOU MADE TO PREVENT WATER STAGNATION?

(4) WHAT IS THE WATER SOURCE FOR THE IMPOUNDMENT?

(5) WILL THERE BE PUBLIC ACCESS FOR FISHING?

INSTRUCTIONS FOR CROSS-SECTION

1. THE TWO EXAMPLES SHOWN ARE "TYPICAL" CROSS-SECTIONS OF A WATER IMPOUNDMENT LEFT AFTER EXCAVATION IS COMPLETE.

2. IF ONE OF THE PLANS SHOWN IS TO BE USED, PLEASE INDICATE WHICH ONE AND PROVIDE THE FOLLOWING INFORMATION ON THE PLAN SELECTED. YOU DO NOT HAVE TO RE-DRAW THE CROSS-SECTION.

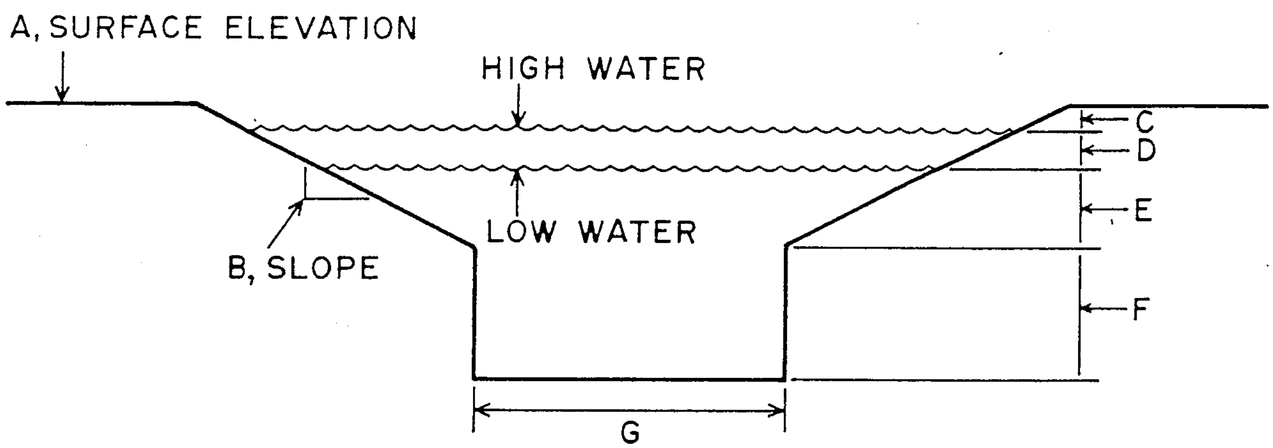
   A. SURFACE ELEVATION TO THE NEAREST 5 FEET.

   B. SLOPE OF THE BANK (MAXIMUM IS 2:1 OR 27°).

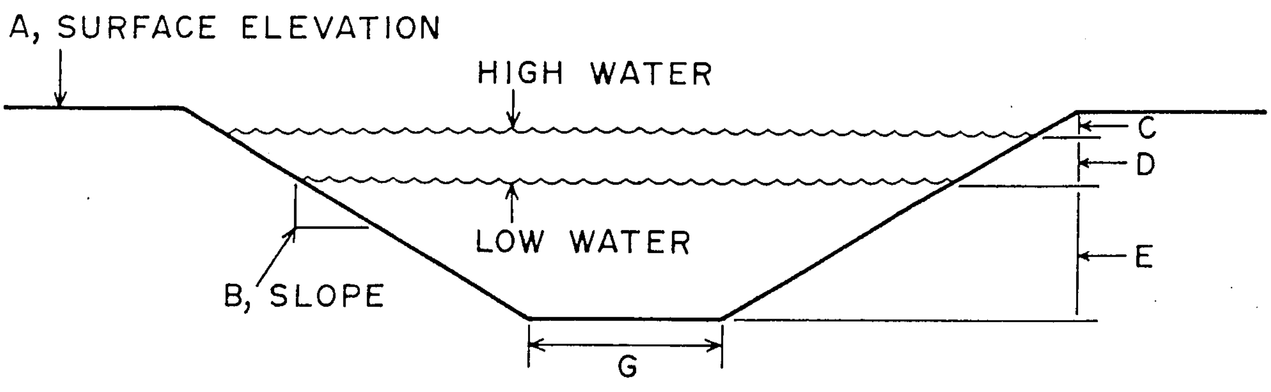
   C - G. THE DIMENSIONS IN FEET.

Typical Cross - Section(s) of Water Impound

TYPE I



TYPE II



APPENDIX B

State Statutes 390.655 and 390.725

Permit Application--Removal, of Sand, Rock, Minerals, Marine Growth or Other Natural Products of the Oregon Shore

390.655 Standards for improvement permits. The State Highway Engineer shall consider applications and issue permits under ORS 390.650 in accordance with standards designed to promote the public health, safety and welfare and carry out the policy of ORS 390.610, 390.620 to 390.660, 390.680, 390.690, and 390.705 to 390.770. The standards shall be based on the following considerations, among others:

(1) The public need for healthful, safe, esthetic surroundings and conditions; the natural scenic, recreational and other resources of the area; and the present and prospective need for conservation and development of those resources.

(2) The physical characteristics or the changes in the physical characteristics of the area and suitability of the area for particular uses and improvements.

(3) The land uses, including public recreational use if any, and the improvements in the area, the trends in land uses and improvements, the density of development and the property values in the area.

(4) The need for recreation and other facilities and enterprises in the future development of the area and the need for access to particular sites in the area.
[1969 c.601 §11]

390.725 Permits for removal of products along ocean shore. (1) No sand, rock, mineral, marine growth or other natural product of the ocean shore, other than fish or wildlife, agates or souvenirs, shall be taken from the state recreation areas described by ORS 390.635, except in compliance with a rule of or permit from the Department of Transportation as provided by this section. Permits shall provide for the payment of just compensation by the permittee as provided in subsection (5) of this section.

(2) Rules or permits shall be made or granted by the Department of Transportation only after consultation with the State Fish and Wildlife Commission, the State Department of Geology and Mineral Industries and the Division of State Lands. Rules and permits shall contain provisions necessary to protect the areas from any use, activity or practice inimicable to the conservation of natural resources or public recreation.

(3) On request of the governing body of any coastal city or county, the Department of Transportation may grant a permit for the removal of sand or rock from the area at designated locations on the ocean shore to supply the reasonable needs for essential construction uses in such localities if it appears sand and rock for such construction are not otherwise obtainable at reasonable cost, and if such removal will not materially alter the physical characteristics of the area or adjacent areas, nor lead to such changes in subsequent seasons. Before issuing a permit the department shall likewise take into consideration the standards described by ORS 390.655. The department may grant a permit to take and remove sand, rock, mineral or marine growth from the area at designated locations. The department shall also issue permits to coastal cities or counties to remove or authorize removal of sand from the ocean shore, under the standards provided by ORS 390.655, if the city or county determines that the sand accumulation on the ocean shore constitutes a hazard or maintenance problem to the city or county.

(4) The terms, royalty and duration of a permit under this section are at the discretion of the department. A permit is revocable at any time in the discretion of the department without liability to the permittee.

(5) Whenever the issuance of a permit under this section will affect lands owned privately, the Department of Transportation shall withhold the issuance of such permit until such time as the permittee shall have obtained an easement, license or other written authorization from the private owner, which easement, license or other written authority must meet the approval of the department, except as to the compensation to be paid to the private owner.
[1969 c.601 §23]

390.730 [Formerly 274.090; 1969 c.601 §18; renumbered 390.668]

390.735 [1969 c.601 §25; repealed by 1973 c.642 §13]

390.740 [Formerly 274.100; renumbered 390.665]

390.750 [Formerly 274.110; 1969 c.601 §19; renumbered 390.685]

STATE OF OREGON - PERMIT APPLICATION

REMOVAL OF SAND, ROCK, MINERALS, MARINE GROWTH OR OTHER NATURAL PRODUCTS OF THE OCEAN SHORE
Department of Transportation (DOT)

1. ______________________________
Name & Mailing Address of Applicant

2. Location of Material: Section______Township______Range______W.M.______Aerial Map Reference____________

3. ______________________________
Description and Amount of Material to be removed

4. Purpose of Removal______________________________

Any permit application for the removal of sand or rock to be used for construction purposes must be accompanied by a letter from the appropriate unit of local city or county government requesting that a permit be granted and certifying that:

(a) The sand or rock is essential to meet the reasonable needs for essential construction uses in the area;
(b) The sand or rock for such construction is not otherwise obtainable at reasonable cost; and
(c) The removal of the sand or rock will not materially alter the physical characteristics of the area or adjacent area, nor lead to such subsequent changes in subsequent seasons.

5. Method of removal and equipment involved:______________________________

____

6. Location of the removal site must be plainly delineated on the ground for inspection. Please give name, address, and telephone number of the person who is to be contacted to give assistance.

Name______________________Address______________________Phone______________

7. Month______________Year______________; Month______________Year______________
Estimated date of the starting and completion of project.

8. The following items are to be included with the permit application:
   A. Copy of deeds or other documents showing ownership and legal description or easement, license or other written authorization from owner(s) of lands from which the material is to be removed.
   B. Plot plan showing detailed location of proposed removal site in relation to property boundaries and beach zone line.

Note: Data on beach zone line available in the County Courthouse or from the Region Parks Office. This application will be reviewed for consistency with the Statewide Planning Goals and/or acknowledged local comprehensive plan and also against the Beach Improvement Standards and comments received from DOT notification review.

9. ______________________________
Signature of Applicant Date

FOR OFFICE USE

Application Received______________By:______________________________
Regional Park Supervisor

Comments:

APPENDIX C

Cooperative Regional
Planning Processes
developed by the
National Parks Service

"COOPERATIVE REGIONAL PLANNING

"The plans of outside agencies and interests affect and are affected by proposed actions within units of the National Park System. Cooperative planning, therefore, is needed to integrate the park into its regional environment and to ensure that potential conflicts between interdependent actions are minimized or eliminated.

"Joint agency planning may be undertaken when a park is adjoined by Indian reservations, other Federal lands, State lands, or lands subject to State, regional or local planning or regulation. Formal written agreements to establish joint planning efforts with planning agencies and other governmental agencies shall be negotiated where appropriate.

"Cooperative planning on specific proposals will be done to ensure that various points of view are considered in formulating proposals and that potential sources of conflict are discovered and, if possible, resolved. Cooperative planning normally will be accomplished utilizing periodic informal workshops in which park planners and representatives of affected interests can frankly discuss matters of mutual concern.

"SHORELINE PROCESSES

"In natural zones, shoreline processes--erosion, deposition, dune formation, inlet formation, etc.--will be allowed to take place naturally, except where control measures, required by law or Service commitment, are necessary to protect life and property in neighboring areas.

"In historic zones, control measures, if necessary, will be predicated on thorough studies taking into account the nature and velocity of the shoreline processes, the threat to the cultural resource, the significance of the cultural resources, and alternatives, including costs, for protecting the cultural resource. Such studies must also determine if and how control measures would impair resources and processes in natural zones, in order that management may make an informed decision on the course of action to be followed.

"In development zones, management should plan to phase out, systematically relocate, or provide alternative developments to facilities located in hazardous areas that cannot be reasonably protected. New developments will not be placed in areas subject to flood or wave erosion or active shoreline processes unless it can be demonstrated that they are essential to meet the park's purpose, that no alternative locations are available, and that the development will be reasonably assured of surviving during its planned lifespan without the need of shoreline control measures. Before development in such areas is provided the requirement of Executive Order 11968, 'Floodplain Management' must be fulfilled.

"Where erosion control is required by law, or where present developments must be protected to achieve park management objectives, the Service will employ the most natural appearing and effective method feasible.

"Most shoreline areas of the National Park System are part of larger physiographic systems, and the processes of these larger systems directly affect the management of those NPS areas contained therein. Therefore, the Service shall seek to obtain the assistance of appropriate Federal, State and local agencies in carrying out the management objectives of NPS shoreline areas.

"The Service will cooperate with State and other Federal entities to develop strategies for maintaining existing transportation and utility links on barrier islands in the event of storm damage or inlet formation.

"Where these links are interrupted by inlet formation, the Service will recommend, within the limits of practicality, reestablishment in a manner that allows the unimpeded operation of inlet formation and closures.

"Where navigation channels are established in NPS waters, the Service will work with the responsible agency to see that necessary dredging is carefully controlled and that dredged material is disposed of in such a manner as to have the least adverse impact on the aquatic ecosystem and to optimize the value of spoil deposit as wildlife habitat."

U. S. National Park Service, 1978
pp. II-5, IV-22, and IV-23

Oregon's Coastal Beaches & Dunes:

Uses, Impacts

&

Management Considerations

Oregon Coastal Zone Management Association, Inc.

This report was prepared as part of a larger document addressing various beach and dune planning and management considerations and techniques. Other segments of the document and additional materials are:

I. BACKGROUND ON BEACH AND DUNE PLANNING:

Background of the Study

An Introduction to Beach and Dune Physical and Biological Processes

Beach and Dune Planning and Management on the Oregon Coast: A Summary of the State-of-the-Arts

II. BEACH AND DUNE IDENTIFICATION:

A System of Classifying and Identifying Oregon's Coastal Beaches and Dunes

III. PHYSICAL AND BIOLOGICAL CONSIDERATIONS:

Physical Processes and Geologic Hazards on the Oregon Coast

Critical Species and Habitats of Oregon's Coastal Beaches and Dunes

IV. MANAGEMENT CONSIDERATIONS:

Dune Groundwater Planning and Management Considerations for the Oregon Coast

Off-road Vehicle Planning and Management on the Oregon Coast

Sand Removal Planning and Management Considerations for the Oregon Coast

Oregon's Coastal Beaches and Dunes: Uses, Impacts and Management Considerations

Dune Stabilization and Restoration: Methods and Criteria

V. IMPLEMENTATION TECHNIQUES:

Beach and Dune Implementation Techniques: Findings-of-Fact

Beach and Dune Implementation Techniques: Site Investigation Reports

*Beach and Dune Implementation Techniques: Model Ordinances**

VI. ANNOTATED BIBLIOGRAPHY:

Beach and Dune Planning and Management: An Annotated Bibliography

VII. EDUCATIONAL MATERIALS:

Slide show: *Managing Oregon's Beaches and Dunes*

Brochure: *Planning and Managing Oregon's Coastal Beaches and Dunes*

*Prepared under separate contract between Oregon Department of Land Conservation and Development and the Bureau of Governmental Research, Eugene.

Cover design by Jay Rasmussen, Toledo, Oregon.

OREGON'S COASTAL BEACHES AND DUNES:

IMPACTS, USES AND MANAGEMENT CONSIDERATIONS

by

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and

Christianna Stachelrodt Crook, Research Associate

OCZMA Beaches and Dunes Study Team

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May, 1979

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PREFACE

The following report presents the results of an in-depth analysis of appropriate uses and potential impact of activities within beach and dune areas as conducted by the Oregon Coastal Zone Management Association, Inc. This report constitutes one element of an overall analysis of planning for, and managing, coastal beaches and dunes as required by Oregon's Beaches and Dunes Goal.

This report was prepared by Carl A. Lindberg, OCZMA Beaches and Dunes Study Team Project Director and Christianna Crook, OCZMA Beaches and Dunes Study Team Research Associate, with assistance from other Study Team members composed of Wilbur Ternyik, Project Coordinator, Arlys Bernard, Project Secretary, and Kathy Fitzpatrick, Project Administrator.

In addition, valuable review and comments were made by the Beaches and Dunes Steering Committee composed of:

R. A. Corthell, U.S. Soil Conservation Service
Steve Stevens, U.S. Army Corps of Engineers
Sam Allison, Oregon Department of Water Resources
Peter Bond and John Phillips, Oregon Department of Transportation, Parks and Recreation Division
Bob Cortright, Oregon Department of Land Conservation and Development
Jim Lauman, Oregon Department of Fish and Wildlife
Jim Stembridge, Oregon Department of Soil and Water Conservation Commission
Steve Felkins, Port of Coos Bay
Rainmar Bartl, Clatsop-Tillamook Intergovernmental Council
Gary Darnielle, Lane Council of Governments
Kathleen Mecone, Coos-Curry Council of Governments
Marilyn Adkins, City of Florence Planning Department
Phil Bredesen, Lane County Planning Department
Steve Goeckritz, Tillamook County Planning Department
Oscar Granger, Lincoln County Planning Department
Curt Schneider, Clatsop County Planning Department

Additionally, OCZMA extends special appreciation to Marilyn Adkins, City of Florence Planning Department, for her timely and detailed review of this product.

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I. INTRODUCTION

The determination of appropriate uses is the final planning procedure identified within the Oregon Beaches and Dunes Goal. After completing inventories of existing beach and dune types and characteristics, coastal jurisdictions are then directed to:

> "establish policies and uses for these [beach and dune] areas consistent with the provisions of this goal." (LCDC, 1977)

Furthermore:

> "Uses shall be based on the capabilities and limitations of beach and dune areas to sustain different levels of use or development, and the need to protect areas of critical environmental concern, areas having scenic, scientific, or biological importance, and significant wildlife habitat." (Ibid)

The purpose of this report is to provide extracts of information from a wide range of sources that focus both on the impact of uses in beaches and dunes and on considerations for designing such uses so as to minimize negative impacts on the beach and dune systems. However, it is important to note that when planning for beach and dune areas, attention must be given to Oregon's eighteen other statewide planning goals prior to making the ultimate determination of appropriate land uses for land parcels. In other words, after a beach and dune area is determined to be urban or rural (Goal #14-Urbanization) planned for general land use categories (Goal #3-Agricultural Lands, Goal #4-Forest Lands, Goal #5-Open Spaces, Scenic and Historic Areas, and Natural Resources, Goal #8-Recreational Needs, Goal #9-Economy of the State, Goal #10-Housing, and Goal #17-Coastal Shorelands), then other considerations (Goal #6-Air, Water and Land Resources Quality, Goal #7-Areas Subject to Natural Disasters and Hazards, Goal #11-Public Facilities and Services, Goal #12-Transportation, Goal #13-Energy Conservation, Goal #16-Estuarine Resources, and Goal #18-Beaches and Dunes) are applied to determine the necessary or appropriate levels of uses and supporting services.

Rather than portray uses which are generally appropriate for various beach and dune formations utilizing a matrix, it was felt to be more valuable to present the rationale for why various uses and activities are, or are not, appropriate for beach and dune areas. Matrices have been prepared in the past, however, to assist with appropriate location of activities within Oregon's coastal beaches and dunes, and are included in Appendix A preceded by a conversion table which correlates the various dune classification systems developed to date. Additionally the USDA Soil Conservation Service soil interpretations for active dune land, stabilized dunes and older stabilized dunes is included in Appendix B. Actual implementation of various dune designations and associated permissible activities may be enunciated within the local comprehensive plan policies, be addressed within implementing ordinances, and/or be reviewed on an individual basis utilizing site investigation report requirements.

II. MAJOR USE OR ACTIVITY

A. Agriculture and Forestry

Agriculture and forestry practices can have direct impact(s) on sand stabilizing vegetation as well as on the quality of surface and groundwater in beach and dune areas.

Considerations:

1. Forestry

1. All logging activities should be performed in such a manner as to protect sand stabilizing vegetation (Clark, 1977, p. 377).
2. Buffer strips of natural vegetation should be required along coastal beach and dune systems and water bodies (Clark, p. 377).
3. Slash burning should not be allowed in active or surface stabilized dune areas due to the possibilities of vegetation destruction and subsequent sand activation (Ternyik, 1978).

2. Agriculture

1. Farm operations should be monitored to protect beach and dune vegetation and groundwater from damage by fertilizers, biocides, erosion, altered runoff and sedimentation (Clark, pp. 291-296).
2. The grazing of domestic animals on foredunes should be prohibited to minimize damage to stabilizing vegetation.

B. Residential Development

The demand for shorefront residential property is constantly increasing. The residential land buyer seeks only a small parcel for which many are willing to pay dearly. In the past, residential subdivisions have been approved with little regard for natural beach and dune processes. As these developments begin to fill in, and as developmental pressures increase, the impact on beaches and dunes accelerates producing potentially deliterious results (Olsen and Grant, 1972, p. 39).

Considerations:

1. Residential development should be prohibited from locating in foredunes because they are subject to wave overtopping and/or undercutting.
2. Residential development should be discouraged from locating in deflation plains because (1) they are commonly subject to flooding, and (2) they have naturally high water tables.
3. Residential density should be based on the carrying capacity of the site and adjoining area, and should take into consideration the aesthetic qualities of the site. The carrying capacity would be a function of the physical and biological characteristics of the landform as addressed in a site investigation report or as identified during the inventory process.
4. Residential development should ensure access to beach areas. Public rights-of-way should be designed at frequent intervals and should be posted (Clark, p. 270; Olsen and Grant, p. 39).
5. Residential development proposed for flood prone areas must comply with the federal flood insurance program if the jurisdiction is a participating entity. Non-participating jurisdictions should have authority to regulate housing within flood prone areas to minimize structural damage and water pollution problems.
6. In areas of known geologic hazard, special constraints such as set-backs, etc., should be developed to minimize unnecessary protection programs. Where beachfront protection measures cannot be avoided, beach protection programs for existing waterfront development should be incorporated into a comprehensive, coordinated plan and not left up to individual waterfront residents (Battelle, 1971, p. I-35; Clark, p. 477).
7. Because the Oregon Department of Transportation, Parks and Recreation Branch, has jurisdiction over beachfront protection only in areas west of the beach zone, local jurisdictions may wish to enact provisions giving them authority to regulate beachfront protection structures outside DOT's purvue. Additionally, jurisdictions should coordinate closely with DOT on permit issuance for beachfront protection structures to ensure compatibility with adjacent areas.
8. Jurisdictions should consider designating areas for cluster developments designed so as to maximize open space in sensitive beach and dune areas (Battelle, p. I-34 and I-36).

C. Commercial Development

Commercial development along the Oregon coast provides general retail/wholesale services to developed areas and often is associated with tourist-related development. Such development can become a problem when it reaches concentrations that preclude other necessary and desired uses that seek or require an oceanfront location within a beach and dune area or when it is located in hazardous areas (Olsen and Grant, p. 40).

Considerations:

1. Commercial uses of beach and dune areas which do not require or are not substantially enhanced by an oceanfront location should be discouraged (Olsen and Grant, p. 40).
2. Land use controls should place limitations and standards on oceanfront commercial development consistent with the Shorelands Goal.
3. Commercial development should be prohibited from locating in foredunes because they are subject to wave overtopping and/or undercutting.
4. Commercial development should be discouraged from locating in deflation plains because (1) they are commonly subject to flooding, and (2) they have naturally high water tables.
5. Attention should be given to the various impacts of locating commercial development within dune areas. Such impacts include: aesthetic, pedestrian, parking lots and roads, etc. Additionally, plans should address dune stabilization and maintenance.

D. Industrial Development

For the most part, industrial development along the Oregon coast is related to agriculture, fisheries and timber. Most of these industries are located in conjunction with operating ports and transform raw materials into semi-finished materials.

Considerations:

1. Water-dependent industry should be located within or adjacent to areas presently occupied and committed to industrial use wherever possible (Clark, p. 392). Such areas should include room for expansion of industrial facilities.
2. A site investigation report should address potential impact(s) in ecologically sensitive areas. Likewise, the site investigation report should consider possible impact(s) on dune landforms such as (1) reactivation, (2) pollution of groundwater from chemical and industrial effluent (sand is a poor filtering agent for such compounds), and (3) groundwater withdrawal if appropriate. Additionally, development plans should address dune stabilization and maintenance.

E. Recreational Activities

Recreation is a necessary and valuable use of the beach and dune areas of the Oregon coast. Recreational pressures on the coast have doubled in the last decade; tourism has become the number three industry in the State. The State's coastal park and wayside day user count for 1978 exceeded twelve million people. The coastal jurisdictions containing these recreational attractions face continuing demands on the limited natural resources.

Considerations:

1. Recreational use in surface stable, conditionally stable or active prone dunes should be limited if it is the desire to maintain stable landforms. Access to beaches and dunes which traverse sensitive areas should be provided via raised boardwalks. Paved trails and parking lots are not suitable for unconsolidated sand areas as they are susceptible to inundation and undermining due to deposition and erosion activities. Access areas should be posted with explanations describing the importance of limited access routes.
2. Jurisdictions may wish to consider regulation of driftwood fires adjacent to beach grass areas to avoid destruction of beach grass resulting in reactivation of unconsolidated sands and possible erosion of sand in areas of human habitation.
3. Federal, state and local jurisdictions should cooperate to develop efficient traffic flow patterns, parking arrangements and policing requirements for areas on and adjacent to beach and dune areas, especially parks and access areas (Olsen and Grant, p. 40). This is especially important in areas of off-road vehicle use.
4. Multiple use of an area by clustered compatible recreational facilities should be encouraged to permit joint use of ancillary facilities and provide a wide range of recreational choice among users. Such clusters should not overload the carrying capacity of the area (Battelle, p. I-3).

F. Sand and Driftwood Removal

Indiscriminate removal of sand (for mining or mineral extraction) or driftwood from the beach and dune area can disrupt the natural system and initiate or accelerate erosion. Removal of driftwood diminishes the amount available for incorporation in, and frontal protection of, the foredune resulting in increased vulnerability of the foredune to erosion.

Considerations:

1. Tourists and residents should be informed of the protective qualities of driftwood in foredune stabilization. This could be accomplished through the posting of information signs (Phipps and Smith, 1977, p. 44). Additionally, citizens and jurisdictions should be aware of the Oregon Department of Transportation's Beach Log Removal Policy (Appendix C) which regulates removal of driftwood for commercial endeavors. Through the state's coordination program between local governments and state agencies as required by the Land Conservation and Development Commission, jurisdictions should participate as appropriate in reviewing such permit requests.
2. When sand removal activities are proposed, the accompanying site investigation report should address the following potential impacts (Lindberg, 1979):

a. sand flow patterns
b. sand formed lakes
c. groundwater supplies
d. aesthetics
e. wildlife habitats
f. adjacent property and associated structures.

3. Development plans should address site reclamation, dune stabilization, and maintenance. While the Department of Transportation, Division of State Lands and Department of Geology and Mineral Industries all bear some responsibility for sand removal activities, their mandates are limited. Therefore, jurisdictions may be well-advised to develop techniques allowing them the opportunity to regulate sand removal activites falling outside the scope of legislative mandate. Further, jurisdictions should consider coordination with the appropriate state agencies in the review of sand removal activities affecting their locale.
4. Jurisdictions should endeavor to ensure the safety of residents and workers in areas of sand removal by requiring the maintenance of moderate slope within excavation sites.

G. Fish and Wildlife

There are many areas of significant wildlife habitat in beach and dune areas. Although the stabilized dune forests contain the greatest species diversity, deflation plains and wet interdune areas provide unique habitat values (Burley, 1978; Pinto, et al., 1972).

Considerations:

1. The beach and dune nesting and breeding habitats should be protected during identified breeding and nesting seasons by temporary restriction of access wherever possible (Clark, p. 34; The Conservation Foundation, 1977, p. 111). (For example, pedestrian and vehicular traffic should be limited during the nesting season of the snowy plover [April - June] in appropriate beach areas.)
2. Site investigation reports should be required for developments proposed near identified critical habitats to assist in evaluating development impact and in modifying design criteria as appropriate.
3. Attention should be given to the enhancement and/or restoration of fish and wildlife habitats, particularly with regard to deflation plain areas (e.g., seeding to provide improved food and habitat for migrating and resident waterfowl).

III. ACCESSORY USES OR ACTIVITIES

A. Transportation

Transportation includes roadways (vehicular and rail), pedestrian and equestrian paths and accesses. Such traffic can disrupt the dune vegetation resulting in activation of unconsolidated sands and erosion. Additional problems associated with transportation include trespass, litter and vandalism.

Considerations:

1. In areas of unconsolidated sand, foot traffic should be serviced by wood walkways, preferably elevated (Clark, p. 270; Koppelman, 1978, p. 98). Vehicular traffic should be serviced by wood or paved roads and protected by vegetation (Clark, p. 270).
2. The use of common access pathways over dune areas by shorefront property owners should be encouraged.
3. Control the number of vehicle access points to beach areas and select access points which can maintain the natural form and profile of the beach and dune so impacted (Ruef, 1975, pp. 20-21).
4. Identify existing public access points to the beach and post these routes with explanations as to why such paths are necessary (Olsen and Grant, p. 29).
5. Provide adequte parking, disposal and sanitary facilities at heavily used access points (Olsen and Grant, p. 29).
6. Establish clear responsibility for beach litter removal and vandalism repair (Office of Coastal Zone Management, NOAA, and Department of Natural Resources, Commonwealth of Puerto Rico, 1978, pp. 88-89). Provide litter and vandalism reduction methods including (Office of Coastal Zone Management, NOAA, and Department of Natural Resources, Commonwealth of Puerto Rico, pp. 88-89; Olsen and Grant, p. 29):
    a. persuasion: there should be a continuing public education campaign.
    b. assistance: trash containers should be placed at beach access points, convenient to the public; arrangements for emptying should be made.
    c. enforcement: anti-litter and anti-vandalism laws should be enacted and strictly enforced by cooperation between appropriate local, state and federal agencies.
7. Roadways should not impinge on floodplain areas except under strict environmental constraints, such as elevated causeways to allow for movement of flood waters.
8. Roadway design should not require inordinate amounts of landfill. The natural water flow should be maintained through the use of culverts and bridges.
9. Roadways should be planned and located so as to avoid encroachment by dunes.

B. Beachfront Protection and Management

It is a natural process for sand to erode from dune and sea cliff areas. Such erosion acts to replenish beaches which are the first line of defense from storm wave attack. Consequently, protecting dunes and cliffs from erosion in one area will necessarily result in beach starvation and associated erosion problems in another. The problems and impacts of beachfront protection strategies are well explained in the Oregon Soil and Water Conservation Commission's two volume work, "Oregon Coastal Management Program: Shoreline Erosion Management Policies and Procedures," (1978). Additional information on beachfront protective devices and their impacts can be obtained from the Oregon Department of Transportation and the U.S. Army Corps of Engineers, both of which maintain regulatory authority for placement and design of such activities under certain conditions (Appendix D).

Considerations:

1. Federal, state and local agencies with shoreline construction permit and review powers should consider removal or modification of protective structures when such structures are not performing their intended functions (Koppelman, p. 103).
2. Design coastal erosion protection plans so as to allow, to the maximum extent possible, the continuation of natural geomorphic processes responsible for the maintenance of coastal landforms. It should be recognized, however, that such plans for culturally manipulated and developed shorelines may result in an adjustment of the natural processes (Koppelman, p. 96). Such coastal erosion protection plans should be developed on the basis of shoreline type, use and extent of cultural development.
3. Emphasis should be directed toward non-structural solutions to erosion control problems; structural solutions should be advanced only as supplements to a non-structural program and where there is no other alternative (Clark, p. 322; Koppelman, p. 97).
4. Jurisdictions may want to enact provisions giving them review authority for beachfront protection activities outside the purvue of the Oregon Department of Transportation and/or the U.S. Army Corps of Engineers. In some instances, jurisdictions may want to adopt certain minimum standards for beachfront protection, similar to those of ODOT and the Corps, or may wish to require certification of protection activities from a registered engineer at the developer's expense.

C. Groundwater, Sewage Disposal and Other Utilities

For the most part, human development activities require a range of support activities generally labelled as utilities. These utilities include such services as public water and sewer, telephone, electricity, natural gas and cable television. In some areas, water and/or sewage disposal is handled on site.

The placement of utility lines either above or under ground can accelerate erosion at the site if stabilizing vegetation is not properly replaced. Furthermore, temporary stabilization practices should be used during construction. Buried lines are vulnerable to wind or wave excavation at any time in the future should stabilizing vegetation be destroyed or not maintained. Other development problems, such as flooding, flotation and failure of subsurface structures, can be encountered in areas of high water tables (Crook, 1979). Some quicksand areas occasionally occur in high water table areas resulting from subsurface hydrostatic pressure and the precipitation of sand into ponded sites. The construction of underground utility lines parallel to the beach may harrass or eliminate wildlife species and habitats. Construction activites in general can harrass snowy plover if conducted during periods of nesting (April - June). Harrassment of deflation plain wildlife will also result from construction adjacent to foredunes, within the deflation plain, or in adjacent hummock dune areas. Finally, utility lines located above ground are not compatible with the natural landscape and can be detrimental to the enjoyment of the scenic values characteristic of beach and dune areas.

On site water and sewage disposal require additional consideration. High density development dependent on local wells could deplete the groundwater table and damage or kill surface stabilizing vegetation; saltwater intrusion may destroy stabilizing vegetation as well as contaminate the water supply (Ruef, p. 19). Domestic wastes in sufficient volumes can lead to eutrophication of dune lakes and marshes and may contaminate the limited groundwater supply including wells. Dune sand manifests some serious limitations as a medium for septic tank drainfields. While bacteria are adequately filtered by sand, viruses, non-natural chemical compounds, and nitrate nitrogens may not be adequately dealt with. Subsurface facilities should avoid areas of high water table. Flooding, flotation, uneven settlement, and rupture of structures is likely to occur. Further, the potential for septic tank failure is extremely high at such sites.

Considerations:

1. Utilities
   a. All utilities should be located under ground wherever possible.
   b. Utility easements should be permitted and timed to coordinate with site preparation and construction.
   c. Areas of quicksand and high groundwater tables should be avoided.

2. Water Supplies
   a. Piped water should be provided whenever possible (Clark, p. 268).
   b. When permitting private wells, the water table level necessary to sustain the stabilizing vegetation and prevent saltwater intrusion should be determined and water withdrawals limited accordingly. Controls on groundwater withdrawal should be addressed in a comprehensive water management program where appropriate (Battelle, p. I-16; Brower, et al., 1976, p. 37; Beaulieu & Hughes, 1975, p. 58; Clark, pp. 269 & 384; Ruef, p. 21; Schlicker, et al., 1974, p. 87).
3. Sewage Disposal
   a. A municipal sewer service should be used whenever possible.
   b. Sewer lines should not be located so as to be vulnerable to storm wave action.
   c. Residential density should be contolled when sewer service is not provided (Clark, p. 269).
   d. Septic tank systems should be located and maintained so as to avoid water pollution (Ruef, p. 21; Clark, p. 502).
   e. Septic tank systems should be installed only when the highest annual groundwater level is at least six feet below the absorption field. (Refer to Oregon Department of Environmental Quality subsurface sewage disposal systems for further information.)

D. Site Preparation and Construction

Man-made changes to a site are considered under this broad topical category to be one of three activities:

(1) Activities related to studying, analyzing and siting the development prior to development. Such activities include exploration, investigation, surveying and site planning. For the most part these activities are accomplished on foot with a minimum impact on the site.

(2) Activities relating to preparing the site for development such as clearing, grading, excavating and filling. These activities can affect the entire site and beyond, and generally are accomplished with the use of heavy, earth moving machinery.

(3) Activities relating to the actual construction that most developments have in common, such as stock piling of construction materials, traffic of construction personnel and equipment, and the construction of foundation and vehicle access and parking.

The construction of any development typically requires that the natural setting be modified in preparing the site. When preparing a site on a sand landform the actions involved often destroy the stabilizing vegetative cover exposing the underlying sand to the forces of erosion.

This erosion weakens the structure of the sand landform and decreases its value as a sand reservoir and buffer (Olsen and Grant, p. 31). Examples of specific actions and impacts are:

(1) The lowering of foredune increases the washover potential, salt spray kill-off and wind erosion;
(2) The disruption of dune vegetation can result in destabilization and blow-outs.
(3) The construction on certain foundations in this windblown environment may cause erosion/accretion activities similar to those of jetties by having sand accumulate on the lee side and eroded on the windward side. Certain alignment of structures may also alter wind flows causing similar erosion/accretion activities in the immediate vicinity.

The exact design of a development should be consistent with the features and limitations of a particular site. Additional information on elevated residential structures is available in "Elevated Residential Structures," (U.S.D.H.U.D., Federal Insurance Administration, 1977).

Considerations:

1. The potential impacts of erosion and accretion should be considered within the framework of the site plan (Koppelman, p. 105).
2. Developers should be required to obtain the advice of a qualified sand expert concerning minimizing the impact of the proposed development by the use of erosion control measures, such as stabilization and improved site designs (Koppelman, p. 71).
3. Schedule construction phases to avoid critical periods of hazard (storm season), important biological activity (snowy plover nesting season) and other impacts (excavation during planting season) (Clark, p. 268; Ruef, p. 20; Ternyik, 1978).
4. Restrict construction to areas inland of the foredune; where construction is permitted or exists in the foredune area, require planting and concomitant maintenance of open sand areas (Clark, p. 268; Schlicker, et al., 1973, p. 132; Ternyik, 1978).
5. Provide technical assistance and convenient information on sources of beach grass and other stabilizing measures to property owners (Clark, p. 268; Olsen and Grant, p. 31; Ternyik, 1978).
6. Require additional stabilization around existing and proposed development when needed to avoid hazard (Clark, p. 268; Olsen and Grant, p. 31).
7. Encourage secondary plantings in areas where beach grass has been used for initial stabilization to reduce fire hazards and subsequent erosion potential.
8. Review the cumulative impact of the linear arrangement of structures along the shoreline. Such alignments could lead to large scale variations in the local dynamics of ground level airflow that could likely have negative erosive effects on adjacent areas (Ruef, p. 20).

9. Exercise strict controls on erosion during site preparation and construction (Clark, p. 534). Buffer strips of natural vegetation and artificial temporary stabilization retention systems should be used to control erosion (Clark, p. 535). Ground surfaces should be stabilized immediately after any action that destroys or removes the vegetative cover and leaves the underlying unconsolidated sands exposed to erosion (Clark, p. 537; Ruef, p. 20).
10. Buildings should be built on inactive dunes, and then only if sand movement patterns and vegetation are not seriously affected. Disturbance to the surface should be minimized and stabilizing vegetation should be established and maintained (The Conservation Foundation, pp. 95 and 109).
11. The filling or draining of wetland areas in deflation plains should be restricted due to loss of wildlife habitat, water problems, and associated construction problems. If deflation plains are drained, it is likely that wetland vegetation will no longer be able to survive, and erosion potential will be increased due to wind scouring of the area.
12. Restrict development on beaches, foredunes and deflation plains. Establish building setbacks based on topographic, geologic, and meteorologic characteristics. Setbacks should be entirely landward of the shifting foredunes. They should also be far enough inland to allow for the recession of the shoreline. Development in areas of eroding shorelines should be set back to allow for safe occupancy of the structure during its estimated life. Setback requirements should not be relaxed without a favorable site investigation report in those instances where new structures are proposed at sites along a partially developed shoreline. Existing structures located seaward of the setback line should be designated as non-conforming and criteria and regulations should be developed to limit reconstruction, and/or expansion when the structure is damaged or destroyed.
13. The adverse impacts of sand erosion and accretion can be minimized by restricting developments and topographical alterations in areas of high wave and wind energy. Site investigation reports in beach and dune areas should include consideration of:

    (1) the potential for wind and wave erosion and deposition;
    (2) foundation specifications; and,
    (3) sewage disposal.

    Prospective developers and buyers should be informed of the hazard potential; a disclosure of all known hazards and likelihood of obtaining building permits should be made available to all potential purchasers of land within foredune and deflation plain areas (Beaulieu, and Hughes, 1975, p. 109; Koppelman, p. 98; Olsen and Grant, p. 31; Schlicker, et al., 1972, pp. 128-130; Schlicker, et al., 1973, p. 132; Schlicker, et al, 1974, p. 53).

14. In areas of older dunes containing iron or clay banding and/or buried soils, ponding, high water table, septic tank failures, and slumping are common problems which must be addressed and dealt with.

E. Stabilization and Restoration

Restoration and stabilization programs may be desired to:

(1) stabilize a site prior to, during, or following construction;
(2) to repair storm damage in foredune and deflation plain areas;
(3) to enhance and maintain an area undergoing constant impact such as a park or an area that was developed some time ago without regard for the need to maintain control over moving sands.

Considerations:

1. Stabilization activities within active sand areas to accommodate construction should always be encouraged if the construction activity is within the limitations of the local comprehensive plan. However, it should be noted that attempts to build dunes to unnatural heights or in unnatural configurations can be counter-productive as such features may interfere with, rather than facilitate, natural processes (The Conservation Foundation, p. 97).
2. Stabilization should be performed within accepted planting seasons, utilizing accepted planting procedures and followed by an accepted maintenance schedule (Ternyik, 1979). Again, the adequacy of stabilization proposals should be evaluated within the site investigation report.

F. Aesthetics and Design

The greatest attraction of the beach and dune areas is its natural scenic beauty. Therefore a real concern is the impacts of developments on this basic attraction (Ruef, p. 21). "High-rise buildings built adjacent to a beach were found to be physchologically dominating thus detracting from the beach's appeal as a natural recreation site. A subjective element to determine when buildings dominate beaches by their height was found. Because of an individual's normal cone of vision, a building set back 2.5 times its height would not appear to confine or dominate the beach." (Office of Coastal Zone Management, NOAA, and Department of Natural Resources, Commonwealth of Puerto Rico, 1978, p. 83).

Considerations:

1. Setback: The greater the setback for development from beach and dune features (beach, foredune, bluff crest, etc.) the less is the likelihood of adverse aesthetic impact upon all shore users.
2. Height: Generally, the higher the structure (especially ones of rigid geometry), the more prominent and obtrusive it will appear. The most compatible structures would be those of one to two stories in height depending on topography.
3. Spacing: The more uneven and irregular the spacing of dwellings along the shoreline, the greater the degree of harmony with the natural setting. The clustering of dwellings surrounded by open natural areas is suggested.
4. Roof types: Roofs having ridges and slopes best mirror and harmonize with the undulating topography of the coast.
5. Exterior materials and colors: Depending on site conditions and the urban/rural context, exteriors and colors keeping with those associated with or found naturally along the coast are preferable.
6. Site landscape: Natural or re-constructed (following excavation, construction, etc.) dunes can effectively mask low and medium profile structures as well as enhance the natural setting. Site layout of buildings within given property boundaries may be varied to permit the preservation of fragile beach and dune features. Site conditions should be carefully studied to determine optimum plan alternatives. Shore vegetation should be retained for aesthetic, as well as ecological values, and for landform stability (Battelle, pp. I-17 and I-48 to I-53).

G. Off-road Vehicles

All recreational uses of the beach and dune areas can have impacts, but off-road vehicle (ORV) users have a far greater impact than their pedestrian counterparts. The ORV impacts are greater because:

(1) ORVs are of greater weight and power,
(2) the area of impact is multiplied due to the speed and range of the ORV, and
(3) the noise of the ORV's engine expands the real and perceived impact beyond the range of its physical presence.

ORV's have been observed to have the following impacts on beach and dune landforms and ecosystems:

(1) Alteration of the topography of affected dunes by increasing the down slope sand transport.

(2) Loss of stabilizing vegetation due to ORV activity, which in turn leads to increased wind erosion and sand migration. Few vehicle passes are required to begin destroying beach grasses and other plant species. Once removed, other ORV users feel the open area is a "legitimate" trail, and vegetation removal progresses. The loss of stabilizing vegetation is especially critical on the foredune because such activities can leave the foredune susceptible to winter storm wind and wave damage and erosion.

(3) During dry periods on the dunes the fire hazard in beach grass areas is extremely high and the added risk of fires from ORV emission sparks constitutes a likely ignition source (Ternyik, 1978).

(4) Excessive stress may be placed on local wildlife, livestock and residential inhabitants by unruly ORV use (Burley, 1978; Fowler, 1978, pp. 20-22).

Generally speaking, ORV traffic has the least environmental impact when it is restricted to the summer berm and intertidal zone of the beach or to existing open sand areas. ORV traffic also creates problems when it becomes so intense as to interfere with other users. ORV use can be used as a management tool where a stabilized area is planned for re-activation, or active sand landforms are the management objective. The use of ORVs can be a relatively inexpensive and harmless way of removing vegetation, and will negate the need for herbicides and/or other costly mechanical means (Olsen and Grant, p. 28).

Considerations:

1. Work with the ORV recreationalist to select ORV sites and management programs (Fowler, p. 71).
2. The access corridors to ORV areas should be controllable. The capacity to control access is important to:

   (1) limit the density of the users to the carrying capacity of the site for reasons of safety, public health, resource damage, and law enforcement;
   (2) obtain accurate user counts; and,
   (3) facilitate distribution of important information for users (Fowler, pp. 22-27; Koppelman, p. 107; Olsen and Grant, p. 28; Phipps and Smith, p. 42).

3. ORV areas should be chosen with the ability to be delineated by natural or man-made boundaries that are easily recognized and controlled (Fowler, pp. 22-27).
4. ORV activities adjacent to estuaries should be carefully montiored and controlled because such activities can result in deposition of sand into estuaries, and can conflict with habitat values (noise and harrassment). Additionally, ORV activity within estuarine areas should be consistent with the Estuarine Resources Goal and the LCDC Estuarine Classification system.

5. ORV areas, trails and beach access routes should be monitored. If a site exhibits harmful deterioration, the trail or access should be relocated and consideration given to relocation of the activity (Fowler, p. 33; Koppelman, p. 108).
6. During periods of extreme high tide, discourage ORV use of beach areas to prevent ORVs from driving up on the foredune resulting in possible reactivation of stabilized foredune areas (Koppelman, p. 108).
7. Identify nesting areas of birds considered as being a critical resource. Traffic near such areas during breeding and nesting seasons should be discouraged. Warning signs could be posted at least 300 feet from the outer perimeters of such areas (Burley, 1978; Fowler, pp. 20-22; Koppelman, pp. 108-109).
8. Consideration should be given to requiring registration of ORVs, or requiring ORV permits for ORV use within beach and dune areas. This should include fees to be used for beach and dune restoration projects, enforcement costs, and an educational program for ORV users as to their responsibilities toward the sensitivities of the beach and dune environment and other beach and dune users (Fowler, p. 72; Olsen and Grant, p. 28).

IV. REFERENCES CITED

Battelle Institute. 1971. Shoreland Management Guidelines to Grays Harbor Regional Planning Commission, Aberdeen, Washington. Battelle Pacific Northwest Laboratories, Richland, Washington. 95 pp.

Beaulieu, John D. and Paul W. Hughes. 1975. Environmental Geology of Western Coos and Douglas Counties, Oregon. Department of Geology and Mineral Industries, Portland, Oregon. 148 pp.

Brower, David, Dick Frankenberg and Francis Parker. 1976. Ecological Determinants of Coastal Area Management, Volume II. Sea Grant Publication UNC-SG-76-05. North Carolina State University, Raleigh, North Carolina. 379 pp.

Burley, Bill. Personal Communication. 1978. The Nature Conservancy, Portland, Oregon.

Clark, John. 1977. Coastal Ecosystem Management: A Technical Manual for the Conservation of Coastal Zone Resources. John Wiley and Sons, Inc. New York, New York. 928 pp.

Crook, Christianna. 1979. "Dune Groundwater Planning and Management Considerations for the Oregon Coast," In: Beaches and Dunes Handbook for the Oregon Coast. Kathy Fitzpatrick, Ed. Oregon Coastal Zone Management Association, Inc., Newport, Oregon. 16 pp.

Fowler, Timms R. 1978. "Off-road Vehicle Planning and Management On The Oregon Coast," In: Beaches and Dunes Handbook for the Oregon Coast. Kathy Fitzpatrick, Ed. Oregon Coastal Zone Management Association, Inc., Newport, Oregon. 117 pp.

Koppelman, Lee E. 1978. "A Coastal Erosion Subplan for Nassau and Suffolk Counties." Nassau-Suffolk Regional Planning Board, Hauppauge, New York. 116 pp.

Lindberg, Carl A. 1979. "Sand Removal Planning and Management Considerations for the Oregon Coast," In: Beaches and Dunes Handbook for the Oregon Coast. Kathy Fitzpatrick, Ed. Oregon Coastal Zone Management Association, Inc., Newport, Oregon. 41 pp.

Office of Coastal Zone Management, NOAA and Department of Natural Resources, Commonwealth of Puerto Rico. 1978. United States Department of Commerce Final Environmental Impact Statement, Coastal Management Program for the Commonwealth of Puerto Rico. Department of Commerce, Washington, D. C. 194 pp. + appendices.

Olsen, Stephen B. and Malcom J. Grant. 1972. Rhode Island's Barrier Beaches: Volume I: A Report on a Management Problem and an Evaluation of Options. Marine Technical Report No. 4. University Of Rhode Island, Kingston, Rhode Island. 118 pp.

Oregon Land Conservation and Development Commission. 1977. "Statewide Planning Goals and Guidelines." Oregon Department of Land Conservation and Development, Salem, Oregon. 24 pp.

Phipps, J. B. and J. M. Smith. 1978. Coastal Accretion and Erosion in Southwest Washington. PV-11. Washington State Department of Ecology, Olympia, Washington. 75 pp.

Pinto, Carlos, Eugene Silovsky, Fed Henley, Larry Rich, Jack Parcell, Don Boyer. 1972. Resource Inventory Report for the Oregon Dunes National Recreation Area, Siuslaw National Forest. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Portland, Oregon. 294 pp.

Ruef, Michael H. 1975. "Coastal Sand Dunes Study: Pacific and Grays Harbour Counties, Washington." State of Washington, Department of Ecology, Olympia, Washington. 31 pp.

Schlicker, Herbert G., Robert J. Deacon, John D. Beaulieu, and Gordon W. Olcott. 1972. Environmental Geology of the Coastal Region of Tillamook and Clatsop Counties, Oregon. Bulletin 74, Oregon Department of Geology and Mineral Industries, Portland, Oregon. 164 pp.

Schlicker, Herbert G., Robert J. Deacon, Gordon W. Olcott, and John D. Beaulieu. 1973. Environmental Geology of Lincoln County, Oregon. Bulletin 81, Oregon Department of Geology and Mineral Industries, Portland, Oregon. 171 pp.

Schlicker, Herbert G. and Robert J. Deacon. 1974. Environmental Geology of Coastal Lane County Oregon. Bulletin 85, Oregon Department of Geology and Mineral Industries, Portland, Oregon. 116 pp.

Ternyik, Wilbur. Personal Communication. 1978. Owner, Wave Beachgrass Nursery, Florence, Oregon.

Ternyik, Wilbur. 1979. "Dune Stabilization and Restoration: Methods and Criteria," In: Beaches and Dunes Handbook for the Oregon Coast. Kathy Fitzpatrick, Ed. Oregon Coastal Zone Management Association, Inc., Newport, Oregon.

The Conservation Foundation. 1977. Physical Management of Coastal Floodplains: Guidelines for Hazards and Ecosystems Management. The Council on Environmental Quality, Washington, D.C. 179 pp.

U.S. Army Corps of Engineers, Portland District. 1974. Coastal Reconnaissance Study - Oregon and Washington. Battelle Pacific Northwest, Richland, Washington. 474 pp.

U.S. Department of Agriculture, Soil Conservation Service and Oregon Coastal Conservation and Development Commission. 1975. Beaches and Dunes of the Oregon Coast. U.S. Department of Agriculture, Soil Conservation Service, Portland, Oregon. 161 pp.

U.S. Department of Housing and Urban Development, Federal Insurance Administration. 1977. Elevated Residential Structures: Reducing Flood Damage Through Building Design: A Guide Manual. U.S. Department of Housing and Urban Development, Washington, D.C. 114 pp.

APPENDIX A

Matrices of Uses For Oregon's
Coastal Beaches and Dunes

BEACH AND DUNE CLASSIFICATION CONVERSION TABLE

Currently there are three major beach and dune classification systems developed for the Oregon coast. The first classification was produced in 1972 by the Pacific Northwest Region of the U.S. Forest Service. This document was a resource inventory of the Oregon Dunes National Recreation Area and included both a system (called mapping units) of thirty eight classifications and a detailed set of management considerations.

The second system, published in March of 1975 by the U.S. Soil Conservation Service for the Oregon Coastal Conservation and Development Commission, contained thirteen classifications along with two matrix tables demonstrating compatibility and tolerance for managing the use of beaches and dunes.

The third classification system is a product of the Beaches and Dunes Study commissioned by the Oregon Land Conservation and Development Commission and conducted by the Oregon Coastal Zone Management Association in 1979. The system was developed to meet the requirements of the Beaches and Dunes Goal (Goal #18) and local planning needs.

In addition to the aforementioned classification systems, the U.S. Army Corps of Engineers developed a matrix for recreational uses on beaches and dunes of the Pacific Northwest in 1974.

In order to assist local decision-makers, planners and citizens in utilizing the management information generated to date, a classification conversion table is presented in Table 1. Following the conversion table are copies of the three matrices developed to date:

Table 1. Beach and Dune Classification Conversion Table

OCZMA System	LCDC Dune Form Goal Designations	NRA Classification Symbols	SCS Classification Symbols
Beach	Beach	Beach	B
Foredune	Active/recently stabilized	FD	FD, FDA
Interdune Forms			
Deflation Plain	Interdune Forms	"D" Series	WDP
Occasionally Wet Interdune	Interdune Forms	"D" Series	W
Vegetated Interior Dunes			
Hummock	Active/recently stabilized	"H" Series	H
Surface Stabilized	Recently stabilized	"DS" Series	DS
Older Stable Dune	Older Stabilized	"DS" Series	ODS
Parallel Ridge	Recently Stabilized	HWS	IFD
Open Sand Interior Dunes			
Transverse-ridge	Active	"T" Series	OS
Oblique-ridge	Active	OA	OS
Recently reactivated:			
Blow Out	Active	--	--
Parabola	Active	PA	OS

Discussion of Mapping Units Which Include Geomorphic Feature, Plant Community, Wildlife, and Visual Resource Descriptions and Interpretations*

A. Introduction

In this section, a description of each mapping unit with its geomorphic features and physical characteristics, associated plant community(ies), wildlife species, and visual resources can be found. Factors important to management of these units of land are also listed. Following this narrative description are photographs of typical sites, and tables of interpretation for each mapping unit. Each table of interpretation lists the different facilities or activities (i.e., road construction, horse cross-country travel, etc.) which might occur on the unit. The major considerations or limitations that the geomorphic feature, plant community, wildlife or visual resource has upon the facility, use, or activity is briefly listed. To aid the planning team, some possible alternatives or treatments are given to overcome these limitations or considerations. These are a guide or sampling of some alternatives which could be considered and are not intended to be absolute or the only alternatives or treatments! Possible negative results from the specific alternatives or treatments are also given where applicable.

Delineations which encompassed similar geomorphic features, (landforms of similar development or erosional processes), plant communities and the related wildlife habitats were made on aerial photographs. In some cases, a mapping unit has an exclusive plant community; in others the mapping unit has two or more plant communities; or in some instances, a specific plant community grows on different mapping units. Wildlife species are more closely related to the plant communities to the geomorphic features. The delineated areas were coded and briefly described as to their physical characteristics. These, then, served as a basis, or point of reference, for all resource data collection and interpretations. Interpretations important to the management and recreational development of the area were based on an understanding of the processes and interrelationship of the sand supply, shoreline and dune topography, climatic regime, permanent and seasonal water table, vegetation, and wildlife.

In the process of making interpretations, a variety of man-caused activities, facilities or uses were observed, cause and effect relationships were established, and the interpretation and/or predictions of man's activities were then made. Three rating systems for each expected activity, facility, or use, such as road construction or campground developments, were then developed through the observations, interpretations and knowledge of each of the specialists involved.

<u>The physical suitability ratings</u> are based on the physical ability of the geomorphic feature and plant community to absorb the impact of a specific activity, use, or facility. <u>The tolerance ratings</u> are based on the ability of the wildlife or visual resource to withstand the impact of a specific facility and/or man's influence.

*From Pinto, et al., 1972.

These ratings range from 1 (most suitable or most tolerant) to 5 (least suitable or least tolerant).

B. Activity, Facility or Use Elements, Column 1:

1. Road Construction: This is a consideration of the effect of a road upon the land. A double-lane width, hard-surfaced road, resting on a minimal ballast import (5") and/or minimal culvert spacing and designed on less than 4 percent gradient was considered as a standard.

   "Turnpiking" was not considered as basic design but is recognized later as an "alternative or treatment" since it represents added road construction and design costs.

2. Parking Lots: This facility is defined as having paved spaces for no more than 50 cars. In addition to the effect which the parking lot has on the land, the reverse was also considered. Wind direction, deposition, submergence, erosion, etc., were factors that were recognized.

   Parking lots increase people concentrations on adjacent areas. This is reflected by the Human Occupancy - Day Use Activity. Both must be considered when determining the effect of a parking lot.

3. Drainfields: Specifications for drainfields established by county, State and Federal regulations served as the basis for this facility evaluation. Water tables, bedrock and/or impervious layers in excess of 8 feet below the surface were considered as suitable conditions. The contamination hazard of the ground water reservoir or estuary was also considered. It should be emphasized that this facility requires intensive onsite investigations beyond the scope of this inventory.

4. Campgrounds: This facility is defined as an overnite recreation development, exclusive of sanitation features or buildings. Natural vegetation protection and maintenance were also recognized where they applied. Plantings were considered as an "alternative or treatment." The measure of man's influence becomes the impact created by 15 people per acre during a time period of 4 hours or more.

5. Human Occupancy - Day Use: This considers concentrated day use activities and their impact on the land, waters and related resources. The measure of man's influence becomes the impact created by 50 or more people/acre during active period of 1 to 4 hours.

6. Human Occupancy - Pedestrian Access: The impact of pedestrian access, from one point to another, including cross-country and/or trail traffic, and dispersed activity was considered here. The measure becomes the impact created by 5 people per acre during the time period of 1 to 5 hours.

7. Cross-country Travel - Horses: This is defined as saddle horse movement from one point to another. "Trailing" can be expected in the densely vegetated and steeper portions of the area, while dispersion can be expected in the open sand and possibly the deflation plain areas. Where "trailing" was expected, notations were made on each geomorphic-plant community type.

8. Cross-country Travel - Vehicles: It is defined as vehicle movement (particularly Dune Buggies) from one point to another. The tendency for trailing was recognized. The establishment of trails through sensitive or densely vegetated areas was considered only as an alternative or treatment.

9. Buildings, Continuous Foundation: These are defined as being one-story, wood frame structures secured to a concrete or similar foundation.

10. Buildings, Pole Foundation: These are defined as being similar to above except secured to poles or stilts.

11. Powerline Tower Installations: This facility considered the clearing swath necessary (60-80' width), erosional status, service road, and the foundation capabilities of the soil mantle.

12. Buried Pipeline Installations: This facility considered all subsurface utility installations including water, electricity (up to 38,000 volts) and sewage. Water table levels, salt water erosion, clearing swaths (60-80' width) erosional status of the soil mantle and service road were considered.

13. Vegetative Stabilization: This facility was considered as an area suitable for "dune grass" plantations, which includes the European beachgrass, scotch broom and shorepine species.

C. Considerations and Limitations, Column 2: This column includes brief statements of the naturally occurring conditions which act as limitations to the specific activities, facilities, or uses. Recreational opportunities, such as viewing wildlife, where applicable, are also listed.

Some of the conditions mentioned are severe limitations or constraints, while others can be overcome by increased construction costs, engineering expertise, or maintenance, etc. The rating value in Column 3, provides an overall evaluation of the degree of severity of the conditions listed based on the physical resource. The rating values in columns 4 and 5 indicate the degree of severity of the conditions listed based on the wildlife or visual resource.

D. Physical Suitability Ratings, Column 3:

All physical suitability ratings were based on a projected 10-year period, including expected visitor use, average climatic events, and the usual level of man-caused impact to the soil and native plant resources within the limits of reasonable use. All ratings were based on the physical resource considerations, only.

Most Suitable . . . . Least Suitable

1 5

At the "most" suitable end of the range, it was felt that no severe or irreversible resource damage would occur as the result of a specific activity.

At the "least" suitable end of the scale:

1. Additional or sophisticated treatment measures would need to be employed to protect the site or prevent excessive damage to the resource, or

2. The site is too sensitive to survive without incurring irreversible damage, or

3. Damages to the improvement or facility could be expected.

The "least suitable" rating is not meant to be construed as "impossible" but only serves as the means to "red-flag" certain activities.

E. Wildlife Tolerance Ratings, Column 4:

The tolerance rating for wildlife indicates the impacts a proposed facility(ies) and/or activity(ies) would have on the wildlife species utilizing a habitat. The tolerance rating was assigned to the habitat type (the unit with which the land manager works). The tolerance ratings range from 1 (no significant effect on wildlife anticipated) to 5 (a significant detrimental effect on wildlife).

The following major considerations were used to develop the tolerance ratings:

1. The nature, magnitude and trends in present and anticipated recreational use of the Oregon Coast and N.R.A. A 5-percent average annual rate of increase (probably a minimal estimate) in recreational use of the N.R.A. was anticipated during the next 10 years.

2. The acreage, shape, and location of habitat types.

3. The life histories and behavior of wildlife species utilizing the habitats, especially endangered, rare and unique species. Tolerance ratings of 5 and 4 emphasize the need to (1) avoid the development of recreational facilities in all or certain portions of these habitats, (2) limit the type and magnitude of recreational use these habitats receive, and (3) develop sophisticated treatments and procedures when it becomes absolutely necessary to develop portions of these habitat types (work closely with wildlife biologist on a case-by-case basis).

F. <u>Visual Tolerance Ratings, Column 5:</u>

The tolerance ratings for the visual resource indicates the anticipated impact of proposed facilities or activities on the characteristic landscape. The entire N.R.A. is used as a base of reference. The impacts the proposed facility or activity would have on the dominant factors (form, line, texture, color and in some cases, motion) were considered. The degree of visual harmony a facility or activity has with the dominant features of the characteristic landscape is rated on a scale of 1 (generally compatible with the characteristic landscape) to 5 (starkly incongruous with the dominant features of the characteristic landscape).

G. <u>Some Alternatives or Treatments, Column 6:</u>

Listed here, as a <u>guide</u>, are some possible alternatives or treatments that correspond to the limitations and considerations listed in Column 2.

H. <u>Possible Negative Results, Column 7:</u>

These are the expected negative results of the alternatives or treatments listed in Column 6. Where the results are unknown, a question mark is used. In those cases where no particular negative results are expected, a dashed line is used.

MAPPING UNIT LEGEND

Map Symbol	Description
FD	Foredune
HWS	Hummocks, Occ. Wet, Stabilized
HW	Hummocks, Occ. Wet
HA	Hummocks, Dry
DG	Deflation Plain; grasses, rushes and sedges
DGL	Deflation Plain; low shrubs
DT	Deflation Plain; tall shrub thicket
DST	Deflation Plain; shorepine forest
TW	Transverse Ridge, Occ. Wet
TDA	Transverse Ridge, Dry
OA	Oblique Ridge System
PA	Parabola, Active
DS/TF	Stabilized Dune Surface; transition forest
DS/TFO	Stabilized Dune Surface; transition forest, old-growth
DS/TFC	Stabilized Dune Surface; transition forest, clearcut, 2-12 years
DS/TFS	Stabilized Dune Surface; transition forest, second-growth, 12-50 yrs.
DS/SFR	Stabilized Dune Surface; shorepine forest of stabilized dunes
DSA/TF	Stabilized Dune Surface, Eroding; transition forest
DSA/TFS	Stabilized Dune Surface, Eroding; transition forest, second-growth
DSA/SFR	Stabilized Dune Surface, Eroding; shorepine forest of stabilized dunes
PRS/TF	Precipitation Ridge - Slip Face; transition forest
PRS/SFR	Precipitation Ridge - Slip Face; shorepine forest of stabilized dunes
PRA	Precipitation Ridge - Active Slip Face
PRX	Precipitation Ridge - Active Slip Face, Threatening
SC	Conditionally Stable Slip Face
RS	Rolling, Partially Stabilized Dune Surface
FA	Flood Plain, Active
FA/SM	Flood Plain, Active; salt marsh - meadow
FS/SFR	Flood Plain, Stabilized; shorepine forest of stabilized dunes
FS/TF	Flood Plain, Stabilized; transition forest
MSM	Mountain Front; shoreline marsh
MMV	Mountain Front: marshy valley fill
MDW	Mountain Front; narrow drainageway
MSS/TF	Mountain Front, Steep side slope; transition forest
MSS/TFO	Mountain Front; Steep side slope; transition forest, old-growth
MSS/TFC	Mountain Front, Steep side slope; transition forest, clearcut
MSS/TFS	Mountain Front, Steep side slope; transition forest, second-growth
MTL/TFS	Mountain Front, Tableland; transition forest, second-growth
\!/	Marsh
L or Lake	Lakes and Ponds
—•••—	Beach
Named	Rivers and stream courses
PLANT	Plantations, with years since planted
—•—	Land-use boundary
— —	Gradation boundary between plant communities
	Approximate N.R.A. boundary
	Mass movement, headwall escarpment

Foredune (FD)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis.	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. "Unstable" - subject to wave erosion & log jams b. Uneven and abrupt relief - requires cuts c. Opens beach to vehicle access d. Not compatible with char. landscape e. Excessive snowy plover* harassment (rare species in State) when located parallel to beach	5	5	5	a. Riprap seaward side b. Fill depressions with ballast c. Enforce reg. & construct barriers d. None e. Locate perpendicular to beach	a. Potential for undercutting - visual impact b. Erosion on adj. areas-visual impact c. Neg. visual impact and admin. require. d. -- e. Some harassment will persist
Parking lots	a. "Unstable" b. Uneven and abrupt relief c. Inadequate size of area d. Increased airflow problem e. Not compatible with char. landscape f. Snowy plover harassment (rare species in State)	5	5	5	a. Riprap seaward side b. Fill depressions with ballast c. Landfill on inland side d. Plant larger species e. None f. None	a. Potential for undercutting persists - visual impact b. Erosion on adj. areas c. Increased runoff - neg. visual impact d. -- e. -- f. --
Drainfields	a. Slope, relief & shape unsuitable b. Inadequate size of absorption area c. Pollution hazard estuaries, ground water & wildlife	5	- ?	1	a. Provide vault or sew. collection system b. Landfill c. Sewage collection system	a. Disposal site limitations b. Neg. visual impact c. Disposal site limitations
Campgrounds (24 hr. occup.)	a. Neg. visual impact b. Inhospitable recreat. environ. (wind & moisture) c. Inadequate size of area d. Hazard of wave breaching e. Snowy plover* harassment (rare species in State)	5	5	5 4	a. None b. Construct artificial windscreen c. Landfill d. Riprap e. None	a. -- b. Neg. visual impact c. Extend scouring action to adj. land d. Potential for unsafe cond. persists e. --
Human Occupancy (Day use)	a. Inhospitable environment (wind & moisture) b. Low carrying capacity c. Snowy plover* harassment (rare species in State) d. Vegetation sensitive to trampling	5	5	3	a. None b. Provide reinforcement c. Identify & protect areas April-June; I&E program d. None	a. -- b. Neg. visual impact c. Reduction of recreat. land base d. --
Human Occupancy (Ped. access)	a. Vegetation sensitive to trampling b. Trail-rutting susceptible c. Low carrying capacity d. Snowy plover* harassment (rare species in State)	4	3	1	a. Provide bridging or paving b. " " " " c. " " " " d. Identify & protect areas Apr-June; I&E	a. Slight change in visual b. " " " " c. -- d. Reduction of recreation base; some harassment will persist.

*The snowy plover does not use the foredune itself. It uses the driftwood tangle on the beach and the sand spits of the river and streams. Both of these areas are adjacent to the foredune. Any activity on the foredune would directly affect the snowy plover.

Foredune(FD)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis	Some Alternatives or Treatments	Possible Negative Results
Cross-country travel (horses)	a. Low carrying capacity b. Tendency for trailing c. Trail-rutting susceptible d. Snowy plover harassment (rare species in State)	4	5	2	a. Provide bridging or pave b. " " " " c. " " " " d. Identify & protect areas Apr.-June; I&E program	a. Visual impact b. Slight change in visual c. " " " " d. Reduction of recreation base; some harassment will persist
Cross-country Travel (Vehicles)	a. Vegetation sensitive to wheel traffic b. Tendency for trailing - visual c. Snowy plover harassment (rare species in State)	5	5	4	a. Bridging b. Barrier c. Identify & protect areas April-June I&E program	a. Negative visual impact b. Modification of visual character. c. Reduction of recreation base; some harassment will persist
Buildings (Contin. foundation)	a. "Unstable" due to wave erosion b. Sand deposition on lee side c. Wind scouring on windward side d. Not compatible with charact. landscape	5		5	a. Riprap b. Maintenance c. Plantings d. None	a. Potential for undercutting persists; visual impact b. -- c. -- d. --
Buildings (Pole foundation)	a. Not compatible with char. landscape b. "Unstable" due to wave erosion c. Highest velocity wind exposure	5		4	a. None b. Riprap c. None	a. -- b. Potential for undercutting persists; visual impact c. --
Powerline Tower Install.	a. Not compatible with char. landscape b. "Unstable" due to wave erosion c. Highest velocity wind exposure d. Excessive loss of wildlife habitat and harassment if located parallel to beach, especially snowy plover.	5	5	5	a. Buried pipe b. Riprap c. None d. None	a. -- b. Potential for undercutting persists; visual impact c. -- d. --
Buried Pipeline Install.	a. "Unstable" due to wave erosion b. Excessive loss of wildlife habitat and harassment if located parallel to beach, especially snowy plover	5	5	1	a. Riprap b. None	a. Potential for undercutting persists b. --
Vegetative Stabiliz. (dunegrass)		1		1		

Hummocks, Occ. Wet, Stable (HWS)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. High water table (annual consid.) occ. flooding b. Increased turbulence & wind veloc.(effect on visitor) c. Marginally compatible w/char. landscape d. Alignment difficult to maintain w/o excess cuts e. Excessive loss of wildlife habitat & harassment if parallel to beach.	2	5	5 3 4	a. Turnpike or seasonal restrictions b. Plantings on adj. areas; sand removal program c. Design to fit landscape d. Low-speed roads fit to landscape e. Locate perpendicular to beach, restrict use Oct-May; I&E Program	a. Neg. visual impact b. -- c. -- d. Safety hazard e. Some loss of habitat & harassment will occur
Parking Lots	a. High water table b. Increased turbulence & wind veloc. (effect on visitor) c. Sand deposition (onsite) d. Marginally compat. with char. landscape e. Loss of habitat & harassment of wildlife	2	4	3 4	a. Land fill b. Plantings, on adj. acres, of wind screen species c. Sand removal program d. None e. Limit number of visitors; restrict use Oct-May; I&E	a. Possible subsurface drainage impeden. b. -- c. -- d. -- e. Some habitat loss & harass.will occur
Drain-fields	a. High water table b. Ground water contamination hazard c. Pollution hazard to estuaries & deflation plain	4	5	1	a. Sewage collection system b. " " " c. " " "	a. Disposal site limitations b. " " " c. " " "
Camp-grounds (24-hr. occup.)	a. High water table (seasonal consid.) b. Inhospitable environment (wind) c. Veg. sensitive to trampling d. Loss of habitat & harassment of wildlife	4	4	5	a. Land fill b. Construct artificial wind screens c. Barriers - plant with stronger spec d. Limit number of visitors; restrict use Oct-May; I&E	a. Slight visual impact b. Neg. visual impact c. -- d. Reduction of recreation base; some harassment will persist
Human Occupancy (Day use)	a. Veg. sensitive to trampling b. High water table c. Inhospitable environment d. Loss of habitat & harassment of wildlife	4	4	4	a. Barriers, fertilization & stronger species b. Land fill c. ? d. Limit number of visitors; restrict use Oct.-May - I&E	a. -- b. Slight visual impact c. -- d. Reduct. of recreat. base; some harassment will persist
Human Occupancy (Ped. access)	a. Veg. sensitive to trampling b. Trail rutting on steeper portions c. Wildlife harassment	3	2	2	a. Provide bridging or paving b. " " " c. I&E program	a. Slight visual impact b. " " " c. Some harassment will persist

Hummocks, Occ. Wet, Stable (HWS)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis.	Some Alternatives or Treatments	Possible Negative Results
Cross-country Travel (horses)	a. Tendency for trailing b. Trail-rutting on steeper portions c. Vegetation sensitive to trampling d. Loss of habitat & harassment of wildlife	3	5 (d)	2 (a) 3 (b) 3 (c)	a. Provide bridging & paving b. " " " c. " " " d. Restrict to trails; I&E; zone activity*	a. Slight visual impact b. " " " c. " " " d. Some harassment will persist
Cross-country Travel (vehicles)	a. Trail-rutting on steeper portions b. Veget. sensitive to wheel traffic c. Conflict in recreat. experience d. Loss of habitat & harassment of wildlife	4	5 (d)	3 (a) 4 (b) 4 (c)	a. Provide bridging & paving b. " " " c. Zone specific areas d. Restrict to trails;I&E;zone act.*	a. Slight visual impact b. " " " c. " " " d. Some harassment will persist
Buildings (Cont. found.)	a. High water table b. Subject to high veloc. winds & turbulence c. Wind-scouring & deposition hazard	4		4	a. Land fill b. None c. Plantings	a. Slight visual impact b. -- c. --
Buildings (Pole found.)	a. Subject to high veloc. winds & turbulence	3		4	a. None	a. --
Powerline Tower Install	a. Not compatible with char. landscape b. Subject to salt water corrosion near estuaries c. Subject to high-veloc. wind d. Excessive loss of wildlife habitat & harassment if parallel to beach	3	5 (d)	5 (a)	a. Buried pipe b. Buried, corros.-resistant pipe c. None d. Locate perpendicular to beach; restrict use of service road; I&E	a. Temporary destruction of wildlife habitat b. ? c. -- d. Some loss of habitat & harassment will occur
Buried Pipeline Install.	a. Subject to salt water corrosion near estuaries b. High water table c. Excessive loss of wildlife habitat & harassment if parallel to beach	3	5 (c)	1 (a)	a. Corrosion-resistant pipe b. Pumping & corros-resistant pipe c. Locate perpendicular to beach-restrict use of service road; I&E	a. -- b. Safety hazard c. Some loss of habitat & harassment will occur
Vegetat. Stabiliz. (Dunegrass)		1		1		

*See wildlife overlays for critical habitat areas.

Hummocks, Occ. Wet (HW)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis.	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. High water table (annual consid.), flooding	4			a. Turnpike or seasonal restrictions	a. Slight visual impact
	b. Wind-scouring to water table level (offsite)				b. Plantings on adjacent area	b. Modification of charac. landscape
	c. Sand deposition				c. Plantings on adjacent areas & sand removal program	c. --
	d. Alignment difficult to maintain without excess. cuts			3	d. Low-speed roads; fit to landscape	d. Safety hazard
	e. Increased wind velocities & turbulence (effect on visitor)			3	e. Wind-screen plantings on adj. areas	e. --
	f. Excessive loss of wildlife habitat & harassment when located parallel to beach *		5		f. Locate perpendicular to beach; I&E program	f. Some loss of habitat & harassment will occur
Parking Lots	a. High water table (annual consid.), flooding	4		3	a. Landfill	a. Medium visual impact
	b. Increased wind velocities & turbulence (effect on visitor)			3	b. Wind-screen plantings	b. Change in characteristic landscape
	c. Wind-scouring hazard (offsite)				c. Plantings on adjacent areas	c. --
	d. Sand deposition (onsite)				d. Sand removal program	d. --
	e. Loss of habitat & harassment of wildlife		3		e. Limit number of visitors; I&E	e. Some habitat loss & harass.will occur
Drain-fields	a. High water table	5		1	a. Sewage collection system	a. Disposal site limitation
	b. Ground water contamination hazard				b. " " "	b. " " "
	c. Pollution hazard to estuaries		5		c. " " "	c. " " "
	d. "Quicksand" areas				d. None	d. --
Camp-grounds (24-hr. occup.)	a. High water table (annual consid.), flooding	5		3	a. Landfill	a. Slight visual impact
	b. Veg. sensitive to trampling (on hummocks)				b. Barriers; plant hardier species, fertilize	b. --
	c. "Quicksand" areas				c. Signing; seasonal restrictions	c. --
	d. Inhospitable environment (wind)			4	d. Construct artificial wind screens	d. Slight visual impact
	e. Loss of habitat & harassment of wildlife		3		e. Limit number of visitors; I&E	e. Some habitat loss & harassment will occur
Human Occupancy (day-use)	a. Veg. on hummocks sensitive to trampling	4			a. Barriers; plant hardier species, fertilize	a. --
	b. High water table (annual consid.), flooding				b. Landfill	b. Slight visual impact
	c. Inhospitable environment (wind and water)			3	c. Construct artificial wind screens	c. " " "
	d. "Quicksand" areas				d. Signing; seasonal restrictions	d. --
	e. Loss of habitat & harassment of wildlife		3		e. Limit number of visitors; I&E	e. Some habitat loss & harass.will occur
Human Occupancy (Ped. access)	a. Quicksand areas	2			a. Signing; seasonal restrictions	a. --
	b. Veg. on hummocks sensitive to trampling			1	b. Barriers; plant hardier species, fertilize	b. --
	c. High water table				c. Bridging or seasonal restriction	c. --
	d. Harassment of wildlife				d. I&E program	d. Some harassment will persist

* See wildlife overlays for critical habitat areas.

Hummocks, Occ. Wet (HW)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis.	Some Alternatives or Treatments	Possible Negative Results
Cross-country Travel (horses)	a. Seasonal high water table b. "Quicksand" areas c. Veg. on hummocks sensitive to trampling d. Loss of habitat & harassment of wildlife	2	3	1	a. Seasonal restriction b. Signing; seasonal restriction c. Barriers d. Restrict to trails; I&E. Zone* activity	a. -- b. Maintenance c. " d. Reduct. of rec. land base; some harassment will persist
Cross-country Travel (vehicles)	a. Seasonal high water table b. "Quicksand" areas c. Loss of habitat & harassment of wildlife	2	3	2	a. Seasonal restriction b. Signing; seasonal restriction c. Restrict to trails; I&E. Zone activity *	a. -- b. Maintenance c. Reduct.of rec. land base; some harassment will persist
Buildings (Contin. found.)	a. High water table b. Wind-scouring hazard & sand deposition c. Subject to high velocity winds & turbulence d. Marginally compatible w/charac. landscape	5		4	a. Landfill b. Plantings & sand removal program c. None d. Design to fit landscape	a. Modification of charac. landscape b. -- c. -- d. --
Buildings (Pole found.)	a. Subject to high velocity winds & turbulence b. Marginally compatible w/charac. landscape	4		3	a. None b. Design to fit landscape	a. -- b. --
Powerline Tower Install.)	a. High water table b. Quicksand area c. Not compatible w/charac. landscape d. Excessive loss of wildlife habitat & harassment if parallel to beach	4	5	4	a. Buried pipeline b. None c. Buried pipeline d. Locate perpendicular to beach; I&E	a. -- b. -- c. -- d. Some loss of habitat & harassment will occur
Buried Pipeline Install.)	a. High water table b. "Quicksand areas" c. Excessive loss of wildlife habitat & harassment if parallel to beach	3	5	1	a. Pumping, corros. resist. pipe b. None or avoid c. Locate perpendicular to beach; I&E	a. Safety hazard b. -- c. Some loss of habitat & harassment will occur
Vegeta. Stabiliz. (dunegrass)	a. Lack of nutrients on hummocky portion	2		1	a. Fertilize	a. --

* See Wildlife overlays for critical habitat areas.

Hummocks, Dry (HA)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis.	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. Wind-scouring hazard (offsite)	4			a. Plantings on adjacent areas	a. Reduction of open sand areas
	b. Undulating relief; requires cuts				b. Balanced cut & fill to fit landsc.	b. --
	c. Marginally compatible with characteristic landsc			2	c. Design to fit landscape	c. --
	d. Occas. areas of high water table & flooding				d. Fill; seasonal closure	d. Reduced recreation opportunities
	e. Sand deposition (onsite)				e. Sand removal program	e. --
	f. Increased wind velocities & turbulence (effect on visitor)			3	f. Windscreen plantings on adj. areas	f. ?
	g. Some loss of wildlife habitat & harassment		3		g. None	g. --
Parking Lots	a. Increased wind veloc. (effect on visitors)	4			a. Plantings, on adj. areas of wind-screen species	a. Reduction of open sand areas
	b. Sand deposition (onsite)				b. Sand removal program	b. " " " " "
	c. Creates runoff area & wind-scouring (offsite)			3	c. Plantings on adjacent areas	c. " " " " "
	d. Marginally compatible with charac. landscape				d. Design to fit landscape	d. " " " " "
	e. Occasional area of high water table & flooding				e. Land fill	e. --
	f. Loss of habitat & harassment of wildlife		2		f. Limit number of visitors; I&E prog.	f. Some habitat loss & harass. will occur
Drain-fields	a. Wind-scouring hazard	5		1	a. Plantings	a. Reduction of open sand areas
	b. Ground water contamin. hazard-some locations		1		b. Fill 6-12'	b. Visual impact
Camp-grounds (24-hr. occup.)	a. Veget. on hummocks sensitive to trampling	4			a. Plantings with fertilizer treatment	a. Reduction of open sand areas
	b. Harsh environment (wind)			4	b. Construct artificial windscreens	b. Negative visual impact
	c. Wind-scouring hazard & sand deposition				c. Plantings & sand removal program	c. Reduction of open sand areas
	d. Loss of habitat & harassment of wildlife		2		d. Limit number of visitors; I&E prog.	d. Some habitat loss & harass. will occur
Human Occupancy (day use)	a. Veget. on hummocks sensitive to trampling	3			a. Barriers, plantings	a. Reduction of open sand areas
	b. Wind-scouring hazard & sand deposition				b. Plantings & sand removal program	b. " " " " "
	c. Inhospitable environment (wind)			3	c. Construct artifical windscreen	c. Negative visual impact
	d. Low carrying capacity (whole area)				d. Restrict numbers of visitors	d. Administrative problem
	e. Loss of habitat & harassment of wildlife		2		e. Limit number of visitors: I&E prog.	e. Some habitat loss & harassment will occur
Human Occupancy (Ped. access)	a. Veget. on hummocks sensitive to trampling	2			a. Barriers, plantings	a. Reduction of open sand areas
	b. Trail or path-rutting suscept. on steeper port.			2	b. Plantings	b. " " " " "
	c. Some harassment of wildlife		1		c. I&E program	c. Some harassment will persist

Hummocks, dry (HA)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis	Some Alternatives or Treatments	Possible Negative Results
Cross-Country Travel (horses)	a. Low carrying capacity b. Tendency for trailing c. Trail-rutting on steeper portions d. Some loss of habitat & harassment of wildlife	2	2	2 3	a. Restrict numbers b. Provide paved trails c. Plantings & barriers d. Restrict to trails; I&E	a. Administrative problem b. Negative visual impact c. -- d. Reduct. of rec. landbase; some harassment will persist
Cross-country Travel (vehicles)	a. Veget. on nummocks & grassy areas sensitive to wheel traffic b. Some loss of habitat & harassment of wildlife	2	2	3	a. Barriers & paving b. Restrict to trails: I&E	a. Negative visual impact b. Reduct. of rec. land base; some harassment will persist
Buildings (Cont. found.)	a. Wind-scouring hazard & sand deposition b. Occas. area of high water table c. Subject to high velocity wind & turbulence d. Marginally compatible with charac. landscape	5		4 3	a. Plantings b. Land fill c. None d. Design to fit landscape	a. Reduction of open sand areas b. Visual impact c. -- d. --
Buildings (Pole found.)	a. Subject to high velocity winds & turbulence b. Increase wind turbulence & scouring c. Marginally compatible with charac. landscape	4		4 3	a. None b. Plantings c. Design to fit landscape	a. -- b. Reduction of open sand areas c. --
Powerline Tower Install.)	a. Not compatible with charac. landscape b. Subject to high velocity winds & turbulence c. Wind-scouring hazard & high water table d. Some loss of wildlife habitat & harassment	5	2	4	a. Buried pipeline b. None c. Plantings d. None	a. -- b. -- c. Reduction of open sand areas d. --
Buried Pipeline	a. Wind-scouring hazard b. Occas. wet area c. Clearing would accelerate deflation plain process d. Some loss of wildlife habitat; harassment	4	2	1	a. Plantings b. Pumping & corrosion-resist. pipe c. Avoid destruction of hummocky portions d. None	a. Reduction of open sand areas b. Safety hazard during construction c. -- d. --
Vegetative Stabiliz. (dune-grass)	a. Fertility & moisture lacking	2		1	a. Fertility & plant adaptab. species	a. --

Deflation Plain, grasses, rushes, sedges (DG)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. High water table(annual consid.), flooding	3			a. Turnpike, seasonal restriction	a. Impede subsurface drainage; vis. impact
	b. Interference with water movement (when located perpendicular to beach)				b. Construct on causeway	b. Negative visual impact
	c. Excessive loss of wildlife habitat & harassment if located parallel to beach		5		c. Locate perpendicular to beach, I&E program	c. Some habitat loss & harassment will occur
	d. Not visually compatible			5	d. None	d. --
Parking Lots	a. High water table (annual consid), flooding	4			a. Land fill	a. Impede subsurface drainage; visual impact
	b. Not compatible with charac. landscape			5	b. None	b. --
	c. Subsurface drainage restrictions				c. Design through-flow	c. ?
	d. Loss of wildlife habitat; harassment		5		d. None	d. --
Drainfields	a. High water table (annual consid.)	5			a. Sewage collection system	a. Disposal site limitations
	b. Ground water contamination hazard			1	b. " " "	b. " " "
	c. Pollution hazard to estuaries & wildlife	5			c. " " "	c. " " "
Campgrounds (24-hr. occup.)	a. High water table (annual consid.), flooding	5			a. Land fill	a. Slight visual impact
	b. Mosquito habitat			3	b. Biological control	b. --
	c. Loss of wildlife habitat		5		c. None	c. --
	d. Inhospitable environment (wind)			4	d. Construct artifical windscreens	d. Susceptible to wind damage; modification of charac. landscape
Human Occupancy (day use)	a. High water table, (annual consid.), flooding	4			a. Land fill	a. Slight visual impact
	b. Mosquito habitat		3		b. Biological control	b. --
	c. Loss of wildlife habitat; harassment		5		c. None	c. --
	d. Modification of charac. landscape			3	d. Specialized design	d. --
Human Occupancy (Ped. access)	a. High water table, flooding (seasonal consid.)	3		2	a. Land fill or boardwalks	a. Possible negative visual impact
	b. Wildlife harassment		4		b. Restrict use Oct-May; I&E Program	b. Reduction of recreat. base; some harassment will persist

Deflat[illegible] lain, grasses, rushes, sedges (DG)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels Biol.	Vis	Some Alternatives or Treatments	Possible Negative Results
Cross-country Travel (horses)	a. High water table, flooding (seasonal consid.) b. Wildlife harassment	3	4	2	a. Seasonal restriction b. Restrict use Oct-May; confine to estab. trails; I&E	a. -- b. Reduction of recreation base; some harassment will persist
Cross-country Travel (vehicles)	a. High water table, flooding (seasonal consid.) b. Veg. sensitive to to wheel traffic - rutting c. Wildlife harassment	3	4	3	a. Seasonal restriction b. Confine to estab. improved trails c. Restrict use Oct-May; confine to estab. trails; I&E	a. -- b. Interference with water movement c. Reduction of recreation base; some harassment will persist
Buildings (Cont. found.)	a. High water table (annual consid.) b. Subject to high velocity winds c. Not visually compatible d. Loss of wildlife habitat & harassment	5	4	5	a. Land fill b. None c. None d. None	a. Impede subsurface drainage b. -- c. -- d. --
Buildings (Pole found.)	a. Subject to high velocity winds b. Not visually compatible c. Loss of wildlife habitat & harassment	4	4	5	a. None b. None c. None	a. -- b. -- c. --
Powerline Tower Install.	a. Not compatible with charac. landscape b. High water table c. Excessive loss of wildlife habitat if located parallel to beach; harassment	3	5	5	a. Buried pipeline b. " " c. Locate perpendicular to beach, construct July to Sept.; restrict use of service road; I&E	a. -- b. -- c. Some loss of habitat & harassment will occur
Buried Pipeline Install.	a. High water table b. Excessive loss of wildlife habitat if located parallel to beach; harassment	2	5	1	a. Pumping required - corros-resis.pipe b. Locate perpendicular to beach: construct July-Sept., restrict use of service road, I&E	a. -- b. Some loss of habitat & harassment will occur
Vegetative Stabiliz. (Dunegrass	a. Undesirable plant composition b. Loss of shorebird & waterfowl habitat by speeding up plant succession	4	5	3	a. Plant with native or adapt. species b. Plant with grasses other than beachgr	a. -- b. --

Deflation Plain, low shrubs (DGL)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels Biol.	Vis	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. High water table (annual consid), flooding b. Interference with water movement (when located perpendicular to beach) c. Excessive loss of wildlife habitat & harassment if located parallel to beach d. Not visually compatible	3	5	5	a. Turnpike, seasonal restriction b. Construct on causeway c. Locate perpendicular to beach, I&E program d. None	a. Impede subsurface drainage b. Negative visual impact c. Habitat loss & harassment will occur d. --
Parking Lots	a. High water table (annual consid.), flooding b. Not compatible with charac. landscape c. Subsurface drainage restriction d. Loss of wildlife habitat & harassment	3	4	5	a. Land fill b. None c. Design through-flow d. None	a. Impede subsurface drainage b. -- c. ? d. --
Drain-fields	a. High water table (annual consid.) b. Ground water contamination hazard c. Pollution hazard to estuaries & wildlife	5	5	2	a. Sewage collection system b. " " " c. " " "	a. Disposal site limitations b. " " " c. " " "
Camp-grounds (24-hr. occup.)	a. High water table (annual consid.), flooding b. Mosquito habitat c. Loss of wildlife habitat & harassment d. Inhospitable environment (wind)	4	4	4	a. Land fill b. Biological control c. None d. Construct windscreen	a. Slight visual impact b. -- c. -- d. Susceptibility to wind damage
Human Occup. (day use)	a. High water table (annual consid.), flooding b. Mosquito habit c. Loss of wildlife habitat; harassment	3	4	3	a. Land fill b. Biological control c. None	a. Slight visual impact b. -- c. --
Human Occup. (ped. access)	a. High water table, flooding (seasonal consid.) b. Wildlife harassment	2	3	2	a. Land fill or boardwalks b. Restrict use certain areas Oct-May, I&E program	a. Possible negative visual impact b. Reduction of recreation base; some harassment will persist

Deflation Plain, low shrubs (DGL)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis.	Some Alternatives or Treatments	Possible Negative Results
Cross-country Travel (horses)	a. High water table, flooding (seasonal consid.) b. Wildlife harassment	2	3	2	a. Seasonal restriction b. Restrict use of certain ar as Oct-May; confine use to estab. trails; I&E program	a. -- b. Reduction of recreation base; some harassment will persist
Cross-country Travel (vehicles)	a. High water table, flooding (seasonal consid.) b. Vegetation sensitive to wheel traffic-rutting c. Wildlife harassment	3	4	3	a. Seasonal restrictions b. Confine to established, improved trails c. Restrict use of certain areas Oct-May; confine to est. trails; I&E	a. -- b. Interference with water movement c. Reduction of recreation base; harassment will persist
Buildings (Cont. found.)	a. High water table (annual consid.) b. Subject to high velocity winds c. Not visually compatible d. Loss of wildlife habitat	5	4	5	a. Land fill b. None c. None d. None	a. Impede subsurface drainage b. -- c. -- d. --
Buildings (Pole found.)	a. Subject to high velocity winds b. Not visually compatible c. Loss of wildlife habitat	4	4	5	a. None b. None c. None	a. -- b. -- c. --
Powerline Tower Install.	a. Not compatible with charac. landscape b. High water table c. Excessive loss of wildlife habitat if located parallel to beach; harassment	3	5	5	a. Buried pipeline b. " " c. Locate perpendicular to beach, construct July-Sept; restrict use of service road; I&E	a. -- b. -- c. - Some loss of habitat & harassment will occur
Buried Pipeline Install.	a. High water table b. Excessive loss of wildlife habitat if located parallel to beach; harassment	2	5	2	a. Pumping required corros.-resis.pipe b. Locate perpendicular to beach; construct Jul-Sept.; restrict use of service road; I&E	a. Safety hazard during construction b. Some loss of habitat & harassment will occur
Vegetat. Stabiliz. (dunegrass)	a. Undesirable plant composition b. Accelerate loss of shore-bird-waterfowl habitat by speeding up plant succession	4	5	3	a. Plant with native or adapt. species b. Plant with grasses other than beachg.	a. - b. --

Deflation Plain, tall shrub thicket (DT)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis.	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. High water table (annual consid.), flooding b. Interference with water movement (when located perpendicular to beach) c. Excessive loss of wildlife habitat & harassment if located parallel to beach d. Questionable visual compatibility	3	5	3	a. Turnpike, seasonal restriction b. Construct on causeway c. Locate perpendicular to beach; I&E Program d. Sensitive location & design	a. Interference with subsurface drainage b. Slight visual impact c. Some habitat loss & harassment will occur d. --
Parking Lots	a. High water table (annual consid.), flooding b. Marginally compatible with charac. landscape c. Loss of wildlife habitat & harassment d. Interference with subsurface drainage	3	3	3	a. Land fill b. Design & locate to fit vegetation c. Limit number of visitors; I&E prog. d. Design through-flow	a. Impede subsurface drainage b. -- c. Reduction of recreation base; some harassment will persist d. ?
Drain-fields	a. High water table (annual consid.) b. Ground water contamination hazard c. Pollution hazard to estuaries	5 5	5	3	a. Sewage collection system b. " " " c. " " "	a. Disposal site limitations b. " " " c. " " "
Camp-grounds (24-hr occup.)	a. High water table (annual consid) flooding b. Pine pitch moth infestation susceptibility c. Western gall rust susceptibility d. Marginal recreat. envir. opportunity for wildlife viewing e. Loss of wildlife habitat & harassment	3	3	3	a. Land fill b. Individual tree treatment c. Tree removal or treatment d. Trails required e. Limit numbers of visitors; I&E prog.	a. -- b. Aesthetic loss c. " " d. -- e. Some habitat loss & harassment will occur
Human Occupancy (day use)	a. High water table b. Mosquito habitat c. Pine pitch moth & western gall rust & suscept. d. Loss of wildlife habitat & harassment e. Opportunity for wildlife viewing	3	3	3	a. Land fill b. Biological control c. Tree removal or treatment d. None - I&E program e. Trails required	a. -- b. -- c. Aesthetic loss d. Some harassment will persist e. --
Human Occup. (ped. access)	a. High water table (seasonal consid.) b. Wildlife harassment c. Opportunity for wildlife viewing	2	2	2	a. Land fill b. I&E Program c. Trails required	a. -- b. Some harassment will persist c. --

Deflation Plain, tall shrub thicket (DT)

acility or ctivity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis	Some Alternatives or Treatments	Possible Negative Results
Cross-country Travel (horses)	a. High water table (seasonal consid.) b. Tendency to trail c. Wildlife harassment	2	2	2	a. Land fill b. Reinforce trails c. I&E Program	a. -- b. Slight visual impact c. Some harassment will persist
Cross-country Travel (vehicles)	a. High water table (annual consid.) b. Tendency to trail c. Wildlife harassment	4	2	4	a. Land fill b. Restrict or confine to reinforced trail c. I&E Program	a. -- b. Slight visual impact c. Some harassment will persist
Buildings (Cont. found.)	a. High water table (annual consid.) b. Subject to wind turbulence c. Marginally compatible	4		3	a. Land fill b. Utilize natural windscreening c. Design & locate to fit vegetation	a. -- b. -- c. Custom design required for each building complex
Buildings (Pole found.)	a. Subject to wind turbulence b. Marginally compatible	2		2	a. Utilize natural windscreening b. Design & locate to fit vegetation	a. -- b. Custom design each bldg. complex
Powerline Tower Install.	a. High water table b. Not compatible with charac. landscape c. Excessive loss of wildlife habitat if parallel to beach; harassment	2	5	5	a. Buried pipeline b. " " c. Locate perpendicular to beach; I&E	a. Slight visual impact b. -- c. Some habitat loss; harassment will occur
Buried Pipeline Install.	a. High water table b. Clearing required c. Excessive loss of wildlife habitat if parallel to beach	2	5	4	a. Pumping required ; corros-resis.pipe b. -- c. Locate perpendicular to beach; I&E	a. Safety hazard during construction b. -- c. Some habitat loss & harassment will occur
Vegeta. Stabil. (dunegrass)	a. Undesirable plant composition	4		3.	a. Plant with native or adapt. species	a. --

Deflation Plain, shorepine forest (DST

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. High water table (annual consid.) flooding b. Interference with water movement (when located perpendicular to beach) c. Excessive loss of wildlife habitat, especially snags, if located parallel to beach; harassment d. Modification of characteristic landscape	3	5	3	a. Turnpike; seasonal restriction b. Construct on causeway c. Locate perpendicular to beach; retain snags; I&E Program d. Alignment	a. Impede subsurface drainage; not compatible with charac. landscape b. Slight negative visual impact c. Some habitat loss & harassment will occur d. Cost, construction problems
Parking Lots	a. High water table (annual consid), flooding b. Alteration of characteristic landscape c. Loss of wildlife habitat, especially snags; harassment	3	4	4	a. Land fill b. -- c. Retain snags; limit number of parking lots; I&E Program	a. Visual impact b. -- c. Reduction of recreation base; some harassment will persist
Drainfields	a. High water table (annual consid.) b. Ground water contamination hazard c. Pollution hazard to estuaries d. Noncompatible with charac. landscape	5	5	4	a. Sewage collection system b. " " " c. " " " d. None	a. Disposal site limitations b. " " " c. " " " d. " " "
Campgrounds (24 hr. occup.)	a. High water table, flooding b. Mosquito habitat c. Loss of wildlife habitat, especially snags; harassment	3	4	3	a. Land fill b. Biological control c. Retain snags; limit number of campgrounds; I&E	a. Impede subsurface drainage; visual impact b. -- c. Reduction of recreation base; some harassment will persist
Human Occupancy (day use)	a. High water table, flooding b. Inhospitable environment c. Loss of wildlife habitat, especially snags; harassment	3	4	3	a. Land fill b. None c. Retain snags; limit number of facilities; I&E	a. Impede subsurface drainage; visual impact b. -- c. Reduction of recreation base; some harassment will persist
Human Occupancy (ped. access)	a. High water table, flooding (seasonal consid.) b. Impenetrable vegetation c. Possibility for nature trail development d. Wildlife harassment	2	1	2	a. Land fill or turnpike trails b. Paths & trails required with reinf. c. -- d. I&E Program	a. Poss. subsurface drainage interference; visual impact b. Negative visual impact c. -- d. Some harassment will persist

Deflation Plain, shorepine forest (DST)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis.	Some Alternatives or Treatments	Possible Negative Results
Cross-country Travel (horses)	a. High water table (seasonal consid.) b. Vegetation is a natural barrier c. Wildlife harassment	2	2	2	a. Landfill or turnpike trails b. Provide reinforced trails c. I&E Program	a. Possible subsurface drainage imped.; visual impact b. -- c. Some harassment will persist
Cross-country Travel (vehicles)	a. Vegetation is a natural barrier b. Water table (annual consid.) c. Visual impacts from trailing d. Wildlife harassment	5	2	3	a. Trails required with reinforcement b. Turnpike c. -- d. I&E Program	a. Negative visual impact. b. Possible subsurface drainage impedence c. -- d. Some harassment will persist
Building (Contin. found.)	a. High water table (annual consid.) b. Slight visual impact	4		2	a. Land fill b. Custom design, careful placement	a. Visual impact b. --
Buildings (pole found.)	a. Slight visual impact	2		2	a. Custom design, careful placement	a. --
Powerline Tower Install.	a. Not compatible with charac. landscape b. High water table c. Quantity of clearing required d. Excessive loss of wildlife habitat, especially snags, if located parallel to beach; harassmnt	2	5	5	a. Buried pipe b. " " c. Fit to landscape d. Locate perpendicular to beach; retain snags; I&E	a. Slight visual impact b. -- c. -- d. Some habitat loss & harassment will occur
Buried Pipeline Install.	a. High water table b. Quantity of clearing required c. Excessive loss of wildlife habitat when located parallel to beach, especially snags	2	5	4	a. Pumping required; corros.-res.pipe b. Fit to landscape c. Locate perpendicular to beach; retain snags; I&E	a. Safety hazard during construction b. Increased construction cost c. Some habitat loss & harassment will occur
Vegetative Stabiliz. (dunegrass)	a. Undesirable plant composition	4	3	4	a. Plant with natives or adapt. species	a. --

Transverse Dunes, Dry (TDA)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis	Some Alternatives or Treatments	Possible Negative Resul-
Cross-Country Travel (Horses)		1		1		
Cross-Country Travel (Vehicles)		1		1		
Buildings (Contin. foundation)	a. Actively eroding landscape b. Creates wind turbulence (scouring & deposition) c. Not compatible w/char. landscape	5		5	a. Plantings b. Plantings & sand removal program c. None	a. Reduction of open sand area b. Reduction of open sand area c. -
Buildings (Pole Foundation)	a. Actively eroding landscape b. Creates wind turbulence (scouring) c. Not compatible w/char. landscape	4		5	a. Planting b. " c. None	a. Reduction of open sand area b. " " " " " c. -
Powerline Tower Installation	a. Wind excavation b. Not compatible w/char. landscape	5		5	a. Plantings b. Buried pipelines	a. Reduction of open sand area b. --
Buried Pipeline Installation	a. Wind excavation	2		1	a. Plantings - place below water table level	a. Reduction of open sand areas
Vegetative Stabiliza. (Dunegrass)	a. Lack of moisture & fert. b. Loss of open sand area c. Not compatible w/char. landscape	3		5	a. Fert. & possibly irrigation b. None c. I & E Program	a. -- b. -- c. Loss of open sand

Transverse Dunes, Dry (TDA)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. Actively eroding landscape b. Wind scouring hazard (offsite) c. Increased surface runoff, ditch eros. (off-site) d. Sand deposition (on-site) e. Not compatible w/char. landscape	5	*	5	a. Planting b. " c. Planting, and lined ditch d. Sand removal progress e. None	a. Reduction of open sand area b. " " " " " c. " " " " " d. - e. -
Parking lots	a. Sand deposition (on site) b. Actively eroding landscape c. Not compatible w/char. landscape d. Increase in wind velocity and sand blasting (effect on visitor)	5		5	a. Sand removal progress b. Planting c. None d. Plantings and artif. wind screen	a. - b. Reduction of open sand area c. - d. Neg. visual impact
Drainfields	a. Wind excavation hazard b. Excessive slopes in some areas	5		1	a. Plantings b. Sew. Collection system	a. Reduction of open sand area b. Disposal site limitation
Campgrounds (24-hr. occup.)	a. Actively eroding landscape b. Inhospitable environ. (wind & sand blasting) c. Not compatible w/char. landscape d. Sand deposition (on-site)	5		5 5	a. Plantings b. Construct artif. wind screens c. None	a. Reduction of open sand area b. Neg. visual impact c. -
Human Occupancy (day-use)	a. Actively eroding landscape b. Inhospitable environ. (wind & sand blasting) c. Not compatible w/char. landscape	4		4 5	a. Plantings b. Construct artif. wind screens c. None	a. Reduction of open sand area b. Neg. visual impact c. -
Human Occupancy (Ped. access)		1		1		

* No biological tolerance levels were deemed necessary for these geomorphic units. Their wildlife value can only be meaningful when studied with neighboring geomorphic units.

Oblique Ridge System (OA)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. Actively eroding landscape b. Wind scouring hazard (off-site) c. Increased surface run off, ditch eros. (off-site) d. Sand deposition (on-site) e. Steep slopes, requires ext. cuts, activ. failures f. Not compatible w/char. landscape	5	*	5	a. Plantings b. Plantings c. Plantings & ditch lining d. Sand removal program e. Plantings & retaining walls f. None	a. Reduction of open sand area b. Reduction of open sand area c. Reduction of open sand area d. Reduction of open sand area e. Reduction of open sand area; visual impact f. --
Parking lots	a. Wind scouring hazard (off-site) b. Steep slopes, requires extensive excavation c. Increased surface run-off (off-site) d. Sand deposit in (on-site) e. Not compatible w/char. landscape	5		5	a. Plantings b. Plantings c. Plantings and dispersal system d. Sand removal c. None	a. Reduction of open sand area b. Reduction of open sand area c. Reduction of open sand area d. -- e. --
Drain-fields	a. Wind excavation b. Excessive slope in most locations	5		1	a. Plantings b. Sew. collection system	a. Reduction of open sand area b. Disposal site limitation
Camp-grounds (24-hr. occup.)	a. Wind scouring hazard (off-site) b. Sand deposition (on-site) c. Inhosp. environment (wind & sandblasting) d. Not compatible w/char. landscape	5		5	a. Plantings b. Sand removal program c. Construct artif. wind screens d. None	a. Reduction of open sand area b. -- c. Neg. visual impact d. --
Human Occupancy (day-use)	a. Windscouring hazard (off-site) b. Inhosp. envirn. (wind & sandblasting) c. Sand deposition (on-site) d. Not compatible w/char. landscape	5		5	a. Plantings b. Construct artif. wind screens c. Sand removal program d. None	a. Reduction of open sand area b. Neg. visual impact c. -- d. --
Human Occupancy (Ped. access)		1		1		

* No biological tolerance levels were deemed necessary for these geomorphic units. Their wildlife value can only be meaningful when studied with neighboring geomorphic units

Oblique Ridge System (OA)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis.	Some Alternatives or Treatments	Possible Negative Results
Cross Country Travel (Horses)		1		1		
Cross-Country Travel (Vehicles)		1		1		
Buildings (Contin. foundation)	a. Wind excavation b. Sand deposition & scouring c. Not compatible w/char. landscape	5		5	a. Plantings b. Plantings c. None	a. Reduction of open sand area b. Reduction of open sand area c. --
Buildings (Pole Foundation)	a. Wind excavation b. Not compat. w/char landscape	5		5	a. Plantings b. None	a. Reduction of open sand area b. --
Powerline Tower Installation	a. Wind excavation b. Not compatible w/char. landscape	5		5	a. Plantings b. None	a. Reduction of open sand area b. --
Buried Pipeline Installation	a. Wind excavation b. Steep slopes - machinery limitation	4		1	a. Plantings b. Limit mach. size	a. Reduction of open sand area b. --
Vegetative Stabiliza. (Dunegrass)	a. Loss of open sand area b. Lack of moisture & fert. c. Not compatible w/char. landscape	2		5	a. None b. Fert. & possibly irrig. c. I & E Program	a. -- b. Modification of charac. landscape c. Loss of open sand area

Parabola, active (PA)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. Actively eroding landscape b. Slope & relief often excessive requiring ext. cuts c. Wind scouring hazard (off-site) d. Sand deposition (on-site) e. Increased surface runoff, ditch eros. (offsite) f. Not compatible w/chan. landscape	5	*	5	a. Plantings b. Plantings c. Plantings d. Plantings e. Plantings & ditch lining f. None	a. Reduction of open sand area b. " " " " " c. " " " " " d. " " " " " e. " " " " "; f. -- slight visual impact
Parking lots	a. Actively eroding landscape b. Slope & relief often excessive, require. ext. excavator c. Increased surface run-off (off-site) d. Sand deposition (on-site) e. Wind scouring hazard (off-site) f. Not compatible w/char. landscape	5		5	a. Plantings b. " c. Plantings & Dispersal system d. Plantings e. " f. None	a. Reduction of open sand area b. " " " " " c. " " " " " d. " " " " " e. " " " " " f. --
Drain-fields	a. Wind excavation hazard b. Slope & relief excession, most locations	5		1	a. Plantings b. Sew. collection system	a. Reduction of open sand area b. Disposal site limitation
Camp-grounds (24-hr. occup.)	a. Actively eroding landscape b. Slope & relief excessive, most locations c. Harsh site (wind & sand blasting) d. Veg. on fringe sensitive to trampling e. Not compatible w/char. landscape	5		5	a. Plantings b. Locate on more than 10% slopes c. Construct artificial wind screen d. Barriers & plantings e. None	a. Reduction of open sand area b. Decrease in density, inc. in cost c. Slight Neg. visual impact d. Interference w/natural process e. --
Human Occupancy (day-use)	a. Actively eroding landscape b. Slope & relief excessive, most locations c. Harsh site (wind & sand blasting) d. Veg. on fringe sensitive to trampling e. Not compatible w/char. landscape	5		5	a. Plantings b. Locate on 10% slope c. Construct artif. wind screen d. Barriers & plantings e. None	a. Reduction of open sand area b. Decrease in density, inc. in cost c. Slight neg. visual impact d. Interference w/natural process e. --
Human Occupancy Ped. Access)	a. Veg. on fringe sensitive to trampling	1		1	a. Barriers & plantings	a. Interference w/natural process; slight visual impact

*No biological tolerance levels were deemed necessary for these geomorphic units. Their wildlife value can only be meaningful when studied with neighboring geomorphic units.

Parabola, active (PA)

cility or tivity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis.	Some Alternatives or Treatments	Possible Negative Results
oss-country avel horses)	a. Veg. on fringe sensitive to trampling	1		1	a. Signing or barriers	a. Slight visual impact
oss-country avel ehicles)	a. Veg. on fringe sensitive to trampling	1		1	a. Signing or barriers	a. Slight visual impact
uildings Contin. found.)	a. Actively eroding landscape b. Subject to high velocity winds (venturi effect) c. Not compatible with charac. landscape	5		5	a. Plantings b. None c. None	a. Reduction of open sand areas b. -- c. --
uildings Pole found.)	a. Subject to high velocity winds b. Actively eroding landscape c. Not compatible with charac. landscape	5		4	a. None b. Plantings c. None	a. -- b. Reduction of open sand areas c. --
owerline ower nstall.	a. Actively eroding landscape (wind excavation) b. Not compatible with charac. landscape c. Burial of powerlines	5		5	a. Plantings b. None c. Plantings	a. Reduction of open sand areas b. -- c. Slight visual impact; potential sand movement acceleration
uried ipeline nstall.	a. Actively eroding landscape (wind excavation)	5		1	a. Plantings	a. Reduction of open sand areas
Vegeta. Stabil. Dune-grass)	a. Moisture-limiting b. Undesirable plant composition c. Not compatible with charac. landscape	3		5	a. Irrigate, possibly b. Plant with natives or adapt. species c. I&E Program	a. -- b. Modification of charac. landscape c. Loss of open sand

Stabilized dune surface, transition forest $\frac{(DS)}{(TF)}$

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. Slope & relief require extensive cuts (some areas) b. Creates surface runoff, ditch erosion c. Airflow velocities increase when located parallel to prevailing winds d. High water tables in some areas e. Loss of wildlife habitat; especially snags	2	4	4	a. Design to fit landscape b. Line ditches; keep below 6% grad. c. Vary alignment d. Turnpike e. Limit number of visitors;retain snags	a. -- b. -- c. Safety hazard d. Visual impact e. Reduction of recreation base
Parking Lots	a. Size limitation due to slope & relief in some areas (> 15%) b. High water table in some areas c. Loss of wildlife habitat, especially snags	2	4	4	a. Specialized design b. Turnpike or land fill c. None	a. Decrease parking stalls; increase in land base loss b. Visual impact c. --
Drainfields	a. Slope & relief variable, often excessive (>7%) b. High water table in some areas c. Visual impact from clearing	3	1	4	a. Other collection system b. Sewage collection system c. Limited clearing	a. Increased O&M costs b. Disposal site limits c. Decreased efficiency
Campgrounds (24-hr. occup.)	a. Areal size limitations due to slope & relief, some areas b. High water table in some areas c. Moderate visual impacts d. Loss of wildlife habitat, especially snags	2	4	3	a. Locate on more than 10% gradients b. Land fill c. Careful design d. None	a. Decrease in density of units; increase in cost b. Visual impact c. -- d. --
Human Occupancy (Day use)	a. Areal size limitations due to slope & relief, some areas b. Vegetation dense & impenetrable c. Trails required d. Moderate visual impact e. Loss of wildlife habitat, especially snags	2	4	3	a. Locate on more than 10% gradients b. Provide clearings c. Provide reinforced paths d. Careful design e. None	a. Decrease in density of units, increase in cost b. Visual impact c. Visual impact d. -- e. --
Human Occupancy (Ped. access)	a. Vegetation is natural barrier b. Wildlife harassment	2	2	2	a. Provide reinforced paths b. I&E Program	a. Source of surface runoff; visual impact b. Some harassment will persist

Stabilized dune surface, transition forest (DS)/(TF)

acility or activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis	Some Alternatives or Treatments	Possible Negative Results
ross-country ravel (horses)	a. Vegetation is a natural barrier b. Wildlife harassment	2	3	2	a. Provide reinforced trails b. I&E Program	a. Source of runoff; slight visual impact b. Some harassment will persist
ross-country ravel (vehicles)	a. Vegetation is a natural barrier b. Conflict in recreational experience c. Wildlife harassment	5	3	4	a. Provide reinforced & drained running surface (see Road Construction) b. None c. I&E Program	a. Source of runoff; visual impact b. -- c. Some harassment will persist
uildings ontin. ound)	a. Slope & relief variable & steep (>15%) some areas b. High water table in some areas c. Visual impact	1		3	a. Custom planning b. Land fill c. Custom design	a. ? b. Visual impact c. --
uildings Pole found.)	a. Visual impact	1		2	a. Custom design	a. --
owerline ower nstall.	a. Quantity of clearing required b. Occasional area of high water table c. Loss of wildlife habitat, especially snags; harassment	3	4	5	a. Design to fit landscape b. Buried pipe c. Locate perpendicular to stand: restrict use of service road; I&E	a. Loss of aesthetic values b. Visual impact c. Some habitat loss & harassment will occur
uried ipeline nstall.	a. Quantity of clearing required b. Occasional area of high water table c. Loss of wildlife habitat, especially snags, & harassment	3	4	3	a. Design to fit landscape b. Corros-resist. pipe; pumping req. c. Locate perpendicular to stand; restrict use of service road; I&E	a. Loss of aesthetic values b. Safety hazard during construction c. Some habitat loss & harassment will occur.
egeta. tabiliz. unegrass)	a. Undesirable plant composition b. Shading & plant composition	4	3	4	a. Plant with natives or adapt. species b. --	a. -- b. --

Rolling, partially stabilized dune surface (RS)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. Some areas of high water table b. Rolling, with considerable relief c. Some snag areas - critical habitat for cavity nesters d. Visual impacts	2	4	3	a. Turnpike b. Design to fit landscape c. Identify and protect specific areas d. Design to fit landscape	a. Visual impacts b. -- c. Reduction of recreation base d. --
Parking Lots	a. Some areas of high water table b. Rolling, variable relief c. Some snag areas - critical habitat for cavity nesters d. Visual impact	2	4	4	a. Land fill b. Major excavations c. Identify and protect specific areas d. Design to fit landscape	a. Visual impact b. Resource loss, visual impact c. Reduction of recreation base d. Limited parking volume
Drain-fields	a. Onsite invest. needed (high water table, slopes) b. Some snag areas - critical habitat for cavity nesters c. Visual impact from clearing	3	4	4	a. -- b. Identify & protect specific areas c. Limited clearing	a. -- b. Reduction of recreation base c. Limit efficiency
Camp-grounds (24-hr. occup.)	a. Veg. sensitive to trampling b. Gall rust susceptibility c. Some areas of high water table d. Surface area lacking e. Some snag areas-critical habitat for cavity nest.	4	4 4	2	a. Reinforce pathways; barriers b. See I&DC for treatments c. Land fill d. Specialized design e. Identify & protect specific areas	a. Admin. & enforcement; visual impact b. -- c. Visual impact d. Decrease in density; increase in cost e. Reduction of recreation base
Human Occupancy (Day use)	a. Veg. sensitive to trampling b. Gall rust susceptibility c. Some areas of high water table d. Some snag areas-critical habitat for cavity nest.	3	4 4	2	a. Reinforce pathways, barriers b. See I&DC for treatments c. Land fill d. Identify & protect specific areas	a. Admin. & enforcement; visual impact b. -- c. Visual impacts d. Reduction of recreation base
Human Occupancy (Ped. access)	a. Veg. sensitive to trampling b. Wildlife harassment	2	2 2	1	a. Reinforce pathways, barriers b. I&E Program	a. Admin. & enforcement; slight vis. impact b. --

Rolling, partially stabilized dune surface (RS)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Vis	Some Alternatives or Treatments	Possible Negative Results
Cross-country Travel (horses)	a. Veg. sensitive to trampling b. Wildlife harassment	3	5 3	2	a. Reinforce pathways, barriers b. I&E Program	a. Admin. & enforcement; slight vis. impact b. --
Cross-country Travel (vehicles)	a. Veg. sensitive to wheel traffic b. Wildlife harassment	4	5 4	4	a. Provide reinforced & drained running surface (See Road Construction) b. I&E Program	a. Source of runoff (some areas; visual impact) b. --
Buildings (Contin. found.)	a. Some areas of high water table b. Some snag areas - critical habitat for cavity nesters c. Visual impact	2	2	3	a. Land fill b. Identify & protect specific areas c. Custom design	a. Destruction of snag areas; critical habitat; visual impact b. Reduction of recreation base c. --
Buildings (Pole found.)	a. Some snag areas - critical habitat for cavity nesters b. Visual impact	1	2	3	a. Identify & protect specific areas b. Custom design	a. Reduction of recreation base b. --
Powerline Tower Install.	a. Clearing swath required b. Marginally compatible with charac. landscape c. Some snag areas--critical habitat for cavity nesters	4	4	4	a. Design to fit landscape b. None c. Identify & protect specific areas	a. Destruction of snag areas--crit. habitat b. -- c. --
Buried Pipeline Install.	a. Clearing swath required b. Loss of sensitive & pioneering plant cover c. Some snag areas--critical habitat for cavity nesters	3	4	4	a. Design to fit landscape b. None c. Identify & protect critical areas	a. -- b. -- c. --
Vegetative Stabiliz. (Dunegrass)	a. Undesirable plant community	3	3	4	a. Restore with natives or adapt. species	a. --

Flood plain, Active (FA)

Facility or Activity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels: Biol.	Biological & Visual Tolerance Levels: Vis	Some Alternatives or Treatments	Possible Negative Results
Road Construction	a. Loss of critical wildlife habitat & harassment b. Flooding & water erosion hazard c. Water table (poor bearing strength) d. Modification of charac. landscape	5	5	5	a. None; I&E program b. Binwalls, gabions & riprap c. Ballast & land fill d. None	a. -- b. Loss of critical wildlife habitat; visual impact c. Loss of critical wildlife habitat; visual impact d. --
Parking Lots	a. Loss of critical wildlife habitat & harassment b. Flooding & water erosion hazard c. Water table (poor bearing strength) d. Modification of charac. landscape	5	5	5	a. None; I&E Program b. Binwalls, gabion & riprap c. Ballast & land fill d. None	a. -- b. Loss of critical wildlife habitat; visual impact c. Loss of critical wildlife habitat; visual impact d. --
Drain-fields	a. Estuary pollution hazard (high water table) b. Critical wildlife habitat, destruction c. Subject to water erosion	5	5	1	a. Sewage collection system b. " " " c. " " "	a. Limited disposal sites b. " " " c. " " "
Campgrounds (24-hr. occupancy)	a. Flooding & water erosion hazard b. Water table c. Loss of critical wildlife habitat & harassment d. Modification of charac. landscape	5	5	5	a. Binwalls, gabion, riprap b. Land fill c. None; I&E Program d. None	a. Loss of critical wildlife habitat b. " " " "; visual impact c. -- d. --
Human Occupancy (day use)	a. Flooding & water erosion hazard b. Water table c. Loss of critical wildlife habitat & harassment d. Modification of charac. landscape	5	5	5	a. Binwalls, gabions, riprap b. Land fill c. None; I&E Program d. None	a. Loss of critical wildlife habitat b. " " " " visual impact c. -- d. --
Human Occupancy (ped. access)	a. Subject to flooding (seasonal limitations) b. Low carrying capacity c. Critical wildlife habitat, harassment	1	3	1	a. Seasonal restriction (natural) b. Signing & regulation c. Restrict access; I&E	a. -- b. Admin. & enforcement c. Reduct. of rec. land base; some harassment will persist

Flood Plain, active (FA)

:cility or :tivity	Considerations and Limitations	Physical Suitability Rating	Biological & Visual Tolerance Levels Biol.	Vis	Some Alternatives or Treatments	Possible Negative Results
ross-ountry ravel horses)	a. Subject to flooding (seasonal limitation) b. Critical wildlife habitat, harassment	1	5	1	a. Seasonal restriction (natural) b. Restrict access; I&E Program	a. -- b. Reduct. of rec. land base; some harassment will persist
ross-ountry ravel vehicles)	a. Subject to flooding (seasonal limitation) b. Critical wildlife habitat, harassment	1	5	1	a. Seasonal restriction (natural) b. Restrict access; I&E Program	a. -- b. Reduct. of rec. land base; some harassment will persist
uildings Contin. found.)	a. Flooding & water erosion hazard b. Water table c. Loss of critical wildlife habitat d. Modification of charac. landscape	5	5	5	a. Binwalls, gabions, riprap b. Land fill c. None d. None	a. Loss of critical wildlife habitat b. " " " ", visual impact c. -- d. --
uildings Pole found.)	a. Flooding & water erosion hazard b. Water table c. Loss of critical wildlife habitat d. Modification of charact. landscape	5	5	5	a. Binwalls, gabions, riprap b. Land fill c. None d. None	a. Loss of critical wildlife habitat b. " " " "; visual impact c. -- d. --
owerline ower nstall	a. Flooding & water erosion hazard b. Water table c. Loss of critical wildlife habitat d. Not compatible with charac. landscape	5	5	5	a. Binwalls, gabions, riprap b. Land fill c. None d. None	a. Loss of critical wildlife habitat b. " " " ; visual impact c. -- d. --
uried ipeline nstall	a. Flooding & water erosion hazard b. Water table c. Loss of critical wildlife habitat	5	5	1	a. Binwalls, gabions, riprap b. Land fill c. None	a. Loss of critical wildlife habitat b. " " " " ; visual impact c. --
egeta. tabiliz.	a. Flooding & water erosion hazard b. Loss of critical wildlife habitat	5	5	5	a. None b. None	a. -- b. --

MAJOR IMPACTS IN MANAGEMENT*

Mapping Units		Wildlife Habitat	Mining	Grazing	General Agriculture	Logging	Urban Development Density			Recreation				Water Table Alteration	Subsurface Disposal
										Undeveloped			Developed		
Symbol	Name						Low	Med.	High	Pedestrian	ORV	Equestrian			
B	Beach	3	2A	-	-	-	0	0	0	3	3	3	0	-	0
DC	Dune complex of OS, OSC, DS, and W	2	0	0	0	0	1	0	0	1	0	0	0	1	2A
DS	Younger stabilized dunes	3	2	2	2	1	3	2	2	3	1	3	3	1	2A
FD	Recently stabilized foredunes	3	0	0	0	0	1	0	0	2	0	1	0	1	1
FDA	Active foredune	3	0	0	0	0	0	0	0	3	0	1	0	1	1
H	Active dune hummocks	3	0	0	0	0	0	0	0	3	0	3	0	1	0
ODS	Older stabilized dunes	3	2	2	2	2	3	3	3	3	2	3	3	2	1A
OS	Open dune sand	1	3	-	-	-	0	0	0	3	3	3	0	2	3A
OSC	Open dune sand conditionally stable	1	0	0	0	0	1	0	0	1	0	0	0	1	2A
W	Wet interdune	3	1	1	1	1	1A	0	0	2C	0	1	1A	1A	0
WDP	Wet deflation plain	3	0	1	3B	-	1A	0	0	2C	0	1	1A	0	0
IFD	Inland foredune	3	0	2	1	1	2	0	0	3	1	1	-	1	2A
OFD	Older foredune	3	0	2	3A	3A	3	2	1	3	2	3	-	2	1-2A

- \- Not applicable
- 0 No tolerance
- 1 Tolerance level low
- 2 Tolerance level medium
- 3 Tolerance level high
- A Site Specific
- B Specialty Crop
- C Seasonal

*From U.S.D.A., Soil Conservation Service and OCCDC, 1975.

MAJOR IMPACTS IN MANAGEMENT (continued)

Mapping Units: Symbol	Mapping Units: Name	Filling	Road Construction	Vegetative Removal	Fire Hazard	Deep Excavation	Stream Undercutting	Ocean Undercutting	Debris Removal (driftwood)	Vegetative Stabilization Enhancement (Chance of success0
B	Beach	0	0	-	1A	-	-	3A	3A	-
DC	Dune complex of OS, OSC, DS, and W	-	0	0	1	1	0	0	-	2
DS	Younger stabilized dunes	2	2	2A	2	1	1	1	-	3
FD	Recently stabilized foredunes	-	1A	0	1	0	0	1	0	3
FDA	Active foredune	-	0	0	1	0	0	1	0	1
H	Active dune hummocks	-	1	0	2	0	0	0	-	1
ODS	Older stabilized dunes	2	3	2A	2	2	2	2	-	3
OS	Open dune sand	-	0	-	-	3	0	0	-	1-2
OSC	Open dune sand conditionally stable	-	0	0	1	1	0	0	-	3
W	Wet interdune	0	1A	2	2	0	0	-	-	3
WDP	Wet deflation plain	0	1A	2	2	0	0	-	2A	3
IFD	Inland foredune	-	2A	1A	2	2A	0	0	-	3
OFD	Older foredune	-	3A	3A	2	3A	2	1	-	3

- Not applicable
0 No tolerance
1 Tolerance level low
2 Tolerance level medium
3 Tolerance level high
A Site Specific
B Specialty Crop
C Seasonal

ACTIVITY COMPATIBILITY OR CONDITION*

DESIGNATED ACTIVITY OR CONDITION

COMPETING CONDITION	Wildlife Habitat	Mining (Surface)	Grazing	General Agriculture	Logging	Low Density Urban	Medium Density Urban	High Density Urban	Undeveloped Ped. Rec.	Undeveloped ORV Rec.	Undeveloped Equ. Rec.	Developed Recreation	Water Table Alteration	Subsurface Disposal	Filling	Road Construction	Vegetative Removal	Fire Hazard	Deep Excavations	Stream Undercutting	Ocean Undercutting	Driftwood Removal	Vegetative Stabilization
Wildlife Habitat		0	1	1	1	1	1	0	2	1	1	0	-	-	1	1	0	0	0	0	0	1	1
Mining (Surface)	0		0	0	0	0	0	0	2	1	2	0	1	1	1	1	2	-	2	1	1	2	0
Grazing	1	1		1	1	0	0	0	2	0	2	0	-	-	0	0	0	1	1	0	0	2	1
General Agriculture	0	0	2		0	0	0	0	2	0	2	1	-	2	0	1	1	1	0	0	0	2	1
Logging	1	1	1	0		0	0	0	2	1	2	0	-	2	1	1	2	0	1	1	1	2	0
Low Density Urban	1	0	1	1	1		-	-	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1
Medium Density Urban	0	0	0	0	0	-		-	1	0	1	1	1	1	1	1	1	0	0	0	0	1	1
High Density Urban	0	0	0	0	0	-	-		1	0	0	1	1	1	1	1	1	0	0	0	0	1	0
Undeveloped Ped. Rec.	2	2	2	2	2	2	-	-		1	2	2	-	-	-	1	1	0	1	0	0	2	1
Undeveloped ORV Rec.	0	0	1	0	1	0	0	0	1		1	0	-	-	1	1	1	0	0	0	0	0	0
Undeveloped Equ. Rec.	2	2	2	1	2	1	1	0	2	1		1	-	-	1	1	1	0	1	0	0	2	0
Developed Recreation	0	0	0	0	0	1	0	0	2	0	1		-	1	1	1	1	0	0	0	0	1	1
Water Table Alteration	1	1	1	1	1	1	1	1	1	1	1	1		1	-	1	1	1	0	-	-	2	1
Subsurface Disposal	2	1	2	2	2	1	1	1	2	2	2	1	1		1	1	1	-	1	0	0	2	2
Filling	0	0	1	1	1	1	1	1	2	1	2	1	-	1		1	1	1	0	0	0	0	0
Road Construction	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	0	0	1	1
Vegetative Removal	1	2	1	1	1	1	1	1	1	1	1	1	1	-	-	1		1	1	0	0	1	0
Fire Hazard	0	1	0	0	0	0	0	0	0	0	0	0	0	-	-	0	2		-	-	-	-	0
Deep Excavations	1	1	0	0	0	0	0	0	2	1	2	0	0	0	0	1	2	-		0	0	0	0
Stream Undercutting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0		-	-	0
Ocean Undercutting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	-		0	0
Driftwood Removal	1	0	1	1	1	1	1	1	1	0	1	1	-	-	0	1	1	0	0	0	0		1
Vegetative Stabilization	1	0	1	0	0	1	1	1	1	0	0	1	1	-	0	1	0	0	0	0	0	1	

- = Not Applicable
0 = Activities which conflict with the designated uses.
1 = Activities which may conflict with the designated use depending upon site characteristics and use intensities.
2 = Activities which do not hinder the designated use.

*From U.S.D.A., Soil Conservation Service and OCCDC, 1975.

Habitat Tolerance to Recreation Use *

		Habitat Types																						
		BEACH			DEFLATION PLAIN			UPLAND DUNE				HEADLAND			INLAND WATER		ESTUARINE						MARINE	
Activity	ACTIVITY INTENSITY LEVEL	Bare Sand	Driftwood	Beach Grass	Marsh	Shrub	Forest	Bare Sand	Grass-Forb	Shrub	Forest	Bare	Shrub	Forest	Lake	Swamp	Bay	Jetty	Mud Flat	Rocky Shore	Sand Flat	Marsh	Ocean	Sand Flat
Camping (Informal)	L	0	1	1	1	-	-	-	3	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-
	M	0	1	1	2	-	-	0	3	2	-	-	2	2	-	-	-	-	-	-	-	-	-	-
	S	0	1	2	-	-	-	0	3	2	-	-	2	2	-	-	-	-	-	-	-	-	-	-
Picnicking (Informal)	L	0	1	1	1	-	-	0	3	1	-	-	1	1	-	-	-	0	-	0	-	-	-	-
	M	0	1	1	2	-	-	0	3	2	-	-	2	2	-	-	-	0	-	1	-	-	-	-
	S	0	1	2	-	-	-	0	3	2	-	-	2	2	-	-	-	0	-	2	-	-	-	-
Sunbathing	L	0	0	0	1	-	-	0	1	1	-	-	1	-	-	-	-	0	-	0	0	-	-	0
	M	0	0	1	1	-	-	0	2	1	-	-	1	-	-	-	-	0	-	1	0	-	-	0
	S	0	0	1	-	-	-	0	3	2	-	-	2	-	-	-	-	0	-	2	0	-	-	0
Viewing	L	0	0	1		-	-	0	3	3	-	0	3	2	-	-	-	0	-	3	0	-	-	0
	M	-	-	-		-	-	0	-	-	-	0	3	2	-	-	-	0	-	3	-	-	-	-
	S	-	-	-	-	-	-	0	-	-	-	0	3	2	-	-	-	0	-	3	-	-	-	-
Outdoor Games	L	0	0	1	0	-	-	0	3	-	-	-	1	-	-	-	-	-	-	-	0	-	-	0
	M	0	-	1	1	-	-	0	3	-	-	-	-	-	-	-	-	-	-	-	0	-	-	0
	S	0	-	2	-	-	-	0	3	-	-	-	-	-	-	-	-	-	-	-	0	-	-	0
Beachcombing	L	0	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	-	0
	M	0	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1	0	1	-	0
	S	0	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0	2	0	2	-	0
Hunting and Trapping	L	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
	M	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
	S	0	0	0	0	1	1	-	1	1	1	0	1	1	0	1	0	0	0	1	0	1	0	0
Fishing	L	0	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	0	0	0	0	-	0	0
	M	0	-	-	-	-	-	-	-	-	-	-	-	-	1	-	0	0	1	1	1	-	0	0
	S	0	-	-	-	-	-	-	-	-	-	-	-	-	1	-	0	0	1	2	1	-	0	0
Swimming	L	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	0	-
	M	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	0	-
	S	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	0	-
Motorized Boating*	L	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	0	-	-	-	-	-	0	-
	M	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	0	-	-	-	-	-	0	-
	S	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	0	-
Hiking	L	0	0	0	0	-	0	0	2	0	-	0	0	0	-	-	-	0	1	0	0	0	-	0
	M	0	0	1	0	-	1	0	3	1	-	0	1	1	-	-	-	0	-	1	0	1	-	0
	S	0	0	1	1	-	2	0	3	2	-	0	1	1	-	-	-	0	-	2	0	0	-	0
Nature Walking	L	0	0	0	0	0	0	0	1	0	0	0	0	0	-	0	-	0	0	0	0	0	-	0
	M	0	0	0	0	1	1	0	2	1	1	0	1	1	-	1	-	0	0	1	0	1	-	0
	S	0	0	1	1	2	1	0	2	2	1	0	1	1	-	1	-	0	0	2	-	2	-	0
Walking for Pleasure	L	0	0	1	0	-	1	0	2	1	-	-	1	1	-	-	-	0	-	1	0	-	-	0
	M	0	0	1	1	-	2	0	3	2	-	-	1	2	-	-	-	0	-	2	0	-	-	0
	S	0	1	2	2	-	2	0	3	3	-	-	2	2	-	-	-	0	-	3	0	-	-	0
Bicycling	L	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	M	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
	S	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Motor Vehicle Riding	L	1	-	3	2	-	-	1	3	1	-	-	1	-	-	1	-	-	1	2	1	1	-	1
	M	1	-	3	3	-	-	2	3	2	-	-	-	-	-	-	-	-	1	-	1	2	-	1
	S	1	-	3	3	-	-	2	3	3	-	-	-	-	-	-	-	-	1	-	1	3	-	1
Motorcycling	L	1	-	3	2	-	-	1	3	1	-	-	1	-	-	-	-	-	-	1	1	1	-	1
	M	1	-	3	3	-	-	2	3	2	-	-	2	-	-	-	-	-	-	-	1	2	-	1
	S	1	-	3	3	-	-	2	3	3	-	-	3	-	-	-	-	-	-	-	1	3	-	1

*Non-motorized boating is considered to have no detectable impact.

KEY:
0 = No detectable impact
1 = Slight impact--detectable impact but habitat recovers easil (<12 months)
2 = Moderate impact--recovers slowly (1 to 3 years)
3 = Severe impact--setback in succession
- = Not applicable
L = large spacing between participants
M = moderate spacing between participants
S = small spacing between participants

*From U.S. Army Corps of Engineers, 1974.

APPENDIX B

Soil Conservation Service
Soil Interpretations:
Active Dune Land, Westport and
Netarts Series

OR-SOILS-1 12/72
FILE CODE SOILS 12

SOIL INTERPRETATIONS FOR OREGON   U.S.D.A. SOIL CONSERVATION SERVICE

DATE: January, 1974 GBT, GEO *Active Dune Land* SERIES   SOILS: 1. *Active Dune Land*

This land type consists of wind-drifted sand in the form of dunes, ridges, or hummocks. The material is not stabilized and has no vegetation established on it. Dunes are generally 5 to 40 feet high; they have a maximum elevation of about 180 feet. The relief is a succession of irregularly distributed dunes and ridges, which rise above the intervening wind-formed valleys and swales. Dunes are bare of vegetation or the growth is not dense enough to protect the sand and to prevent it from blowing. The dunes are constantly shifting under the influence of strong ocean winds. Elevation is 0 to about 180 feet. Average annual precipitation is 60 to 80 inches, average annual temperature is 50 to 52°F.; and the frost-free period is about 202 days. Active Dune Land consists of grayish-brown, single grained, porous sand and fine sand.

This land type is used primarily for wildlife habitat and recreation. This soil occurs in the Coast Range and Valley Resource Area (A1).

(Classification: Entisol)

ESTIMATED SOIL PROPERTIES

DEPTH FROM SURFACE (in.)	CLASSIFICATION			COARSE FRACT. OVER 3 IN.	% OF MATERIAL PASSING SIEVE				LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (in/hr)	AVAIL. WATER CAP. (in/in)	SOIL REACTION (pH)	SHRINK SWELL POTENTIAL
	USDA TEXTURE	UNIFIED	AASHO		#4	#10	#40	#200						
0-72	Fine sand or sand	SM-SP	A-2	0	100	100	60-75	10-30	Nonplastic		6.0->20.0	.05-.07	4.6-5.0	Low

DEPTH (in.)	CONDUCTIVITY (mmhos/cm)	CORROSIVITY		EROSION FACTORS		WIND EROD. GROUPS	FLOODING			HIGH WATER TABLE			HYDROLOGIC GROUP
		STEEL	CONCRETE	K	T		FREQUENCY	DURATION	MONTHS	DEPTH (ft.)	KIND	MONTHS	
0-72	-	Low	High	-	5	1	None			>6			A

CEMENTED PAN DEPTH (in.)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (in.)	BEDROCK HARDNESS	FROST ACTION	REMARKS
-		>60		-	

SANITARY FACILITIES AND COMMUNITY DEVELOPMENT

USE	SOIL	RATING	RESTRICTIVE FEATURES
SEPTIC TANK ABSORPTION FIELDS	1	Severe	Percolates rapidly
SEWAGE LAGOONS	1	Severe	Percolates rapidly
SANITARY LANDFILL (TRENCH)	1	Severe	Percolates rapidly
SANITARY LANDFILL (AREA)	1	Severe	Percolates rapidly
DAILY COVER FOR LANDFILL	1	Poor	Too sandy
SHALLOW EXCAVATIONS	1	Severe	Too sandy
DWELLINGS WITHOUT BASEMENTS	1	Slight to severe	Slope
DWELLINGS WITH BASEMENTS	1	Slight to severe	Slope, soil blowing
SMALL COMMERCIAL BUILDINGS	1	Slight to severe	Slope, soil blowing.
LOCAL ROADS AND STREETS	1	Severe	Soil blowing

SOURCE MATERIAL AND WATER MANAGEMENT

USE	SOIL	RATING	RESTRICTIVE FEATURES
ROADFILL	1	Good	
SAND	1	Fair	Excess fines
GRAVEL	1	Unsuited	Excess fines
TOPSOIL	1	Poor	Too sandy
POND RESERVOIR AREA	1	Severe	Percolates rapidly
EMBANKMENTS DIKES AND LEVEES	1	Severe	Low strength, piping, percolates rapidly
DRAINAGE	1		Not needed
IRRIGATION	1		Not needed
TERRACES AND DIVERSIONS	1		Not needed
GRASSED WATERWAYS	1		Not needed

CONTINUATION SHEET OR-SOILS-1 12/72

Active Dune Land SERIES

RECREATION

USE	SOIL	RATING	RESTRICTIVE FEATURES	USE	SOIL	RATING	RESTRICTIVE FEATURES
CAMP AREAS	1	Severe	Too sandy, soil blowing	PLAYGROUNDS	1	Severe	Too sandy, soil blowing
PICNIC AREAS	1	Severe	Too sandy, soil blowing	PATHS AND TRAILS	1	Severe	Too sandy, soil blowing

CAPABILITY AND PREDICTED YIELDS - CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

SOIL	CAPABILITY														REMARKS
	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	
1	VIIIe														

WOODLAND SUITABILITY

SOIL	POTENTIAL PRODUCTIVITY		WOOD SUIT. GROUP	MANAGEMENT PROBLEMS					NATIVE SPECIES
	SPECIES	SITE INDEX		EROSION HAZARD	EQUIPMENT LIMIT.	SEEDLING MORTALITY	WINDTHROW HAZARD	PLANT COMPET.	
	None								

WINDBREAKS

SOILS	SPECIES	HT. AGE 20	PERFOR-MANCE	SPECIES	HT. AGE 20	PERFOR-MANCE	SPECIES	HT. AGE 20	PERFOR-MANCE
	None								

WILDLIFE HABITAT SUITABILITY

SOIL	POTENTIAL FOR HABITAT ELEMENTS								POTENTIAL AS HABITAT FOR:			
	GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLAND WILDLIFE	WOODLAND WILDLIFE	WETLAND WILDLIFE	RANGELAND WILDLIFE
1	Very poor	Very poor	Poor	-	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	-

RANGELAND

RANGE SITE NAME	SOIL	KEY SPECIES AND % COVER	POTENTIAL YIELDS		NORMAL SEASON	
			TOTAL lb/Ac	USABLE Ac/AUM	GROWING	GRAZING
		None				

FOOTNOTES

DATE: 1/74 GBT-GEO WESTPORT SERIES

SOILS:
1. *Westport fine sand, 0 to 12 percent slopes*
2. *Westport fine sand, 0 to 20 percent slopes*
3. *Westport fine sand, 12 to 30 percent slope*
4. *Westport fine sand, 30 to 70 percent slope*
5. *Westport loamy sand, 0 to 12 percent slope*
6. *Westport loamy sand, 12 to 30 percent slop*
7. *Westport-Yaquina loamy sands, 0 to 30 percent slopes*
8. *Westport-Duneland complex, 12 to 30 percen slopes*

The Westport series consists of deep, excessively drained soils that formed in wind-deposited material on nearly level to steep stabilized dunes. The vegetation is Sitka spruce, shore pine, manzanita, evergreen huckleberry, dune grass, forbs and other shrubs. Elevation is 0 to 300 feet. Average annual precipitation is 60 to 100 inches; average annual air temperature is 50 to 53° F. The frost-free period at 32° F. is 200 to 250 days.

A mat of mosses, litter and roots is on top of the mineral soil. Typically, the surface layer is very dark grayish-brown and dark grayish-brown fine sand to loamy fine sand about 16 inches thick. The subsoil is brown to olive gray fine sand to depths greater than 60 inches.

Permeability is very rapid. Runoff is slow from all units. The erosion hazard is high for all units, assuming the vegetation is removed. The total available water holding capacity is 3 to 4 inches. The water supplying capacity is 18 to 20 inches. Effective rooting depth is over 60 inches.

Westport soils are used for homesites, wildlife habitat, and recreation. These soils are in the Northern Pacific Coast Range and Valleys Land Resource Area (MLRA-A1).

(Classification: Typic Udipsamments; mixed, mesic family)

ESTIMATED SOIL PROPERTIES

DEPTH FROM SURFACE (in.)	CLASSIFICATION USDA TEXTURE	UNIFIED	AASHO	COARSE FRACT. OVER 3 IN.	% OF MATERIAL PASSING SIEVE #4	#10	#40	#200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (in/hr)	AVAIL. WATER CAP. (in/in)	SOIL REACTION (pH)	SHRINK SWELL POTENTIAL
0-60	fine sand	SM	A-2	0	100	100	65-80	20-35	non-plastic		6.0- >20.0	.05-.07	5.1-6.0	low

DEPTH (in.)	CONDUCTIVITY (mmhos/cm)	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	T	WIND EROD. GROUPS	FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (ft.)	KIND	MONTHS	HYDROLOGIC GROUP
0-60	-	Low	Moderate	-	5	1	none			> 6			A

CEMENTED PAN DEPTH (in.)	HARDNESS	BEDROCK DEPTH (in.)	HARDNESS	FROST ACTION	REMARKS
-		> 60		-	

SANITARY FACILITIES AND COMMUNITY DEVELOPMENT

USE	SOIL	RATING	RESTRICTIVE FEATURES
SEPTIC TANK ABSORPTION FIELDS 1/	1,5 2,7 3,4,6,8	Slight-Mod Slight to Severe Severe	Slope Slope Slope
SEWAGE LAGOONS 1/	1,2,3,4,5,6,7,8	Severe	Percolates rapidly, slope
SANITARY LANDFILL 1/ (TRENCH)	1,2,3,4,5,6,7,8	Severe	Percolates rapidly, too sandy, slope
SANITARY LANDFILL 1/ (AREA)	1,5 2,3,4,6,7,8	Severe Severe	Percolates rapidly Percolates rapidly, slope
DAILY COVER FOR LANDFILL	1,5 2,3,4,6,7,8	Poor Poor	Too sandy Too sandy, slope
SHALLOW EXCAVATIONS	1,2,5 3,4,6,7,8	Severe Severe	Too sandy Too sandy, slope
DWELLINGS WITHOUT BASEMENTS	1,2,5 3,4,6,7,8	Moderate Severe	Slope Slope
DWELLINGS WITH BASEMENTS	1,2,5 3,4,6,7,8	Moderate Severe	Slope Slope
SMALL COMMERCIAL BUILDINGS	1,2,3,4,5,6,7,8	Severe	Slope
LOCAL ROADS AND STREETS	1,5 3,6 2,4,7,8	Slight Moderate to Severe Severe	- Slope Slope

SOURCE MATERIAL AND WATER MANAGEMENT

USE	SOIL	RATING	RESTRICTIVE FEATURES
ROADFILL	1,5 3,6 2,4,7,8	Good Fair-Poor Poor	- Slope Slope
SAND	1,2,3,4,5,6,7,8	Poor	Excess fines
GRAVEL	1,2,3,4,5,6,7,8	Unsuited	Excess fines
TOPSOIL	1,2,3,4,5,6,7,8	Poor	Too sandy
POND RESERVOIR AREA	1,2,3,4,5,6,7,8	Severe	Percolates rapidly
EMBANKMENTS DIKES AND LEVEES	1,2,3,4,5,6,7,8	Severe	Piping, percs rapidly
DRAINAGE	1,2,3,4,5,6,7,8	-	Not needed
IRRIGATION	1,2,3,4,5,6,7,8	-	Not needed
TERRACES AND DIVERSIONS	1,2,3,4,5,6,7,8	-	Not needed
GRASSED WATERWAYS	1,2,3,4,5,6,7,8	-	Not needed

CONTINUATION SHEET OR-SOILS-1 12/72

WESTPORT SERIES

RECREATION

USE	SOIL	RATING	RESTRICTIVE FEATURES	USE	SOIL	RATING	RESTRICTIVE FEATURES
CAMP AREAS	1,5 2,3,4,6,7,8	Moderate Severe	Too sandy Slope	PLAYGROUNDS	1,2,3,4,5,6,7,8	Severe	Too sandy, slope
PICNIC AREAS	1,5 2,3,4,6,7,8	Moderate Severe	Too sandy Slope	PATHS AND TRAILS	1,2,3,5,6,7,8 4	Severe Severe	Too sandy Slope, too sandy

CAPABILITY AND PREDICTED YIELDS - CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

SOIL	CAPABILITY		Pasture AUM/Ac												REMARKS
	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	
1,5	VIe		1	3											
2,3,4,6,7,8	VIIe		-	1											

WOODLAND SUITABILITY

SOIL	POTENTIAL PRODUCTIVITY		WOOD SUIT. GROUP	MANAGEMENT PROBLEMS					NATIVE SPECIES
	SPECIES	SITE INDEX		EROSION HAZARD	EQUIPMENT LIMIT.	SEEDLING MORTALITY	WINDTHROW HAZARD	PLANT COMPET.	
1,2,3,4,5,6,7,8	Sitka spruce	-	-	Severe	Severe	High	High	Slight	Sitka spruce, shore pine

WINDBREAKS

SOILS	SPECIES	HT. AGE 20	PERFORMANCE	SPECIES	HT. AGE 20	PERFORMANCE	SPECIES	HT. AGE 20	PERFORMANCE
1,2,3,4,5,6,7,8	Shore pine	30	Fair	Sitka spruce	30	Fair			

WILDLIFE HABITAT SUITABILITY

SOIL	POTENTIAL FOR HABITAT ELEMENTS								POTENTIAL AS HABITAT FOR:			
	GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLAND WILDLIFE	WOODLAND WILDLIFE	WETLAND WILDLIFE	RANGELAND WILDLIFE
1,2,3,5,6,7,8	Poor	Poor	Fair	-	Poor	Poor	V.poor	V.poor	Poor	Poor	V.poor	-
4	V.poor	V.poor	Fair	-	Poor	Poor	V.poor	V.poor	Poor	Poor	V.poor	-

RANGELAND

RANGE SITE NAME	SOIL	KEY SPECIES AND % COVER	POTENTIAL YIELDS		NORMAL SEASON	
			TOTAL lb/Ac	USABLE Ac/AUM	GROWING	GRAZING
None						

FOOTNOTES

1/ Ground water pollution hazard

OR-SOILS-1 12/72
FILE CODE SOILS 12

SOIL INTERPRETATIONS FOR OREGC . U.S.D.A. SOIL CONSERVATION SERVICE

DATE: March 1974 GEO Netarts SERIES SOILS:
1. Netarts fine sandy loam, 7-30% slopes
2. Netarts sandy loam, 0-12% slopes
3. Netarts sandy loam, 12-40% slopes
4. Netarts loamy fine sand, 0-30% slopes

The Netarts series consists of well drained soils formed on old stabilized sand dunes. Slopes are 7 to 30 percent. Where not cultivated, the vegetation is shore pine, sitka spruce, salal, huckleberry, rhododendron and manzanita. Elevation is 50 to 200 feet. Average annual precipitation is 80 to 100 inches, average annual air temperature is about 52°F. and the frost-free period is about 180 to 210 days.

The surface layer is fine sandy loam and loamy fine sand about 13 inches thick. The subsoil is fine sand about 39 inches thick. The substratum is fine sand many feet thick.

Permeability is moderately rapid. Runoff is slow; the wind erosion hazard is severe. The total available water holding capacity is 3.5 to 5.0 inches. Water supplying capacity is 20 to 24 inches. The effective rooting depth is over 60 inches.

These soils are used mainly for forestry, homesites, and recreation. They are in the Coast Range and Valleys Resource Area (A1).

(Classification: Entic Haplorthods; sandy, mixed, mesic family).

ESTIMATED SOIL PROPERTIES

DEPTH FROM SURFACE (in.)	CLASSIFICATION USDA TEXTURE	UNIFIED	AASHO	COARSE FRACT. OVER 3 IN.	% OF MATERIAL PASSING SIEVE #4	#10	#40	#200	LIQUID LIMIT	PLASTICITY INDEX	PERMEABILITY (in/hr)	AVAIL. WATER CAP. (in/in)	SOIL REACTION (pH)	SHRINK SWELL POTENTIAL
0-13	Loamy fine sand	SM	A-2	0	100	85-100	65-80	20-35	-	NP	2.0-6.0	.09-.10	4.5-5.0	Very low
13-52	Fine sand	SM	A-2	0	100	85-100	55-70	15-30	-	NP	2.0-6.0	.05-.07	5.1-5.5	Very low
52-65	Fine sand	SM	A-2	0	100	100	60-75	20-30	-	NP	6.0- >20.0	.05-.07	5.1-5.5	Very low

DEPTH (in.)	CONDUCTIVITY (mmhos/cm)	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	EROSION FACTORS T	WIND EROD. GROUPS	FLOODING FREQUENCY	FLOODING DURATION	FLOODING MONTHS	HIGH WATER TABLE DEPTH (ft.)	HIGH WATER TABLE KIND	HIGH WATER TABLE MONTHS	HYDROLOGIC GROUP
0-13	-	High	High	.17	5	2	None			> 6			A
13-52	-	High	High	.20									
52-65	-	High	High	.20									

CEMENTED PAN DEPTH (in.)	CEMENTED PAN HARDNESS	BEDROCK DEPTH (in.)	BEDROCK HARDNESS	FROST ACTION	REMARKS
-		> 60		-	

SANITARY FACILITIES AND COMMUNITY DEVELOPMENT

USE	SOIL	RATING	RESTRICTIVE FEATURES
SEPTIC TANK ABSORPTION FIELDS 1/	2 1,4 3	Slight to moderate Moderate to severe Severe	Slope Slope Slope
SEWAGE LAGOONS 1/	1,2,3,4	Severe	Slope, percolates rapidly
SANITARY LANDFILL (TRENCH) 1/	2 1,3,4	Severe Severe	Percolates rapidly Slope, percolates rapidly
SANITARY LANDFILL (AREA) 1/	2 1,3,4	Severe Severe	Percolates rapidly Slope, percolates rapidly
DAILY COVER FOR LANDFILL	2 1,4 3	Fair Fair to poor Poor	Slope, too sandy Slope, too sandy Slope
SHALLOW EXCAVATIONS	2 1,3 4	Slight to moderate Moderate to severe Severe	Slope Slope Too sandy, slope
DWELLINGS WITHOUT BASEMENTS	2 1,3,4	Slight to moderate Moderate to severe	Slope Slope
DWELLINGS WITH BASEMENTS	2 1,3,4	Slight to moderate Moderate to severe	Slope Slope
SMALL COMMERCIAL BUILDINGS	2 1,3,4	Slight to severe Severe	Slope Slope
LOCAL ROADS AND STREETS	2 1,3,4	Slight Moderate to severe	Slope

SOURCE MATERIAL AND WATER MANAGEMENT

USE	SOIL	RATING	RESTRICTIVE FEATURES
ROADFILL	2 1,3,4	Slight Moderate to severe	Slope
SAND	1,2,3,4	Poor	Excessive fines
GRAVEL	1,2,3,4	Unsuited	Excessive fines
TOPSOIL	1,2,3,4	Poor	Too sandy
POND RESERVOIR AREA	1,2,3,4	Severe	Percolates rapidly
EMBANKMENTS DIKES AND LEVEES	1,2,3,4	Moderate	Piping, percolates rapidly
DRAINAGE	1,2,3,4		Not Needed
IRRIGATION	1,2,3,4	Unsuited	Droughty
TERRACES AND DIVERSIONS	1,2,3,4		Not Needed
GRASSED WATERWAYS	1,2,3,4		Not Needed

CONTINUATION SHEET OR-SOILS-1 12/72 Netarts SERIES

RECREATION

USE	SOIL	RATING	RESTRICTIVE FEATURES	USE	SOIL	RATING	RESTRICTIVE FEATURES
CAMP AREAS	2	Slight to moderate	Slope	PLAYGROUNDS	2	Slight to severe	Slope
	1,4	Moderate to severe	Slope, too sandy		1,3,4	Severe	Slope
	3	Severe	Slope				
PICNIC AREAS	2	Slight to moderate	Slope	PATHS AND TRAILS	2	Slight	
	1,4	Moderate to severe	Slope, too sandy		1,3,4	Moderate to severe	Slope
	3	Severe	Slope				

CAPABILITY AND PREDICTED YIELDS - CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

SOIL	CAPABILITY														REMARKS
	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	NIRR	IRR	
1,3,4	VIIe														
2	VIe														

WOODLAND SUITABILITY

SOIL	POTENTIAL PRODUCTIVITY		WOOD SUIT. GROUP	MANAGEMENT PROBLEMS					NATIVE SPECIES
	SPECIES	SITE INDEX		EROSION HAZARD	EQUIPMENT LIMIT.	SEEDLING MORTALITY	WINDTHROW HAZARD	PLANT COMPET.	
1	Sitka spruce	150 (est)	20	Severe	Slight	Slight to moderate	Slight to moderate	Slight	Sitka spruce, shore pine

WINDBREAKS

SOILS	SPECIES	HT. AGE 20	PERFORMANCE	SPECIES	HT. AGE 20	PERFORMANCE	SPECIES	HT. AGE 20	PERFORMANCE
1,2,3,4	Shore Pine	35-40	Fair	Sitka Spruce	35-40	Fair	Western Red Cedar	35-40	Fair

WILDLIFE HABITAT SUITABILITY

SOIL	POTENTIAL FOR HABITAT ELEMENTS								POTENTIAL AS HABITAT FOR:			
	GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLAND WILDLIFE	WOODLAND WILDLIFE	WETLAND WILDLIFE	RANGELAND WILDLIFE
1	Very poor	Very poor	Fair	-	Poor	Good	Very poor	Very poor	Poor	Poor	Very poor	-

RANGELAND

RANGE SITE NAME	SOIL	KEY SPECIES AND % COVER	POTENTIAL YIELDS		NORMAL SEASON	
			TOTAL lb/Ac	USABLE Ac/AUM	GROWING	GRAZING
	1	None				

FOOTNOTES

1/ Ground water pollution hazard

APPENDIX C

Oregon Transportation Commission
Beach Log Removal Policy

State of Oregon TRANSPORTATION COMMISSION

BEACH LOG REMOVAL POLICY - Adopted March 30, 1976

Ocean Shore Management Goal

To assure continuation of scenic and recreational values for public enjoyment at the ocean shore and to protect marine life and intertidal resources, beach logging as a general practice shall be prohibited unless such removal can be shown to provide a significant public benefit.

Proposals for beach log removal shall be considered in light of the following beach management objectives:

1. Management to protect scenic and recreational use values of driftwood. Enhance recreation by opening access routes where necessary, improving scenic values or providing needed beach use area.
2. Management to protect the traditional practice of gathering firewood and ornamental driftwood as long as these activities are compatible with the overall recreation and scenic uses of the beach.
3. Management to provide for the orderly retrieval of branded logs by the legal owner(s).
4. Management to protect shorelines subject to erosion.
5. Management to protect clam beds, intertidal marine life and wildlife habitats.
6. Management to promote public safety by reducing critical fire hazards, reducing critical hazards to shoreline structures or eliminating other public hazards.
7. Management to assist in fish passage or flood control.

BEACH LOG REMOVAL POLICY (continued)

8. Management to provide opportunities for public participation in decision making on proposed projects.
9. Management to protect legal interest of upland property owners and the state.
10. Management to minimize adverse impacts of log loading and hauling operations.

Individual beach areas where log removal would be permitted and the time period allowed for such removal will be determined by the state after evaluation by the State Parks and Recreation Branch, consultation with local government, the upland property owner and affected state agencies (State Land Board, State Fish Commission, State Wildlife Commission, State Geology and Mineral Industries, State Department of Environmental Quality, State Department of Forestry, State Land Conservation and Development Commission) to establish interests to be protected and considered.

Adequate public notice and provision for hearings will be handled in the same manner as beach improvement applications under the State Beach Law, as set forth in ORS 390.650.

The granting of emergency permits necessary to ensure public safety or the emergency retrieval of branded logs or lumber will be handled in the same manner as emergency beach improvements under the State Beach Law, as set forth in ORS 390.650.

Removal permits would be planned and executed to minimize adverse operational impacts and with adequate provisions for public safety, liability insurance and consideration of private property rights. Regulations and supervisory control in this regard will be determined by the State.

APPENDIX D

Oregon Transportation Commission
Beach Improvement Standards

STATE OF OREGON TRANSPORTATION COMMISSION

BEACH IMPROVEMENT STANDARDS

The overall policies and guidelines for the protection of public rights and interests at Oregon's ocean shore have been described by the State Legislature in the Oregon Beach Law (ORS 390.605 - 390.770) which was passed in 1967 and revised in 1969. The law identifies existing state rights in the ocean shore areas seaward of a surveyed beach zone line which are to be protected for the free and uninterrupted use of the public.

The State Highway Division (whose State Parks Branch has jurisdiction over ocean beaches as recreation areas) was given the responsibility for considering applications and issuing permits for construction seaward of the beach zone line. Because of some concurrent jurisdictions, the Highway Division includes the Division of State Lands in such beach permit reviews. Reviews may also include the State Dept. of Geology, the State Fish and Wildlife Commission, Local Government, and other governmental agencies where applicable.

The Oregon Beach Law provides basic standards to be considered in the evaluation of beach improvement permit applications. These standards are presented in ORS 390.655 as follows:

> The standards shall be based on the following considerations, among others:
>
> (1) The public need for healthful, safe, esthetic surroundings and conditions; the natural scenic, recreational and other resources of the area; and the present and prospective need for conservation and development of these resources.
>
> (2) The physical characteristics or the changes in the physical characteristics of the area and the suitability of the area for particular uses and improvements.
>
> (3) The land uses, including public recreational use, if any, and the improvements in the area, the trends in land uses and improvements, the density of development and the property values in the area.
>
> (4) The need for recreation and other facilities and enterprises in the future development of the area and the need for access to particular sites in the area.

Supplementary to the standards presented in the Oregon Beach Law, the Oregon Land Conservation and Development Commission's Beaches and Dunes Goal (Goal No. 18, Implementation Requirements, Sec. 5) prescribes the following beach improvement criteria:

> (5) Permits for beach front protective structures shall be issued under ORS 390.605 - 390.770, only where development existed on January 1, 1977. The

Oregon Department of Transportation, cooperating with local, state and federal agencies shall develop criteria to supplement the Oregon Beach Law (ORS 390.605 - 390.770) for issuing permits for construction of beach front protective structures. The criteria shall provide that:

(a) visual impacts are minimized;

(b) necessary access to the beach is maintained;

(c) negative impacts on adjacent property are minimized; and

(d) long-term or recurring costs to the public are avoided.

In accordance with ORS 390.650, the State Highway Engineer shall grant the permit if approval would not be adverse to the public interest.

To aid in the review of these standards, the following definitions as presented in ORS 390.605 and the State Planning Goals and Guidelines apply:

An "improvement" includes a structure, appurtenance or other addition, modification or alteration constructed, placed or made on or to the land. (ORS 390.605)

"Ocean shore" means the land lying between extreme low tide of the Pacific Ocean and the line of vegetation as established and described by ORS 390.770. (ORS 390.605)

"Develop" - To bring about growth or availability to construct or alter a structure, to conduct a mining operation, to make a physical change in the use or appearance of land, to divide land into parcels, or to create or terminate rights of access. (State Planning Goals and Guidelines)

"Development" - The act, process, or result of developing. (State Planning Goals and Guidelines)

Pursuant to the above directives and the evaluation of more than 100 permit applications since 1967, the State Parks Branch has formulated beach improvement standards. These standards are presented in the form of concerns to be evaluated prior to reaching a decision on permit approval or denial.

BEACH IMPROVEMENT STANDARDS

Each site on the ocean shore presents different conditions and applicants have varying project needs. Evaluations point up the relative significance of the general, scenic, recreational, safety, and other interests of the public.

The physical characteristics or the changes in the area which are important to the project will be reviewed. (These may include bank alignments, topography, shoreline materials and stability, width of the beach, past erosion, storm water levels, sand movement, water currents, adjoining structures, beach access, land uses, etc.)

Public opinion in response to public notice or hearings on the subject will be considered in evaluating each of the following concerns.

Considered together, these assist in the overall decision for granting, denying, or modifying the beach permit application in accordance with the intent of the legislature.

A. GENERAL CONCERNS EVALUATED - The following general concerns will be considered:

1. PROJECT NEED - There must be a critical need or adequate justification for the project to come seaward of the beach zone line and alter the ocean shore area.

2. PROTECTION OF PUBLIC RIGHTS - Public ownership or use easement rights seaward of the beach zone line will be adequately protected.

3. PUBLIC LAWS - The applicant must comply with federal, state, and local laws and regulations affecting the project.

4. PROJECT MODIFICATIONS - There are no reasonable project modifications that would better protect the public rights, reduce or eliminate problems, or avoid long term cost to the public.

5. PUBLIC COSTS - There are no reasonable special measures which might reduce or eliminate significant public costs. Alternatives such as nonstructural solutions, provision for ultimate removal responsibility for structures when no longer needed, reclamation of excavation pits, mitigation of project damages to public interests, or a time limit on project life to allow for changes in public interest have been considered.

6. COMPLIANCE WITH LCDC GOALS - In accordance with the Statewide Land Conservation and Development Commission Goal #18 for Beaches and Dunes, permit applications for beachfront protective structures seaward of the beach zone line will be considered only where development existed on January 1, 1977. The proposed project will be evaluated against the applicable criteria included within Goal #18 and other appropriate statewide planning goals.

   The project must be consistent with local comprehensive plans where such plans have been approved by LCDC.

B. SCENIC CONCERNS EVALUATED - Projects seaward of the beach zone line should be designed to minimize damage to the scenic attraction of the ocean shore area.

1. NATURAL FEATURES - The project should retain the scenic attraction of key natural features. (Beaches, headlands, cliffs, sea stacks, streams.)

2. SHORELINE VEGETATION - The project should retain or restore existing vegetation seaward of the beach zone line when vital to scenic values.

3. VIEW OBSTRUCTION - The project should avoid or minimize obstruction of existing views of the ocean and beaches from adjacent properties.

4. COMPATIBILITY WITH SURROUNDINGS - The project should blend in with the existing shoreline scenery. (Type of construction, color, etc.)

C. RECREATION USE CONCERNS EVALUATED - The project should not eliminate significant public recreation use or access within the ocean shore area.

1. RECREATION USE - The project should avoid eliminating significant public recreation use opportunities within the ocean shore area.

2. RECREATION ACCESS - The project should avoid blocking off or obstructing important public access routes within the ocean shore area.

D. SAFETY CONCERNS EVALUATED - The project should be designed to avoid or minimize safety hazards to the public and shoreline properties.

1. STRUCTURAL SAFETY - The project should not be a safety hazard to the public due to inadequate structural foundations, lack of bank stability, or the use of weak materials subject to rapid ocean damage.

2. OBSTRUCTIONAL HAZARDS - The project should not be an obstruction to pedestrians or vehicles going onto or along the ocean shore area.

3. NEIGHBORING PROPERTIES - The project should be designed to avoid or minimize ocean erosion or safety problems for neighboring properties.

4. PROPERTY PROTECTION - Beachfront property protection projects should be designed to accomplish a reasonable degree of increased safety for the on-shore property to be protected.

E. OTHER RESOURCE CONCERNS EVALUATED - Projects seaward of the beach zone line should avoid or minimize damage to especially significant resource sites or ocean shore conditions for the following where it is applicable:

1. SIGNIFICANT FISH AND WILDLIFE HABITATS
2. ESTUARINE VALUES AND NAVIGATION INTERESTS
3. SIGNIFICANT HISTORIC AND ARCHEOLOGICAL SITES
4. SIGNIFICANT NATURAL AREAS (Vegetation or Aquatic Features)
5. AIR AND WATER QUALITY OF THE OCEAN SHORE AREA.

RIM:aw
3/28/78

Dune Stabilization & Restoration

Methods & Criteria

Oregon Coastal Zone Management Association, Inc.

This report was prepared as part of a larger document addressing various beach and dune planning and management considerations and techniques. Other segments of the document and additional materials are:

I. BACKGROUND ON BEACH AND DUNE PLANNING:

Background of the Study

An Introduction to Beach and Dune Physical and Biological Processes

Beach and Dune Planning and Management on the Oregon Coast: A Summary of the State-of-the-Arts

II. BEACH AND DUNE IDENTIFICATION:

A System of Classifying and Identifying Oregon's Coastal Beaches and Dunes

III. PHYSICAL AND BIOLOGICAL CONSIDERATIONS:

Physical Processes and Geologic Hazards on the Oregon Coast

Critical Species and Habitats of Oregon's Coastal Beaches and Dunes

IV. MANAGEMENT CONSIDERATIONS:

Dune Groundwater Planning and Management Considerations for the Oregon Coast

Off-road Vehicle Planning and Management on the Oregon Coast

Sand Removal Planning and Management Considerations for the Oregon Coast

Oregon's Coastal Beaches and Dunes: Uses, Impacts and Management Considerations

Dune Stabilization and Restoration: Methods and Criteria

V. IMPLEMENTATION TECHNIQUES:

Beach and Dune Implementation Techniques: Findings-of-Fact

Beach and Dune Implementation Techniques: Site Investigation Reports

*Beach and Dune Implementation Techniques: Model Ordinances**

VI. ANNOTATED BIBLIOGRAPHY:

Beach and Dune Planning and Management: An Annotated Bibliography

VII. EDUCATIONAL MATERIALS:

Slide show: *Managing Oregon's Beaches and Dunes*

Brochure: *Planning and Managing Oregon's Coastal Beaches and Dunes*

*Prepared under separate contract between Oregon Department of Land Conservation and Development and the Bureau of Governmental Research, Eugene.

Cover photo by Wilbur E. Ternyik, Florence, Oregon.

DUNE STABILIZATION AND RESTORATION: METHODS AND CRITERIA

by

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PREFACE

The following report presents the results of an in-depth analysis of sand stabilization methods for use on beach and dune areas on the Oregon Coast. This report was prepared under the auspices of the Oregon Coastal Zone Management Association and constitutes one element of an overall analysis of planning for, and managing, coastal beaches and dunes as required by Oregon's Beaches and Dunes Goal.

This report was prepared by Wilbur E. Ternyik, Wave Beachgrass Nursery, Florence, Oregon, with assistance from OCZMA's Beaches and Dunes Study Team composed of Carl Lindberg, Project Director, Christianna Crook, Research Associate, Arlys Bernard, Project Secretary, and Kathy Fitzpatrick, Project Administrator.

In addition, valuable review and comments were made on portions of this product by the Beaches and Dunes Steering Committee composed of:

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Steve Stevens, U.S. Army Corps of Engineers
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Bob Cortright, Oregon Department of Land Conservation and Development
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I. INTRODUCTION

Sand dune stabilization is one dune management option. It is a necessary tool that when used properly can assist planners and developers in achieving the objectives of the Beaches and Dunes Goal. Dune stabilization should be used only where appropriate to accomplish a useful purpose, however.

Current knowledge and techniques are adequate to solve most wind erosion problems utilizing various stabilization techniques. The Oregon coast still benefits from the massive dune stabilization effort of the Warrenton Soil and Water Conservation District in Clatsop County. In recent years, however, dune stabilization projects in the Coos Bay dune sheet south of Florence have exceeded the Warrenton project.

Even though the technical knowledge is sound, not all Oregon coastal stabilization projects were necessary or desireable. Careful evaluation of site investigation reports in the future should help to avoid unnecessary stabilization endeavors. In short, dune stabilization projects should be used to accomplish the following:

(1) Protect natural features, lakes, wetlands, forests, estuarine habitats, etc.
(2) Protect manmade improvements such as highways, parks, shipping channels, structures, etc.
(3) Create deflation plain wetland habitat or upland habitat.
(4) Provide needed beach access.
(5) Serve as a tool to overcome hazardous situations in an effort to allow for beach and dune uses consistent with the Beaches and Dunes Goal.

Dune stabilization projects should not be used to promote the following:

(1) Creation of social program jobs.
(2) Creation of total vegetative cover for no valid given reason.

Where possible, dune stabilization efforts should be kept to the minimum amount required to accomplish the protection or enhancement needed. It should be required that consideration be given to small island or protective strip plantings as opposed to the Warrenton Dune project total vegetative cover approach. In some areas, after careful study, it may be appropriate to remove vegetation inappropriately placed in years past.

The bottom line in dune stabilization is think before you act, because stabilization actions can have a drastic impact on the entire dune sheet involved. Always bear in mind that all forms of dune stabilization are but a thin blanket of security over a still living dynamic landform waiting to be reactivated.

II. USE OF DUNE MANAGEMENT AREAS

It is suggested that due to the living, always moving, nature of coastal dune systems, that they be divided into identified management areas. A dune management area is a region established on the basis of significant natural or manmade boundaries that clearly separate it from interaction with surrounding well-defined zones of contiguous landform types such as foredune, deflation plain, open dunes and older stabilized dunes. The same management area should also be divided into defined areas of proposed future use reflecting the carrying capacity of that area in concert with the needs and long range objectives of the entire dune sheet.

Although not specifically addressed by the Beaches and Dunes Goal, such an approach would greatly assist in managing dunes for health and safety of human inhabitants and for the integrity of the overall dune system.

Dune management areas can be easily identified by focusing on existing natural or manmade boundaries such as highways, rivers, estuaries, etc. These barriers prevent major dune changes taking place in one area from affecting the adjoining areas. For example, in Lane County, a dune management area might be described as:

> from Siltcoos Outlet where it meets the Pacific Ocean upstream to U. S. Highway 101, then north using the Highway 101 as the eastern boundary to the south bank of the Siuslaw River, then downstream to the Pacific Ocean along the bank line, then south along the ocean beach back to the point of origin.

A dune management area in Coos County might be described as:

> from where Coos Bay meets the Pacific Ocean along the north bank upstream to U. S. Highway 101 at Menasha Causeway, then north to Tenmile Outlet, then downstream to the Pacific Ocean, and south along the beach to the point of origin.

The dune management area approach was addressed by the U. S. Army Corps of Engineers in their 1974 Coastal Reconnaisance Study which presents an excellent, detailed example of the technique and benefits from such an analysis. One example of this approach is the Corps' evaluation of the Coos Bay North Peninsula Area. The Table of Contents for this section clearly illustrates the systematic approach for management proposed by the Corps (see Figure 1). Careful study of the evidence developed in such a thorough approach allows for value judgements leading to specific use recommendations as shown in Figure 2.

The clear advantage in this approach is the visual identification of management objectives and a factual written background forming the basis of decision-making. Regardless of whether dune landforms are identified as management areas composed of various management units, it is essential that dune stabilization efforts take into consideration the potential impact(s) of stabilization on the overall dune sheet or management area.

SITE NO. 9

COOS BAY NORTH PENINSULA AREA

CONTENTS

Figure 1. An example of the approach used by the U. S. Army Corps of Engineers in identifying dune management areas and units (U. S. Army Corps of Engineers, 1974, p. 303).

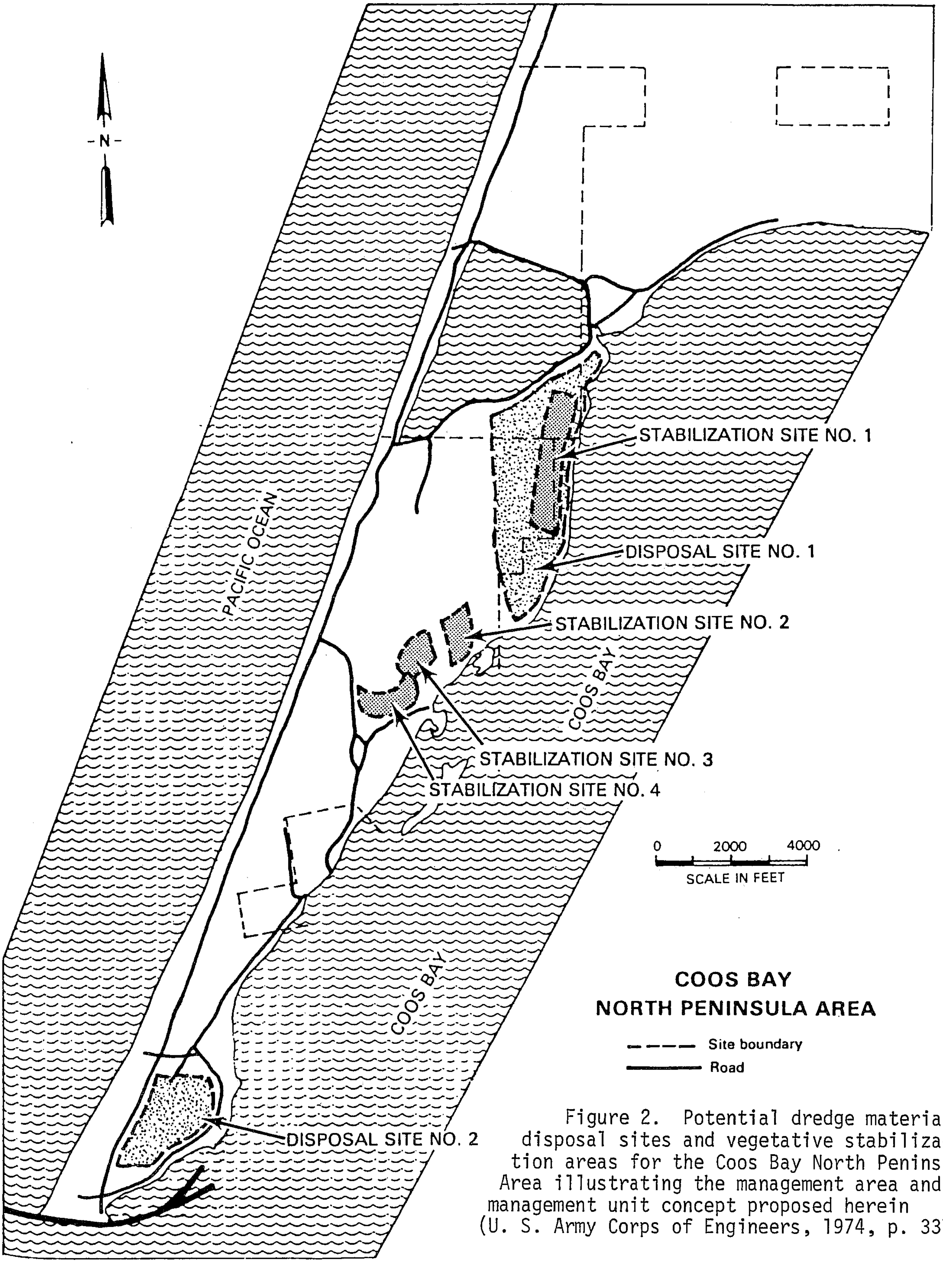

Figure 2. Potential dredge material disposal sites and vegetative stabilization areas for the Coos Bay North Peninsula Area illustrating the management area and management unit concept proposed herein (U. S. Army Corps of Engineers, 1974, p. 337).

III. STABILIZATION METHODS - VEGETATIVE

Due to the distinctly different growing conditions and physical problems associated with beaches and dunes such as proximity to the ocean, wave energy, wind exposure, soil fertility, etc., vegetative stabilization of dune landforms is discussed based on classification of the dune landform location. The following four major classifications are addressed:

(1) Foredune area--that area from the high tide line to the toe of the slope on the lee side of the foredune. In the event that a foredune is not present, the area 200 yards back from the high tide line is considered as the frontal area.
(2) Deflation plain area or wet inner dune area.
(3) Inner open dune areas not subject to ocean influence.
(4) Older stabilized dunes.

A. Foredune Area

Foredune areas along the Oregon coast will continue to be built on regardless of the potential risk. Recent court decisions in Lincoln County regarding Salishan Spit, and the City of Manzanita's decision to take an exception to allow buildings on the foredune area are only two examples. It is therefore the purpose of this section to suggest a sound vegetative management program to minimize the potential for hazard in such areas where development has occured or is allowed to locate.

For the purpose of this discussion, the foredune area is divided into three sections in order to address varying growing conditions: the frontal area, the top surface, and the lee side or reverse slope. These areas of the foredune are generally illustrated in Figure 3.

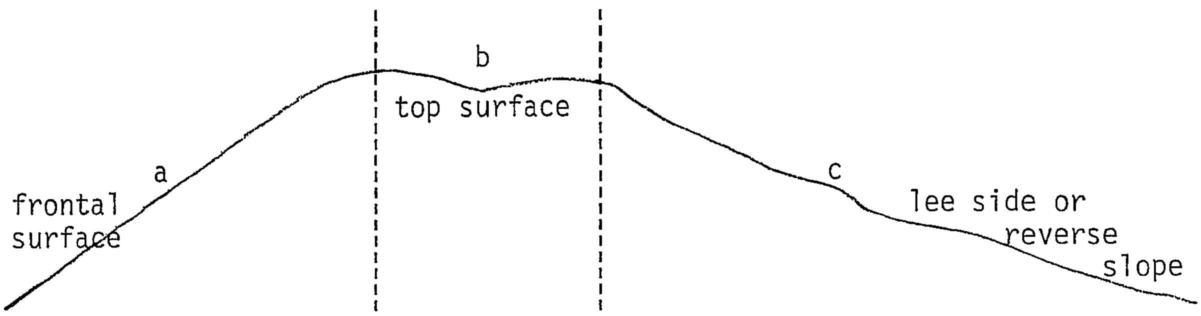

Figure 3. Cross section of a foredune illustrating the (a) frontal section of the foredune or frontal slope dune area facing the beach; (b) the top surface of the foredune or frontal area; and (c) the lee side of the foredune (that portion that receives protection from the wind).

1. Front of the Foredune

The front section of a foredune or frontal slope is best stabilized using European beachgrass (<u>Ammophila arenaria</u>) as indicated in Figure 4. Planting procedures would follow specifications for planting as noted

Planting procedures would follow specifications for planting as noted in Tables 1-3.

Figure 4. European beachgrass planting on foredune frontal area. Note planting pattern and density required to minimize erosion on this severely exposed site.

If the forward slope is steep or the problem is stabilizing coastal sand sea cliffs, then the density of planting and fertilizer requirements differ from the specifications noted in Tables 1-3 as follows:

Density: Density of planting should be at a spacing of 12" x 12" between hills and four to five culms per hill.

Fertilizer: Fertilizer rate would increase to 400 lbs. of 21-0-0 per acre. Application must take place immediately after planting. Failure to fertilize on the day of planting will result in all fertilizer ending up at the bottom of the slope where it is not needed.

Site Preparation: It should be recognized that failure to adequately control water erosion at the base of the foredune or sea cliff areas, makes it totally useless to stabilize frontal or top foredune areas. The water erosion from wave energy can cause massive slope failures and eventually wash away all the grass planted.

Where natural or manmade breaches in the foredune occur, the placement of sand fences parallel to the dune will normally collect enough windblown sand to repair the hole or depression. These fences should be used until the breached area is level with the average height of the foredune. Fence installation should be four foot lath woven wire fence with six foot steel fence posts every ten feet. Front fence should be braced at the end posts and at twenty foot intervals. Placement of two fences twenty to thirty feet apart is essential.

Table 1. Recommended specifications for planting European beachgrass (Ammophila arenaria). Specifications are also applicable to American beachgrass (Ammophila breviligulata) and Sea Lyme-grass (Elymus mollis)

INSPECTION:

1. Inspections should be made by the Contracting Officer or his authorized representative. A representative cross section of not less than 5% of the planted areas should be inspected to ensure compliance with the contract requirements.

2. Nonconformance with any specifications classifies a plant hill as unsatisfactorily planted. A tolerance of 5% or 5 unsatisfactory plant hills per 100 is satisfactory. However, any amount over 5% should be applied as an equal percentage reduction of the acreage planted (payments being made on the basis of net acreage). When the deficiencies are 10% or over, the contractor should be expected to take steps to correct them.

PLANTING STOCK:

1. The stock to be planted is European Beach Grass (Ammophila arenaria). The source and quality of the planting stock should be approved by the Contracting Officer or the authorized representative.

DIGGING, STRIPPING AND TRIMMING:

1. The plants should be thoroughly cleaned by shaking sand and silt from the roots. Dead stalks and trash should be removed from the culms by stripping. The underground stems should be broken back so that one or two nodes remain. The grass culms should be sorted and tied into bundles weighing approximately 10 pounds; tops should be cut back so that the overall length of the planting stock measures about 20 inches.

PLANTING:

1. The grass is planted in hills with three live culms per hill.

2. The spacing between hills should average 18 inches.

3. The grass should be planted to a depth of 12 inches, with sand or silt for cover compacted to exclude air from the roots (nodes). The top of the plant should be upright and extend approximately eight inches above the ground.

4. No planting should be done on any area until the moisture is within three inches of the ground surface. Nor should any planting be done when the temperature exceeds 60 degrees F. or when freezing conditions prevail.

Table 1, continued.

	5. All areas planted should be fertilized with coarse particle ammonium sulfate commercial fertilizer, applied at a rate of forty two pounds of available nitrogen per acre. Fertilizer should be applied when the wind is calm and the rain is steady; irrigation may be substituted for rain. The fertilizer should be applied at the time directed by the Contracting Officer of the authorized representative.
STORAGE:	1. The planting stock should be planted within eight hours of removal from the nursery areas or heeling-in beds. The heeling-beds should be a well-drained damp trench with the roots (nodes) covered to a depth of at least eight inches. Stock should not be held in heeling-in beds for a period exceeding two weeks. The supply of stock at the planting site must be kept in a cool shady place or otherwise protected against damage from excessive drying.
TRANSPORTATION AND HANDLING:	1. The planting stock should be handled and transported by any method that does not damage the planting stock or area.

Table 2. Basic recommended native plant material chart for dune stabilization

	SPECIES	C	S	BR	B&B	Seed	1-0	2-0	2to10	Size	A-1	A-2	A-3	A-4	CA	FC	SP	Season
Grasses	Ammophila arenaria - European beachgrass	x		x				x		20"	x	x	x	x	x		18"x18"	Nov. 15 - March 15
	Ammophila breviligulata - American beachgrass	x		x				x		20"	x	x	x	x		x	18"x18"	Nov. 15 - April 15
	Elymus mollis - sea lyme grass	x		x				x		20"	x					x	18"x18"	Nov. 15 - Feb. 15
	Poa macrantha - seashore bluegrass		x			x				15 lb.			x			x	cc	Sept. or Apr.-June
Legumes	Lupinus littoralis - seashore lupine		x			x				7 lb.	x	x	x	x		x	cc	Sept. or Apr.-June
	Lathyrus maritimus - purple beach pea		x			x				15 lb.	x	x	x	x		x	cc	April - June
Marsh	Carex obnupta - slough sedge	x		x						12"		x			x		18"x18"	April - July
	Deschampsia caespitosa - hairgrass	x		x						12"		x			x		18"x18"	April - July
	Juncus acuminatus - sharp fruited rush	x		x						12"		x				x	18"x18"	April - July
	Juncus effusus - tussock	x		x						14"		x				x	18"x18"	April - July
Woody	Lupinus arboreus - tree lupine		x			x				30 lb.	x	x	x	x		x	cc	April - June
	Gaultheria shallon - salal		x		x			x		1 gal.		x	x	x	x		3'x3'	Dec. - Feb.
	Vaccinium ovatum - evergreen huckleberry		x		x			x		1 gal.		x	x	x	x		3'x3'	Dec. - Feb.
	Cytisus scoparius - scotch broom		x	x			x			14 "		x	x	x		x	8'x8'	Dec. - March
	Myrica californica - wax myrtle		x		x			x		1 gal-10'		x	x	x	x		8'x8'	Dec. - Feb.
	Picea sitchensis - sitka spruce		x	x	x			x		12"-10'		x	x	x	x		8'x8'	Dec. - Feb.
	Pinus contorta - shore pine		x	x	x			x		12"-20'		x	x	x	x		8'x8'	Dec. - Feb.

C - colonizer-initial stabilizer
S - secondary-permanent S
BR - bare root stock
B&B - balled and burlapped
1-0 - one year old
2-0 - two year old
2 to 10 - two to ten years old
Size - height or pounds per acre
A-1 - foredune or frontal areas
A-2 - deflation plain or wet interdune
A-3 - open sand areas
A-4 - older stabilized dunes
CA - commercially available
FC - field collection
SP - spacing inches, feet, cc-complete cover
Season - planting dates (optimum)

Table 3. Transplants needed with varied spacing requirements

Transplant Type	Spacing	1,000 sq. ft.	1 Acre	100 Acres
Beachgrass - 3 culms per hill	12"x12"	3,004	130,680	13,068,000
Beachgrass - 3 culms per hill	18"x18"	1,335	58,080	5,808,000
Beachgrass - 3 culms per hill	24"x24"	751	32,670	3,267,000
Beachgrass - 3 culms per hill	30"x30"	480	20,880	2,088,000
Beachgrass - 5 culms per hill	12"x12"	5,006	217,800	21,780,000
Woody species - 1 transplant per hill	3'x3'	111	5,840	484,000
Woody species - 1 transplant per hill	6'x6'	28	1,210	121,000
Woody species - 1 transplant per hill	8'x8'	16	680	68,000
Woody species - 1 transplant per hill	12'x12'	7	302	30,200

Note - A word of caution: Always order 3% more to offset heavy planting.

Maintenance: Continual maintenance is required on beach grass for about the first two years; after that, only periodic maintenance is required. If a large blow-out develops, the most effective maintenance procedure is to replant with beach grass and then spread brush on the steep edges. Refertilizing all weak areas seems to bring back sufficient cover if the plant root systems have not been uncovered.

2. Top Surface of the Foredune or Frontal Area

Normally the top surface of the foredune experiences severe wind erosion and sand accretion. For this reason, European beachgrass is the recommended plant material for vegetative stabilization. Like the steep frontal areas, 12" x 12" spacing and fertilizer application of 400 lbs. per acre of 21-0-0 are recommended (see Tables 1-3).

Secondary plantings of other species are not recommended due to the hostile environment normally present at these sites. Annual application of 200 lbs. per acre of 21-0-0 applied in March during the rains will provide adequate maintenance.

3. Lee Side of the Foredune

The reverse slope or back area, if open sand, should be stabilized using European beachgrass planted to standard specifications (e. g., three culms per hill using 18" x 18" spacing, see Tables 1-3).

Planted in well established beach grass stands, the following secondary plant material will provide some permanent vegetative cover and alleviate some of the fire hazard associated with old, dense stands of beach grass. Refer to Table 2 for planting specifications pertaining to the following secondary plant material.

Gaultheria shallon	salal
Vaccineum ovatum	evergreen huckleberry
Pinus contorta	shore pine

In addition, the following plant species can be seeded and will provide some fire protection:

Lathyrus maritimus	purple beach pea
Lupinus littoralis	seashore lupine
Lupinus arboreus	tree lupine

Figure 5 illustrates a man-created foredune resulting from the Warrenton Soil and Water Conservation District project. The foredune was created using a combination of the stabilization techniques described herein, including sand fences and plantings of European beachgrass. The foredune, established in 1935, has continued to maintain itself while affording protection to inland areas.

Figure 5. Man-created foredune in the Warrenton Soil and Water Conservation District dune stabilization project several years after initial European beachgrass plantings. Note the vigorous growth resulting from the fertilizing effect of the annual wind-blown beach sand entrapped by the beach grass.

B. Deflation Plain or Wet Interdune Area

Most of the vast open sand deflation plains along the Oregon coast have become vegetated by natural plant invasion. This natural plant succession process is the result of the introduction of European beachgrass from Holland in the early 1900's. Plantings and natural spreading of this species quickly resulted in the establishment of foredunes that created living barriers cutting off the supply of wind-blown beach sand to the interior areas. Wind erosion in areas back of the foredune scoured the areas down to the water table creating a perfect seed bed. Wind-blown and animal carried seeds quickly became established in these plains of deflation, and entire areas were soon vegetated. The introduction of beaver in the Oregon Dunes National Recreation Area hastened this process of vegetation establishment by damming up drainages which raised the water table and created conditions even more attractive to vegetative establishment.

In some areas of the Oregon coastal dunes, open areas of sand behind the foredune still exist. Other open sand areas may appear on the scene as a result of man's interference with the dune system or natural causes such as fire.

Due to the high water table which characterizes the deflation plain areas, very little building activity is expected to occur in this area. Further, septic tank problems, interference with waterfowl habitat, and

HUD Floodplain Insurance Program regulations will probably make it difficult to build on this landform. However, stabilization efforts may be needed to protect some adjoining feature or to provide the opportunity for creation or enhancement of wetland habitat. With this in mind, the following vegetative stabilization methods are recommended.

1. Wildlife Habitat and Permanent Vegetation Stabilization

Carefully selected areas that have scoured down to the summertime water table can be seeded with a mixture of grasses and legumes to accomplish the creation or enhancement of wildlife habitat or stabilization of areas to protect adjoining features. Such seedings should take place in late May or early June, depending on wind conditions. Planting too early can result in a planting failure due to the lowering water table withdrawing moisture from the plant roots. Such planting failures are usually irregular, causing uneven erosion and deposition over the entire area, and compounding the problem of revegetating the area sometime in the future.

The seed and fertilizer mixtures recommended have proved successful for many years in the Oregon Dunes National Recreation Area, as is evidenced in Figures 6 and 7.

Figure 6. Deflation plain planting for establishment of wildlife habitat three weeks after seeding. The seeding was the result of a cooperative effort between the land owner, the U. S. Forest Service, and the Oregon Fish and Wildlife Department, and was conducted near the Siltcoos Outlet, Lane County, Oregon.

Figure 7. Five-month old deflation plain planting for supplemental waterfowl feed, South Jetty Road, Florence, Oregon. Note stand of barley that will soon be flooded by winter rains.

Suggested Seed Mixture:

Species	Common Name	lbs./acre
Hordeum	barley	100
Lolium perenne	perrenial ryegrass	7
Festuca arundinacea	alta fescue	22
Lotus corniculatus	birdsfoot trefoil	4

All seeds suggested are available from commercial seed sources. In addition, any one of the three native species listed in Table 2 for possible use in deflation plain plantings could be added to the mixture noted above. However, all three species must be field collected. Since collection sites are not identified, commercially available seed is the least costly approach at this time.

Fertilizer applied at the time of seedings should be at a rate of 200 lbs per acre of 13-13-13. The seed and fertilizer are usually applied using a tractor drawn double disc drill and fertilizer spreader. One should be aware that pockets of semi-quicksand exist in the deflation plain areas; in the past costly delays have been experienced by equipment sinking.

2. Pacific Flyway Supplemental Feed Plantings

In this application, permanent grasses are not seeded. Instead barley (Hordeum) is seeded annually at a rate of 100 lbs. per acre in an attempt to provide feed for migrating waterfowl. Since seed production is desired, the recommended fertilizer rate is 400 lbs. per acre of 15-15-15. If the site is used year after year, then site preparation in the form of discing is advisable prior to planting. In most areas, slough sedge (Carex obnupta) usually invades the planted areas. Thousands of migratory waterfowl have benefited from this type of dune stabilization efforts in the Oregon Dunes National Recreation Area.

C. Marsh Creation

The opportunity exists in sand spit deflation plains that are tidaly influenced or where dredge material storage areas are located for marsh creation or enhancement (see Figures 8, 9, and 10). Four plant species have been tested by the U. S. Army Corps of Engineers Waterways Experiment Station for this purpose. In this regard, Ternyik (1978) developed specifications for planting four marsh species (see Table 4) as follows:

Carex obnupta	slough sedge
Deschampsia caespitosa	hairgrass
Juncus acuminatus	sharp-fruited rush
Juncus effusus	tussock

Note that the specifications deal only with transplanted materials rather than seeding. Ternyik (1978) indicated total failure after extensive seeding research efforts. It should be clearly understood that these recommendations are for freshwater marsh creation sites only.

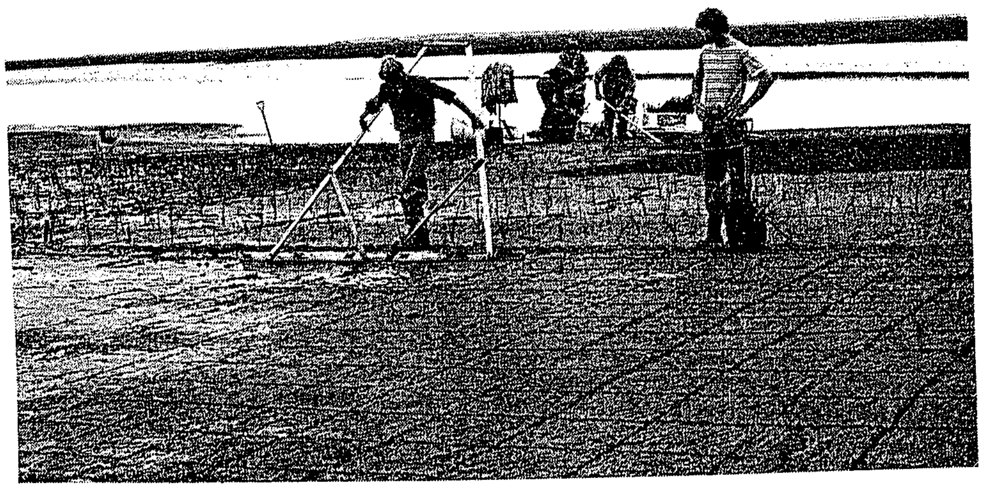

Figure 8. Marsh planting operations at Millers Sand Island, Clatsop County, Oregon. Note method of marking required spacing.

Figure 9. Hand planting slough sedge (Carex obnupta) for marsh habitat establishment, Millers Sand Island, Clatsop County, 1976.

Figure 10. First season's growth of hairgrass (Deschampsia caespitosa) planting for establishment of new marsh habitat, Millers Sand Island, Clatsop County, Oregon.

Table 4. Recommended specifications for planting hairgrass (Deschampsia caespitosa). Specifications are also applicable to slough sedge (Carex obnupta), sharp-fruited rush (Juncus acuminatus), and tussock (Juncus effusus).

INSPECTION:	1.	Inspections should be made by the Contracting Officer of authorized representative. A representative cross section of not less than 5% of the planted areas should be inspected to ensure compliance with the contract requirements.
	2.	Nonconformance with any specifications classifies a plant hill as unsatisfactorily planted. A tolerance of 5% or 5 unsatisfactory plant hills per 100 is satisfactory. Any amount over 5% should be applied as an equal percentage reduction of the acreage planted (payments being made on the basis of net acreage). When the deficiencies are 10% or over, the contractor should be expected to take steps to correct them.
PLANTING STOCK:	1.	The stock to be planted is hairgrass (Deschampsia caespitosa). The source and quality of the planting stock should be approved by the Contracting Officer or authorized representative. Age of planting stock should not exceed two years.
DIGGING AND TRIMMING:	1.	The plants are dug by passing a shovel under the root system and prying upward. Plants should then be dipped in water to clean the root system. The plant is then separated into sprigs of four to seven culms. The tops should be cut back so that the overall top growth length of the planting stock is eight to nine inches. The roots should be cut back so that the overall length does not exceed five to six inches. Plants should not be tied into bundles.
STORAGE:	1.	The planting stock should be planted within four hours of removal from the nursery areas or intertidal storage areas. All transplants should be stored in ventilated plastic containers that allow free flow of tidal water. Containers should be placed in holes dug in the upper one-third of the tidal range. Tidal waters should cover the plants at high tide. Root systems should be protected from excessive drying at all times. Plants should not be stored in tight containers; nor should they be stored over seven days.
TRANSPORTATION AND HANDLING:	1.	The planting stock should be handled and transported

Table 4, continued.

		by any method that does not damage the planting stock or surrounding marsh areas. Planting stock root systems must be kept cool and moist at all times. Main plant stems must not be broken. Dry root systems or broken main stems are grounds for rejection of planting stock prior to planting.
PLANTING:	1.	The grass should be planted in hills and there should be four to seven live culms (stems) per hill. All culms should have a minimum top height of eight inches.
	2.	The spacing between hills should average one-half meter.
	3.	The grass should be planted to a depth of five to six inches. The sand or silt used for cover should be firmly compacted to prevent float outs. The opening must be large enough to prevent J rooting. The top of the plant should be upright and should extend seven to eight inches above the ground.
	4.	No planting should be done on any area until tidal waters have been off the surface for one hour. Nor should any planting be done when temperature exceeds 65 degrees F. or when freezing conditions prevail. The Contract Officer or representative should have full authority to halt work when conditions become unfavorable.
	5.	Planting should be done by hand or by machine provided that machines used do not cause excessive damage to the benthic community. The Contracting Officer or representative should make the decision on an allowable method.
FERTILIZATION:	1.	All areas planted should be fertilized with commercial fertilizer 12-12-12 applied at the rate of 800 lbs. per acre. The fertilizer should be applied no sooner than two weeks after planting and on a day when the wind is calm. Fertilizer can be broadcast by hand or machine. The fertilizer should be applied at the time directed by the Contracting Officer or representative.
CHANGES:	1.	Any changes in the specifications should take place only after the Contractor has received written orders from the Contracting Officer.

C. Inner Open Dune Areas

Contrary to popular belief, the open dune areas present less of a problem for establishing vegetative stabilization than older stabilized dunes. The reason for this is that the landform can be changed before plantings begin. Physical changes, such as leveling, filling, slope alteration, etc. can be accomplished without disturbing the existing plant community root systems since the area is void of vegetion to begin with. In addition, debris from construction activities such as preconstruction clearance, is not present. However, due to the multitude of different individual site problems, great care must be taken to select the proper stabilization program for the individual project proposed. This information should be in the content of the site investigation report. In addition to proper plant species selection and planting techniques, site preparation is advisable. Vast areas of open sand have been successfully stabilized with dramatic results as was the case in Clatsop County as a result of the Warrenton Dune Stabilization Project illustrated in Figures 11 and 12.

Due to the size of the job and short planting seasons, a tightly followed work schedule must be adhered to. While it is true that this is one of the easiest dune forms to stabilize, it is also the area with the best opportunity for making costly mistakes. Foolish mistakes such as planting out of season, use of poor plant material, failure to contour, or improper fertilizer programs, will lead to predictable stabilization failures costing hundreds of thousands of dollars. Added to this is a normally unsightly mess that is extremely difficult to restabilize. For this reason, pay strict attention to the recommendations covered in this section.

In general, stabilization procedures are as follows:

Site preparation: Site preparation, if needed, may consist of leveling extreme humps, ridges, or steep slopes utilizing a dozer. Hummocks are normally left intact, or sometimes are created in order to give the area more character. In most cases, it is desirable to maintain the general contour of the dunes with only slight surface modification. Rough dune areas usually require a greater amount of hand planting and special treatments leading to increased costs of initial stabilization and maintenance.

Planting technique: Initial stabilization of open dune areas along the Oregon coast is normally accomplished by planting European beachgrass (*Ammophila arenaria*) (see Tables 1-3). In recent years, due to increased labor costs, all large areas (five acres or more) are planted by machine. One operator on a tractor and four skilled people feeding two planting units can, under optimum conditions, plant 180,000 culms of beach grass in one day (see Figure 13). The same amount would take a crew of 25 to 30 hand planters. Bear in mind that a 100 acre dune stabilization project planted to European beach grass will require 5,800,000 culms of beach grass. The source and availability of the planting stock must be identified well in advance of the proposed project and should be included within the site

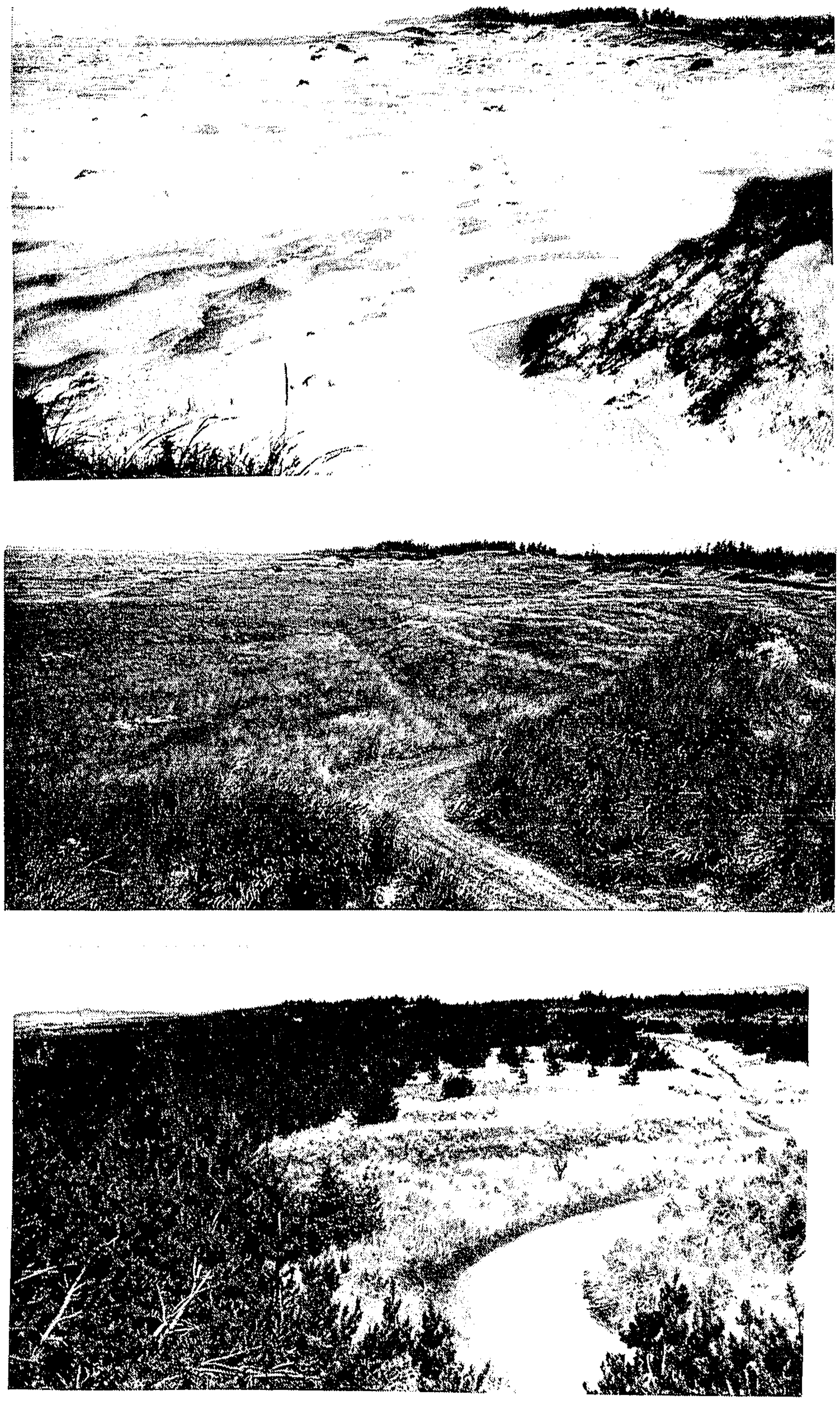

Figure 11. The Warrenton dune stabilization project near Delaura Beach, 1937, 1942 and 1955. Photographs illustrate area prior to stabilization efforts, following initial stabilization with European beachgrass and secondary plantings, and after plantings of shore pine.

Figure 12. The Warrenton Soil and Water Conservation District stabilization project after initial plantings of beach grass, 1937. Note that the deflation plain and open dune areas have all been treated with beach grass. Lower photo illustrates the same area five years following initial stabilization. The stabilization effort has resulted in complete protection of the Sunset Lake Beach access road. Note the solid band of plantings of scotchbroom providing a fire break.

Figure 13. Machine planting of European beachgrass in open dune area.

investigation report.

Contoured Plantings: Large areas with severe wind exposures and bowl areas should be planted in irregular patterns as illustrated in Figure 14. If hand planting, rows should be alternated from diagonal to parallel. When machines are used, rows should not be parallel to prevailing winds (see Figure 15). Plantings that are done without regard to wind patterns and the appropriate pattern planting can blowout within 24 hours (see Figure 16).

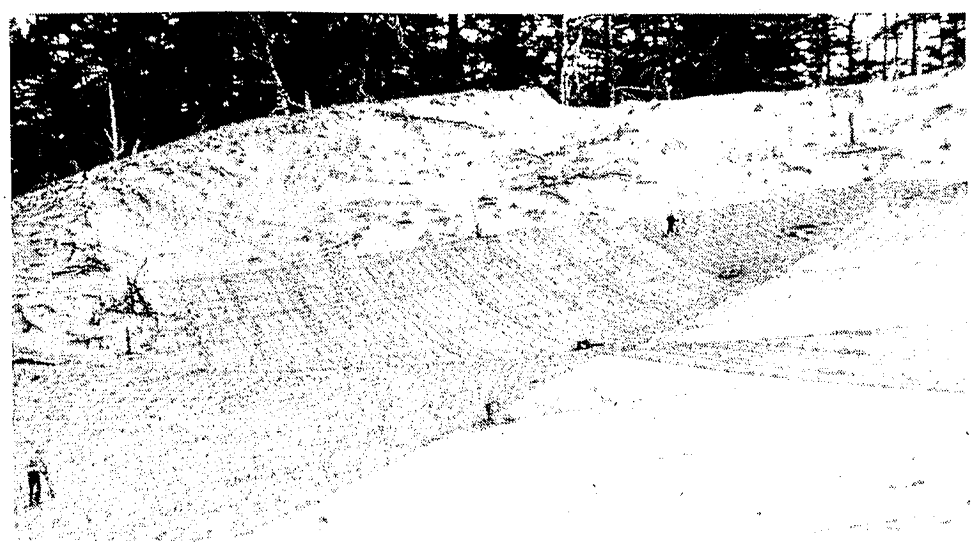

Figure 14. Use of pattern planting to avoid in-row blowout of initial beach grass plantings, Carter Lake, Douglas County.

Figure 15. U. S. Forest Service dune stabilization project at North Bend, Oregon, illustrating initial beach grass machine planting four months after planting. Note the contoured rows planted to prevent in-row erosion.

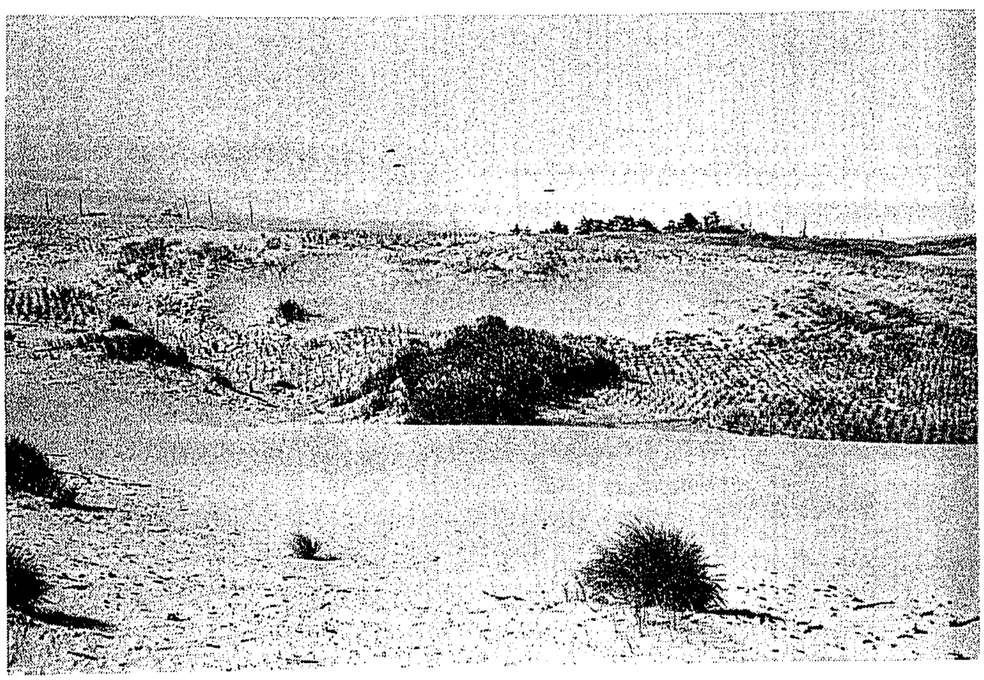

Figure 16. A blowout failure on the northwest edge of an European beachgrass planting in Lane County. Failure to restabilize this blowout could lead to eventual destruction of the entire planting.

Planting dates: Planting dates are critical in open sand areas. While the ideal season is November 15th to March 15th, the best success is with plantings put in by January 31. There are, however, exceptions to this rule in open sand areas. If summer winds have created a multitude of transverse-ridge dunes, and winter winds have not yet begun, it is better to postpone planting until the natural leveling process has taken place. If the area is exposed only to southwest winds, then late plantings in February and March can avoid possible damage from severe southwest wind storms of 45 to 80 miles per hour. In areas subject to northwest winds, plantings should be performed in early November to January 15th for best results.

Fertilization: Fertilizer application is a critical factor in establishing dune vegetation as illustrated in Figure 17. The timing of fertilizer application with regard to rains can be critical in the success or failure of a stabilization project. Steep banks or slopes must be fertilized at the time of planting; other areas should be fertilized within two weeks of planting. Fertilizer application prior to planting can be successful, however, if it becomes dry and windy, the fertilizer will shift from the higher elevations to the lower spots and in some cases may blow off the area entirely. It is therefore best to fertilize during rain storms when the wind is less than five miles per hour.

Figure 17. Two year old planting of European beachgrass at Siltcoos Outlet, Lane County. Light area in center of photograph received zero fertilizer application while the rest of the planting received the normal 200 lbs. per acre 21-0-0 application at time of planting.

The method of fertilizer application can also be crucial to the success of the project. Hand broadcasting of fertilizer is the surest method of obtaining the total desired coverage. Spreading by airplane, while fast and cost efficient, can result in problems with drifting. Fertilizing by tractor is not feasible in large areas as the weight of the tractor destroys the planted vegetation. Ideally, aerial application by helicopter should be used in large projects.

Recommended rates and mixtures for beach grass plantings is 200 lbs. of ammonium sulphate 21-0-0 per acre. However, in all plantings put in after February 15th, or on steep banks, the rate should be 400 lbs. of 21-0-0 per acre. Careful selection of a coarse grain fertilizer can help alleviate windshift problems.

Finally, if for some reason secondary permanent plantings are not put into the initial beach grass planted areas, a continuing annual fertilizer program is a necessity. Failure to do this can result in a threat to the entire stabilization project and any development investment put in (see Figure 18).

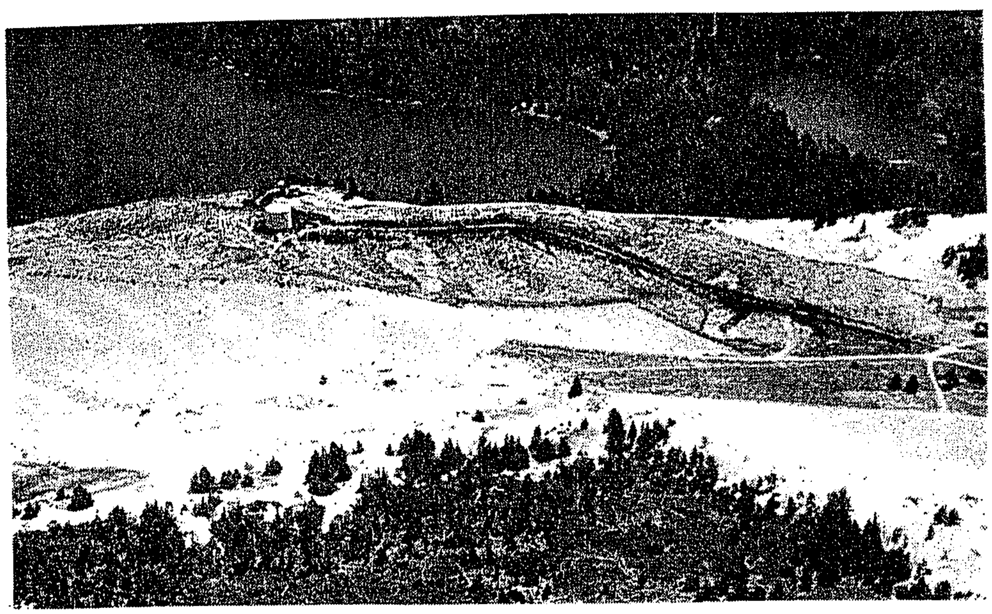

Figure 18. Dune stabilization project threatened with total failure due to lack of fertilizer. No secondary permanent plantings were made and beach grass has starved out. The water tower, pipes and road are threatened by the lack of a vegetative maintenance program in this situation at Clear Lake in Lane County.

Irrigation: If irrigation is not available and winter rains cease, the fertilizer will be displaced in a windshift pattern. All depressions will receive the fertilizer and higher elevations where it is most needed will have none. Water is necessary to make the fertilizer available to the root system; if this does not occur, there will be no new growth and massive blowouts can occur.

Secondary plantings: After the area has been initially stabilized with European beachgrass, it is only conditionally stable -- the dune area has been temporarily tamed by a blanket of grass. Any disturbance to the grass cover can initiate the erosion process. Therefore, permanent secondary plantings should be added into the sand stilling grass stands following the second growing season. Secondary plantings can be either woody species or permanent grasses and legumes (see Table 2). Figures 19 and 20 illustrate secondary stabilization options. A constant vegetation maintenance program should be a part of the development and stabilization plan. Because open dune areas are generally removed from ocean salt spray influence, a wide variety of plant materials can be used for secondary plantings. Plant size will depend on wind exposure.

Figure 19. A secondary planting of permanent grasses and legumes in an European beachgrass stabilized area in Clatsop County. Such secondary plantings provide excellent fire protection and permanent stabilization of the entire area.

Figure 20. A secondary planting of woody species in an European beachgrass stabilized area, Wax Myrtle Campground, Lane County. Open grass areas provide for varied habitat.

In contrast to the general stabilization procedures noted thus far, specific specifications for secondary or permanent stabilization in inner open dune areas is presented in the following discussion.

In most areas, the beach grass plantings are two years old, when follow-up plantings of 1-0 scotchbroom (Cytisus scoparius) and 2-0 shore pine (Pinus contorta) are planted on eight foot centers. Planting season is normally December to February. The scotchbroom is used as a temporary plant with varied benefits. First, its growth is more rapid than the pine so it provides early wind protection for about eight years. Since it is a legume, it provides some nitrogen while also providing good upland bird cover and feed. Finally, it is very fire resistant.

The scotchbroom is usually shaded out by the shore pine between the 10th and 12th year. This method results in a dense shore pine forest habitat with natural intrusion of other woody species from nearby plant communities. Great care should be taken to plan for vegetative firebreaks in large plantings of this kind. Two species are most commonly used. The best is purple beach pea (Lathyrus maritimus) seeded in a permanent grass mixture; seed treatment is H_2SO_4 or scarify. Fires with intense heat rarely burn over twelve feet into a stand of this plant. The other plant is scotchbroom (Cytisus scoparius) 1-0 nursery-grown stock planted on three foot centers in solid bands 50 feet wide. The latter is very expensive due to nursery costs.

The second method used mainly in the Clatsop Plains project is first discing of beach grass followed by seeding to permanent grass mixture (see Figure 21). Due to undependable rain in the Spring, a fall planting should be considered. Seed mixture for upland drier sites is as follows:

Suggested Seed Mixture:

Species	Common Name	lbs./acre
Lupinus littoralis	seashore lupine	7
Poa macrantha	seashore bluegrass	15
Lathyrus maritimus	purple beach pea	15
Festuca rubra	creeping red fescue	8

If the above first three native species are not available, then an alternate mixture of seed normally available on the commercial market would be as follows:

Alternative Seed Mixture:

Species	Common Name	lbs./acre
Festuca rubra	creeping red fescue	8
Lolium multiflorum	annual ryegrass	5
Vicia villosa	hairy vetch	25
Festuca arundinacea	alta fescue	10

All seedings should receive fertilizer application at 300 lbs. 12-12-12 per acre.

When selecting sites for upland habitat improvement, one should consider the complete habitat for all expected users. A mixture of forest, grasslands, and open sand is most desireable. The upland dry dune sites lend themselves to complete multiple use management for wildlife habitat and human recreation. Long range effects of creating new vegetative habitats should be carefully analyzed before planting.

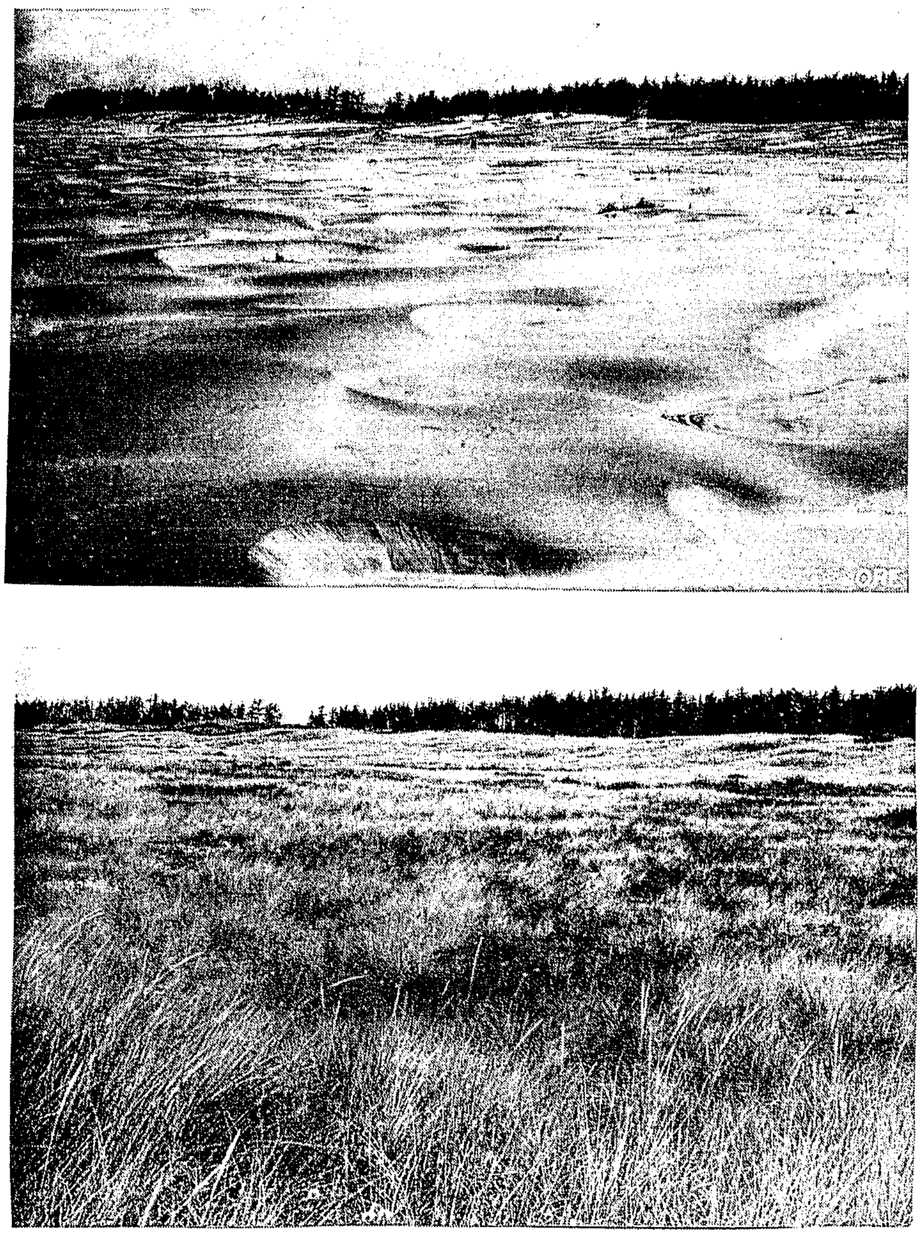

Figure 21. The Warrenton Soil and Water Conservation District dune stabilization project before stabilization in 1937 and after plantings of initial stabilization and secondary plantings of permanent grasses and legumes. Area is now set aside for wildlife habitat.

Other considerations that must be addressed when stabilizing inner open dune areas are as follows:

(1) Because of varying growth rates due to unpredictable weather conditions, it is recommended that no construction take place until a vegetation expert advises that the area is ready to accommodate safely construction activities. The period of time normally required is a minimum of two years.

(2) If complete stabilization has not taken place, drifting sand trapped in streets may completely plug city storm drain systems, as illustrated in Figure 22. This can be avoided by constructing curbs after stabilization is complete.

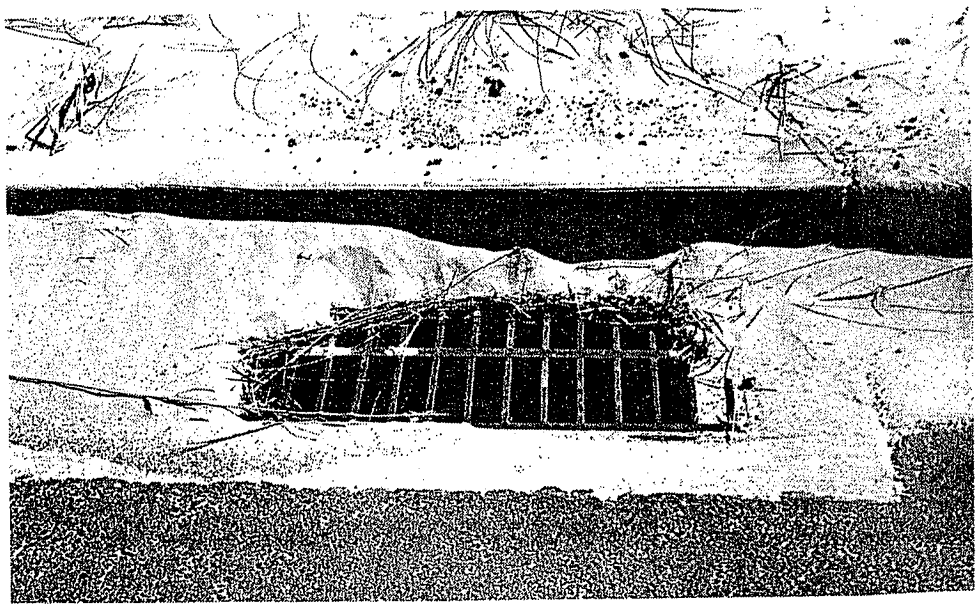

Figure 22. The result of insufficient sand stabilization in a development project. Sand build-up in streets will be flushed into city storm drain systems when rains occur; could lead to serious failure of storm drain system completely off the property.

(3) The most common problem associated with use of Tables 1 and 3 is the lack of understanding of the term "beach grass culm". Figure 23 illustrates what is meant by a culm. The mistake of identifying a clone as a culm leads to costly overplanting with little or no added benefit.

(4) Firebreaks in older stands of beach grass are a necessity. Structures built in areas of beach grass stabilization should have all beach grass within five feet removed or fire retardant species should be introduced by seeding.

The open dune management recommendations as presented herein, when followed carefully, can provide for man's use of dynamic dune forms. An excellent example of what can be accomplished by adhering to stabilization criteria and maintenance requirements is reflected by the development of Salishan, Lincoln County (see Figure 24).

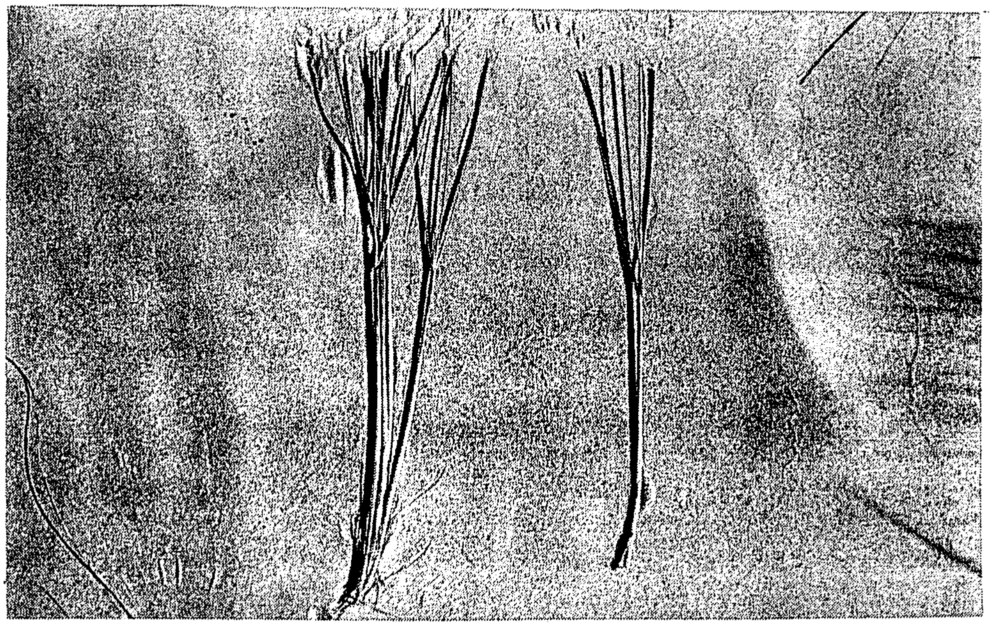

Figure 23. An illustration of the difference between one culm or single stem of beach grass, and several culms attached forming a clone. All plant requirements shown in work specifications will indicate number of culms required.

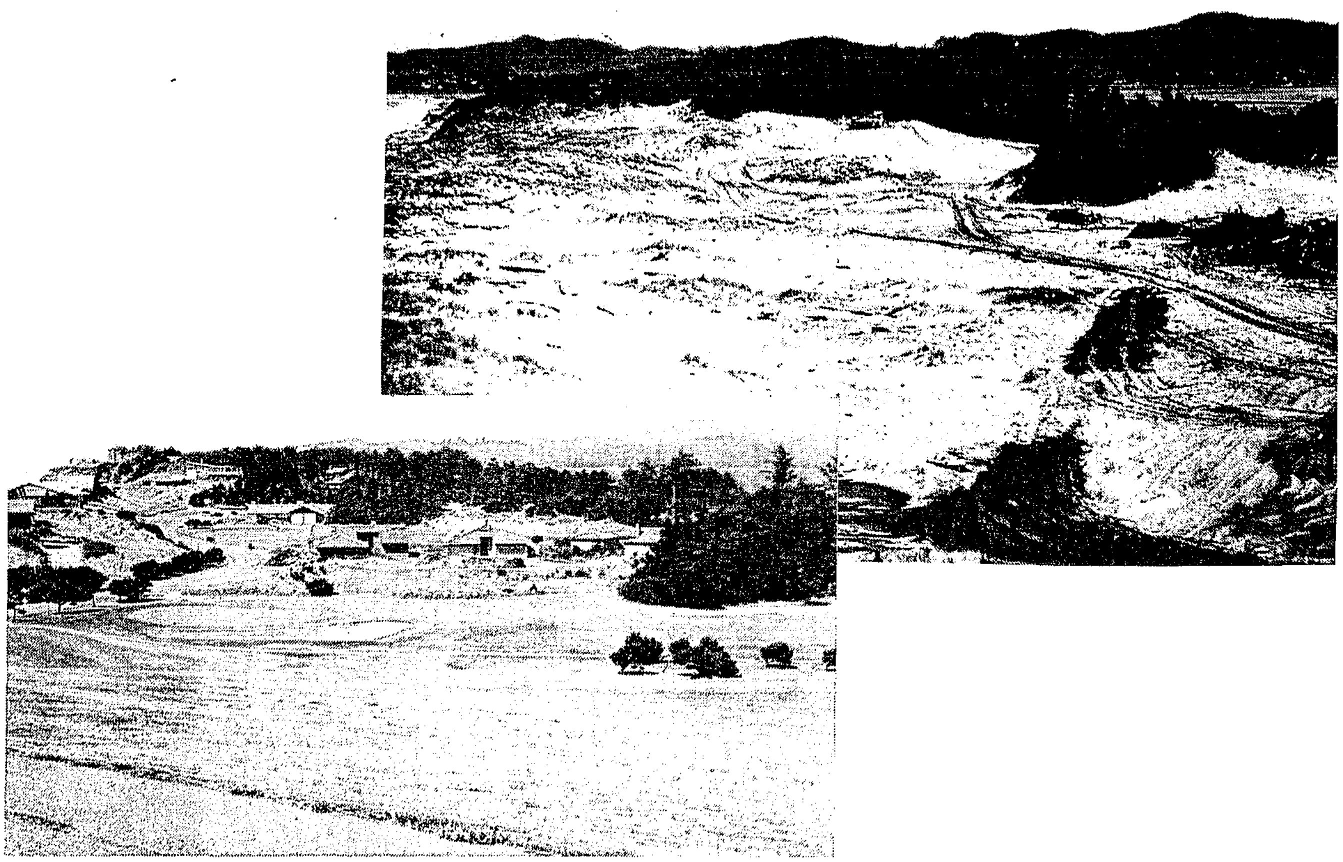

Figure 24. A comparison (1962 and 1979) of the Salishan development, Lincoln County, illustrating the site prior to stabilization and following initial and secondary stabilization efforts.

D. Older Stabilized Dunes

This area, because of its stable appearance, is where most development pressures are likely to occur. In defining older stabilized dunes, most people include well stabilized dunes with a 100 year old climax vegetative cover even if there has not been significant soil development. This leads to the misplaced confidence that no substantial stabilization problems exist.

Actually, in some of the older vegetated ridge systems or sea cliff back areas, major problems can be encountered. Older, mature woody species, because of a usually low water table, tend to develop extensive root systems. Construction activities even 40 feet away can kill portions of this vegetation. Stands of large trees such as shore pine (Pinus contorta) and sitka spruce (Picea sitchensis) contain tremendous weight and cause slope failures when construction takes place down hill from them. Due to summertime drying effect these areas are subject to extreme danger from fire. Too much vegetation removal of trees can cause large scale blow downs of forest vegetation. Removal of forest duff or brush can cause increased groundwater evaporation killing stands of 40 foot to 100 foot trees.

As an example, the Rhodo Dunes Golf Course east of Florence, contained an area of older stabilized dunes dividing the fairways. Present was a dense cover of salal (Gaultheria shallon), huckleberry (Vaccinum ovatum), manzanita (Arctostaphylos columbiana) and forty foot shore pine (Pinus contorta). Customers lost their golf balls in this dense cover and were unhappy. The owner's solution was to remove all the brushy species and leave the beautiful stand of pine trees. All the pine trees died the first summer because of water loss to evaporation. Placement of bark mulch three inches to four inches thick can prevent this kind of water evaporation problem.

Most problems associated with development in older stabilized dunes can be avoided by careful selection of development sites (see Figure 25). Extreme care should be taken to consider vegetation needs. The vegetation should be part of all structure, roadway, and utility locations. If changes to the development plan are made during construction, the advice of a vegetation specialist should be sought so as to assess the possible impacts of those changes. This is very important to the developer's interest; one hasty decision to re-route a road without consulting a vegetation expert can cost thousands of dollars. As a general practice, roads should be kept off the side hills and should be designed to avoid the creation of wind tunnels. Likewise, it is important to be aware of existing root structures and to avoid subsurface damage to vegetation in the area. Finally, the overcut of vegetation can result in massive blow downs of existing forest cover.

Stabilization efforts in older stabilized dunes are similar to open dunes in back areas. However, if development creates minimum disturbance to the vegetative cover, problems are usually minimal. All large areas opened-up to possible wind erosion should be restabilized using methods outlined in the section on open dune areas. The only exception to this would be use of taller, older woody plant materials.

This is possible because of the dense climax vegetation usually present on older stabilized dune landforms. The maximum size of woody species suggested for use are presented in Table 2. If any severe winds are expected because of exposure, a sand fence should be installed for the first year. In addition, all woody species over four feet in height should be staked and wired to prevent wind tip. Large woody species also require topsoil to retain enough moisture while establishing their new root systems.

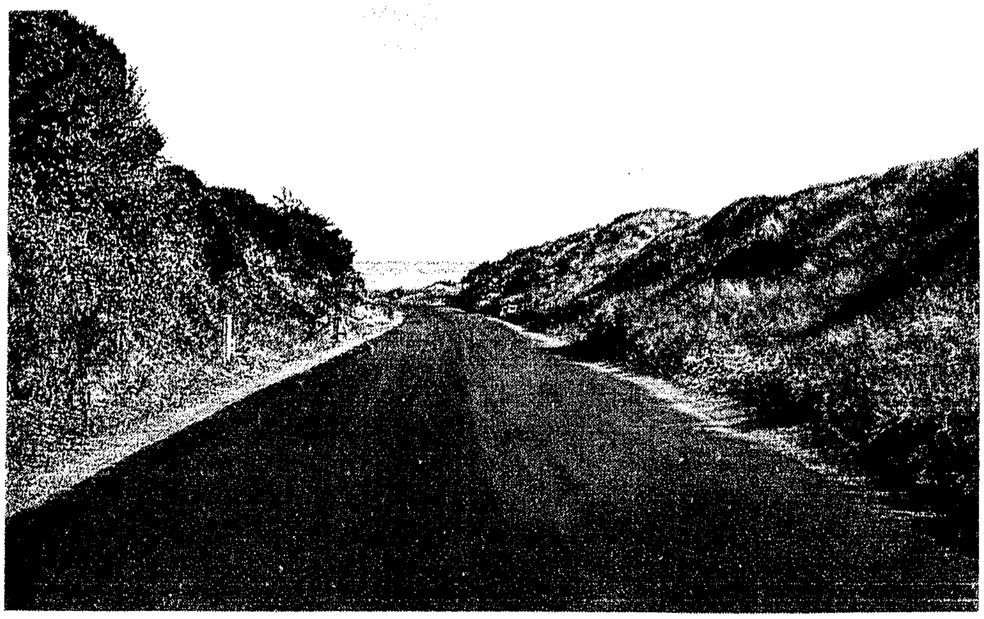

Figure 25. The road pictured above in Lane County was located so as to avoid the necessity for massive vegetation restoration and to protect the visual appearance of the area.

IV. STABILIZATION METHODS - TEMPORARY

On occasion, temporary stabilization may be necessary. However, it should be fully understood that temporary stabilization methods are, as the word implies, temporary. Care should be taken not to allow the use of temporary stabilization methods as a substitute for permanent stabilization.

The methods identified herein have been used on the Oregon coast for years with varying degrees of success. Careful selection of the correct method(s) is essential to avoid possible major wind or water erosion problems during the construction period of a project.

A. Brush Matting

An accepted temporary measure in the past, brush matting entails the complete coverage of an open area by placing a four to six inch mat of branches and leaves on the area (see Figure 26). The material can be obtained from coastal greenery trade reject material. This technique is generally unsightly and later on becomes a difficult planting bed for permanent species. Consequently it is not recommended as a viable temporary stabilization measure.

Figure 26. Use of brush mat to stabilize beach grass planting blowout, south bank of the Siuslaw River, Lane County.

B. Oil Penetration

Oil is used as a sand stabilizer mainly at cuts associated with highway or railroad construction. It is strictly a temporary measure, and is easily destroyed by human or animal activity. At The Dalles, Oregon, the Oregon State Highway Commission tried to stabilize a 100 acre active dune with this method. After two attempts and several years time lapse, the open dune area is now double in size. Failure at any portion of the area treated can result in rough, uneven terrain increasing the cost of follow-up stabilization efforts.

C. Wire Net

Chicken wire netting is normally used to hold down either brush or straw matting on steep slopes. While the application is effective, it contributes to higher costs in vegetative stabilization efforts that follow due to the difficulty of planting through the wire. While wire net stabilization is almost always done during the summer season when vegetative efforts are impossible, it is also an effective method of getting immediate relief from wind erosion. The wire must be laced together and staked down at ten foot intervals to be effective.

D. Straw Mat

This method entails the placement of a three to four inch cover or rye grass straw over the entire area to be stabilized (see Figure 27). The work must be done on a calm day with no wind. On large areas the straw is punched into the sand with a sheepfoot roller or large farm disc. On cut banks or areas of extreme wind exposure, wire netting may have to be used to secure the straw. Permanent grasses and legumes can be seeded directly into the cover in the fall.

Figure 27. Use of straw mulch to provide temporary sand stabilization in development project.

E. Rock, Gravel, Clay or Topsoil

Normally four to six inches of these materials are applied. This treatment is strictly temporary on slopes due to traffic damage or water erosion problems unless followed-up by permanent plantings. However, on flat areas, this practice sometimes leads to natural vegetation stabilization. Rock or gravel is the preferred material for narrow disturbed areas between new roads and existing vegetation. It will not ignite from carelessly thrown cigarettes and can also serve as a good fire break in residential areas. The width of a rock or gravel fire break should be at least five feet and four inches in depth.

F. Bark

In recent years, fir or hemlock bark has been used for temporary stabilization. This material is much more tolerant of traffic than rock. However, on steep banks the same problems exist. Bark can be applied by hand or blown-on out of the transportation truck. This material, though expensive, provides an attractive visual appearance (see Figure 28). It is also an excellent material to prevent moisture loss from sand underneath. Bark is available in several sizes, from bark rock (a coarse one to three inch bark) down to bark mulch (a finely ground soil-like material). Bark rock should be used on areas of strong wind exposure and bark mulch sould be used in back or protected areas.

Figure 28. The use of ground bark to provide out of season stabilization in late European beachgrass planting, Lane County, Oregon.

Three cautions should be noted when using bark for stabilization:

(1) The entire area must be covered or adjoining sand will quickly fill all the voids and speed up the sand transport (see Figure 29).

(2) The bark should be kept back at least five feet from all wooden structures. Bark poses a significant fire hazard to wood structures or adjoining vegetation and can smolder for hours before igniting into full flame.

(3) Do not place unperforated plastic sheeting under bark cover. Because bark is bouyant, the heavy winter rains will result

in displacement of the bark. Additionally, bark placed on plastic on slopes has a tendency to slide to the bottom of the slope, especially during the rainy season.

Figure 29. An example of a bark stabilization failure, off site sand has filled all the voids and created a smooth, hard surface that accentuates sand transport.

G. Log Placement

In recent years, cut banks have been stabilized with beach logs to accomplish stabilization that some find visually attractive. If large voids exist between the logs, vegetation should be planted. The weight of the logs helps prevent natural slumping (see Figure 30).

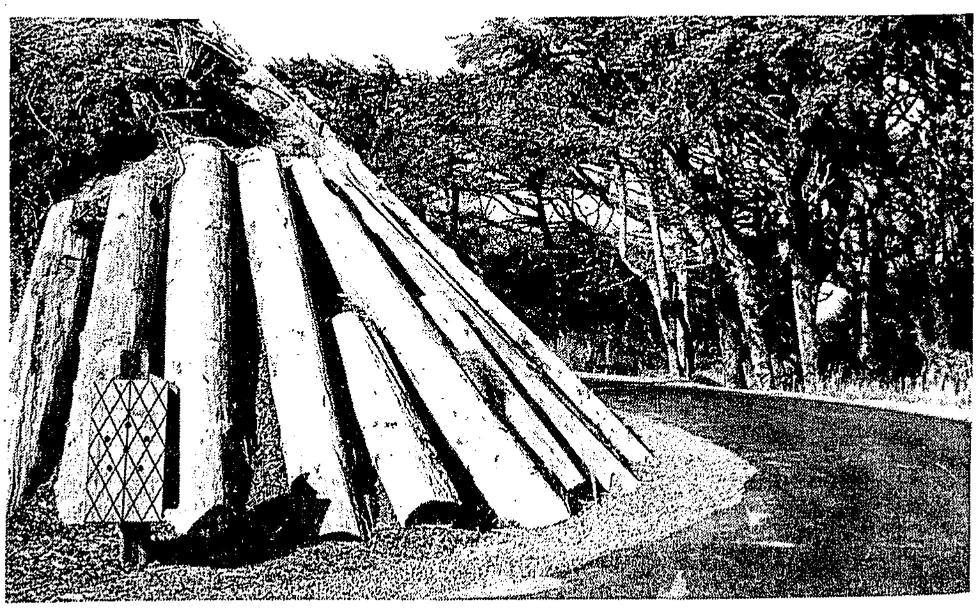

Figure 30. An illustration of the use of logs to stabilize a cut bank in a development project, Lane County, Oregon.

H. Lath and Wire Sand Fencing

Sand fencing is an important temporary stabilization method used for years on the Pacific Coast. It is normally used to gain temporary relief from large windblown movements of sand from open dunes areas or recently disturbed areas. Sand fences have also been used to create foredunes or fill breaches (Figure 31). In some cases, fences have been used to raise roadbeds across soft, wet deflation plains where equipment could not work (Figure 32).

The fencing material ranges from 1" x 4" individual pickets to 4' wire and lath snow fence (see Figure 33). Fence installations are effective when placed in two parallel rows about thirty feet apart. Proper position of the fences is critical if desired results are to be obtained. Improperly placed they may result in inundation of areas needing protection. Fences should be installed using six foot heavy duty steel posts driven into the sand eight feet apart; end posts should be anchored in three directions. The fence wire should be firmly attached to each post at the top, middle and bottom.

Figure 31. Warrenton Soil and Water Conservation District, Clatsop County, dune stabilization project illustrating use of sand fences to create foredune.

Fences four feet in height placed thirty feet apart across prevailing winds have in some cases filled-in in one week. The lee side of such a fence will sometimes experience fifty feet of sloping sand from accretion. It is consequently recommended that fences be used only where experienced advice is available, since the results of sand fence placement can be phenomenal.

Figure 32. Illustration of sand fencing used to raise a roadbed across a wet deflation plain near Florence, Oregon.

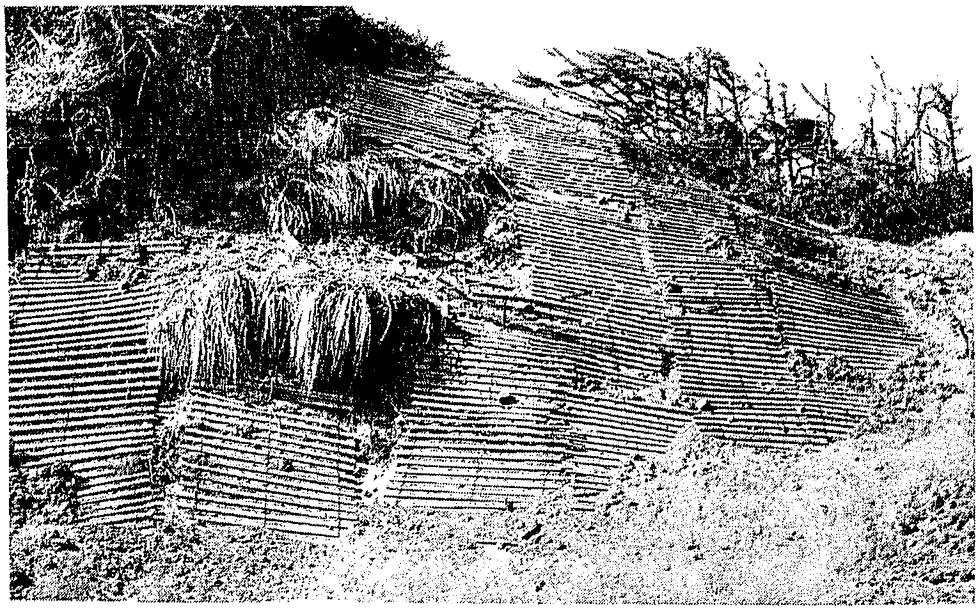

Figure 33. Snow fencing placed flat on the ground can provide temporary stabilization on cut banks, such as that performed above in Lane County, Oregon.

V. CONCLUSION

In the final analysis, all areas covered by the Oregon Beaches and Dunes Goal can, with proper procedures, be stabilized. In fact, dune stabilization has been successfully accomplished throughout the world since the days of the Roman Empire. The question we face in Oregon today is not whether to stabilize dunes, but rather is stabilization appropriate given the direction of the Beaches and Dunes Goal? This question must be answered with findings-of-fact that will substantiate the compatibility of the proposed dune stabilization project with the local comprehensive land use plan and the Oregon Beaches and Dunes Goal.

Further information pertaining to dune stabilization is found within the following publications:

<u>Beaches and Dunes of the Oregon Coast</u>, 1975, by the USDA Soil Conservation Service and Oregon Coastal Conservation and Development Commission.

"Controlling Coastal Sand Dunes in the Pacific Northwest", 1942, by Willard T. McLaughlin and Robert L. Brown, Nursery Division of the USDA Soil Conservation Service

and, <u>Plants of the Oregon Coastal Dunes</u>, 1974, by Alfred Wiedemann, LaRea Dennis, and Frank Smith, Department of Botany, Oregon State University.

VI. REFERENCES CITED

McLaughlin, Willard T., and Robert L. Brown. 1942. "Controlling Coastal Sand Dunes in the Pacific Northwest." Circular No. 660. U.S. Department of Agriculture, Washington, D.C. 46 pp.

U.S. Army Corps of Engineers, Portland District. 1974. Coastal Reconnaissance Study: Oregon and Washington. Battelle Pacific Northwest Laboratories, Richland, Washington. 478 pp.

U.S. Department of Agriculture, Soil Conservation Service and Oregon Coastal Conservation and Development Commission. 1975. Beaches and Dunes of the Oregon Coast. U.S. Department of Agriculture, Soil Conservation Service, Portland, Oregon. 161 pp.

Weideman, Alfred M., Dennis J. LaRea, and Frank H. Smith. 1974. Plants of the Oregon Coastal Dunes. Oregon State University Book Stores, Inc., Corvallis, Oregon. 117 pp.

Beach & Dune

Implementation Techniques:

FINDINGS-OF-FACT

Oregon Coastal Zone Management Association, Inc.

This report was prepared as part of a larger document addressing various beach and dune planning and management considerations and techniques. Other segments of the document and additional materials are:

I. BACKGROUND ON BEACH AND DUNE PLANNING:

Background of the Study

An Introduction to Beach and Dune Physical and Biological Processes

Beach and Dune Planning and Management on the Oregon Coast: A Summary of the State-of-the-Arts

II. BEACH AND DUNE IDENTIFICATION:

A System of Classifying and Identifying Oregon's Coastal Beaches and Dunes

III. PHYSICAL AND BIOLOGICAL CONSIDERATIONS:

Physical Processes and Geologic Hazards on the Oregon Coast

Critical Species and Habitats of Oregon's Coastal Beaches and Dunes

IV. MANAGEMENT CONSIDERATIONS:

Dune Groundwater Planning and Management Considerations for the Oregon Coast

Off-road Vehicle Planning and Management on the Oregon Coast

Sand Removal Planning and Management Considerations for the Oregon Coast

Oregon's Coastal Beaches and Dunes: Uses, Impacts and Management Considerations

Dune Stabilization and Restoration: Methods and Criteria

V. IMPLEMENTATION TECHNIQUES:

Beach and Dune Implementation Techniques: Findings-of-Fact

Beach and Dune Implementation Techniques: Site Investigation Reports

*Beach and Dune Implementation Techniques: Model Ordinances**

VI. ANNOTATED BIBLIOGRAPHY:

Beach and Dune Planning and Management: An Annotated Bibliography

VII. EDUCATIONAL MATERIALS:

Slide show: *Managing Oregon's Beaches and Dunes*

Brochure: *Planning and Managing Oregon's Coastal Beaches and Dunes*

*Prepared under separate contract between Oregon Department of Land Conservation and Development and the Bureau of Governmental Research, Eugene.

Cover illustration by Arlys Bernard, Newport, Oregon.

BEACH AND DUNE IMPLEMENTATION TECHNIQUES:

SITE INVESTIGATION REPORTS

by

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PREFACE

The following report presents the results of an in-depth analysis of site investigation reports as a tool for use by local jurisdictions in evaluating proposals for beach and dune areas. This report was prepared under the auspices of the Oregon Coastal Zone Management Association and constitutes one element of an overall analysis of planning for, and managing, coastal beaches and dunes as required by Oregon's Beaches and Dunes Goal.

This report was prepared by Wilbur E. Ternyik, Wave Beachgrass Nursery, Florence, Oregon, with assistance from OCZMA's Beaches and Dunes Study Team composed of Carl Lindberg, Project Director, Christianna Crook, Research Associate, Arlys Bernard, Project Secretary, and Kathy Fitzpatrick, Project Administrator.

In addition, valuable review and comments were made on portions of this product by the Beaches and Dunes Steering Committee composed of:

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Sam Allison, Oregon Department of Water Resources
Peter Bond and John Phillips, Oregon Department of Transportation, Parks and Recreation Division
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I. THE SITE INVESTIGATION

Suggested within the Guidelines of the Beaches and Dunes Goal as one possible method that local governments might use to direct beach and dune development is the "site investigation report" (LCDC, 1977):

> *"Local governments should adopt strict controls for carrying out the Implementation Requirements of [the Beaches and Dunes Goal...including] requirement of a site investigation report financed by the developer."*

For the purpose of this report, the site investigation report is intended to provide a systematic process for developer and jurisdiction review of the following types of information:

(1) the identification of possible negative impacts caused by geologic hazard accentuated by or impacting the proposed development, adjoining property, and overall dune sheet;

(2) to suggest solutions or remedies to identified problems to overcome geological hazard or to accommodate other environmental considerations; and

(3) to identify consistency or conflict with local, state and federal regulations, including the Oregon Beaches and Dunes Goal and other statewide planning goals, and the local comprehensive plan.

In this regard, the site investigation report would serve to provide planning staffs and decision-makers with all the pertinent information necessary in any deliberation concerning beach and dune areas to arrive at a decision based on findings-of-fact.

The purpose of the site investigation report in beach and dune areas is to provide information on geologic hazards and environmental constraints which may affect or be affected by the proposed development, in addition to identifying pertinent regulations affecting the development proposals. Because Oregon's Beaches and Dunes Goal suggests that local governments require SIRs to assist in "evaluating beach and dune plans and actions," additional information pertaining to impacts of the proposed development, over and above potential geologic constraints, is noted within the following material. However, the primary objective of the Beaches and Dunes Goal and the SIR is to ensure development that is compatible with the beach and dune landforms. In this regard, benefits to be derived from a project, whether social, economic, environmental, recreational, or otherwise, should not solely be used to determine the appropriateness of a proposal that is clearly inconsistent with identified hazards. However, cities and counties may find such information to be useful in evaluating other aspects of the proposed development once it is determined to be compatible with the landform. For this reason, and to ensure compliance with existing regulations, the material presented herein has been developed in a fashion that comprehensively evaluates development proposals in an effort to assist both the developer and the local decision-maker. In short, the SIR is intended to provide a systematic analysis of proposed uses in beach and dune areas that are "consistent with their ecological, recreational, aesthetic, water resource, and economic values, and consistent with the natural limitations of beaches, dunes and dune vegetation for development" (LCDC, 1977).

In order to maintain sound management of Oregon's coastal beach, dune and cliff areas and still provide for acceptable development, data must be collected to allow for wise decision-making. Even more important is the accuracy of the data due to possible later legal challenges to decisions made. Great care should be taken to ensure that the evidence developed and used for "findings-of-fact" will stand up in court and reflect a true method of implementing the Oregon Land Conservation and Development Commission's statewide planning goals and local land use regulations affecting uses in coastal beach, dune and cliff areas. Because of the report's use in developing findings-of-fact that may be tested in court, the jurisdiction should give clear direction on all necessary information needed.

It is recommended that the Site Investigation Report (SIR) contain two phases. The first would be a simple "yes" or "no" development proposal handout checklist available from local planning offices. If significant hazards are identified as a result of the Phase 1 SIR, or if there are possible compliance problems with state or local land use regulations, then a Phase 2 SIR would be required.

Although the use of the short form Phase 1 SIR should quickly eliminate a large share of proposals from full site investigations, careful review of the Phase 1 SIR would be required of the local planning staff in order to determine if a Phase 2 investigation should be required. Official planning commission action should determine if the full site investigation report is required (or such authority could be delegated to the planning staff).

Once the determination is made that there is sufficient reason to require a Phase 2 SIR, the development proposal will be subjected to intense scrutiny. The applicant should be notified by certified mail of the need to conduct a Phase 2 SIR and what his/her responsibilities will be. Additionally, it is important that the applicant be informed of the various roles and responsibilities of the agencies involved.

For the purpose of the site investigation report, major and minor impacts are not distinguished by size, but rather by their cumulative impacts on coastal landforms and/or hazard potential. The smallest project can have a major impact, whereas a large project can have a minor impact depending on location and associated design modifications.

Finally, due to the dynamic nature of Oregon's coastal beach and dune systems, the interdependencies of the system, and the intent of the Beaches and Dunes Goal, it is necessary that public agency (federal, state and local) development proposals within the beach and dune area be required to follow the site investigation report procedure with local units of government as identified herein. If this is not done, management of Oregon's coastal beaches and dunes will be uncoordinated and haphazard, without regard for the integrity of the dune system or the regulations which mandate balanced management of these unique systems.

While the format and emphasis of any particular site investigation report will vary with location and situation, it is recommended that the site investigation report generally include the following types of information:

I. Purpose of the Site Investigation Report
II. Scope of the Investigation including methods and commissioning party
III. Site Data and Identification including project description and location
IV. Site Investigation Report
   A. State and Local Zoning Regulations
   B. Identified Set-back Lines
   C. Identified Hazardous Conditions
   D. Existing Site Vegetation
   E. Fish and Wildlife Habitat
   F. Floodplain Elevation
   G. Historical and Archaeological Sites
   H. Condition of Adjacent Areas
   I. Development Impacts
   J. Proposed Design
   K. LCDC Coastal Goal Requirements
V. Graphic Portrayal of Data
VI. Conclusions
VII. Recommendations
VIII. Other information including literature referenced, copies of approved permits, etc.

While not specific to beaches and dunes, the City of San Jose, California has developed guidelines for geologic and engineering geology reports that provide an example of the format and contents of a site investigation report (Nelson, 1976).

II. BEACHES AND DUNES SITE INVESTIGATION - PHASE I
INITIAL PROPOSED DEVELOPMENT APPLICATION CHECKLIST[1]

LOCATION:

YES NO 1. LOCAL ZONING REGULATIONS

___ ___ Does the proposed development site plan conform to City, or County Zoning Regulations regarding setback lines and other code provisions? (Contact the City or County Engineer for details.)

YES NO 2. COMPREHENSIVE PLAN SETBACK LINE OR DESIGNATION

___ ___ a. Has a Coastal Construction Setback Line (CCSBL) been adopted for this County or City? (Inquire from the County or City Engineer.)

___ ___ b. If a CCSBL has been adopted for this County or City is the proposed site seaward of the CCSBL?

___ ___ c. If the proposed site is seaward of the adopted CCSBL, has application for a variance or exception been made to the Planning Commission having jurisdiction?

[1] If answer to any of the above is Yes then full details of location, extent, type, and possible remedies will be required.

YES	NO	
		3. IDENTIFIED HAZARDOUS CONDITIONS
___	___	a. Has any portion of the property been identified as being affected by any potential or existing geological hazard? (Contact County or City Planning Departments for information published by the State Department of Geology and Mineral Industries, U.S. Department of Agriculture-Soil Conservation Service, U.S. Geological Survey, U.S. Army Corps of Engineers and other government agencies).
		b. Are any of the following identified hazards present?
___	___	1. Active foredune
___	___	2. Water erosion
___	___	3. Flooding
___	___	4. Wind erosion
___	___	5. Landslide or sluff activity
___	___	c. Are there records of these hazards ever being present on the site?

YES	NO	
		4. EXISTING SITE VEGETATION
___	___	a. Does the vegetation on the site, afford adequate protection against soil erosion from wind and surface water runoff?
___	___	b. Does the condition of vegetation present constitute a possible fire hazard or contributing factor to slide potential?
		(If answer is Yes, full details and possible remedies will be be required.)

YES	NO	
		5. FISH AND WILDLIFE HABITAT
___	___	a. Does the site contain any identified rare or endangered species or unique habitat (feeding, nesting or resting)?
___	___	b. Will any significant habitat be adversely affected by the development? (Contact State Fish and Wildlife, County and City Planning Staffs for inventory data.)

YES	NO	
		6. HISTORICAL AND ARCHAEOLOGICAL SITES
___	___	Are there any identified historical or archaeological sites within the area proposed for development? (Contact local planning office.)

YES	NO	
		7. FLOOD PLAIN ELEVATION
___	___	a. If the elevation of the 100 year flood plain or storm tide has been determined, does it exceed the existing ground elevation at the proposed building site? (Contact the Federal Insurance Administration, City or County Planning Departments for information on 100 year flood plain information. Existing site elevations can be identified by local registered surveyor.)

YES NO

___ ___ b. If elevation of the proposed development is subject to flooding during the 100 year flood or storm tide, will the lowest habitable floor be raised above the top of the highest predicted storm-wave cresting on the 100 year flood or storm tide?

YES NO 8. CONDITION OF ADJOINING AND NEARBY AREAS

Are any of the following natural hazards present on adjoining or nearby properties that would pose a threat to this site?

___ ___ a. Open dunes

___ ___ b. Active foredunes

___ ___ c. Storm runoff erosion

___ ___ d. Wave undercutting or wave overtopping

___ ___ e. Slide areas

___ ___ f. Combustible vegetative cover

(Contact County and City Planning staffs for local hazard information.)

YES NO 9. DEVELOPMENT IMPACTS

___ ___ a. Will there be adverse off-site impacts as a result of this development?

b. Identify possible problem type

___ ___ 1. Increased wind exposure

___ ___ 2. Open sand movement

___ ___ 3. Vegetative destruction

___ ___ 4. Increased water erosion (storm runoff, driftwood removal, reduction of foredune, etc.)

___ ___ 5. Increased slide potential

___ ___ 6. Affect on aquifer

___ ___ c. Has landform capability (density, slope failure, groundwater, vegetation, etc.) been a consideration in preparing the development proposal?

___ ___ d. Will there be social and economic benefits from the proposed development?

e. Identified benefits

___ ___ 1. New jobs

___ ___ 2. Increased tax base

___ ___ 3. Improved fish and wildlife habitat

YES NO

___ ___ 4. Public access

___ ___ 5. Housing needs

___ ___ 6. Recreation potential

___ ___ 7. Dune stabilization (protection of other features)

___ ___ 8. Other ________________________________

YES NO 10. PROPOSED DESIGN

___ ___ a. Has a site map been submitted showing in detail exact location of proposed structures?

___ ___ b. Have detailed plans showing structure foundations been submitted?

___ ___ c. Have detailed plans and specifications for the placement of protective structures been submitted if need is indicated?

___ ___ d. Has a plan for interim stabilization, permanent revegetation and continuing vegetative maintenance been submitted?

e. Is the area currently being used by the following?

___ ___ 1. off-road vehicles

___ ___ 2. motorcycles

___ ___ 3. horses

___ ___ f. Has a plan been developed to control or prohibit the uses of off-road vehicles, motorcycles, and horses?

YES NO 11. LCDC COASTAL GOAL REQUIREMENTS

___ ___ a. Have you read the LCDC Goals affecting the site? (Contact LCDC, City or County office for copies of Goals.)

___ ___ b. Have you identified any possible conflicts between the proposed development and the Goals or acknowledged comprehensive plan? (If so, list them and contact local planning staff for possible resolution.)

___ ___ c. Have all federal and state agency consistency requirements been met? (Contact local planning office.)

___ ___ d. Has applicant or investigator determined that the development proposal is compatible with the LCDC Beaches and Dunes Goal and other appropriate statewide land use planning laws?

III. BEACHES AND DUNES SITE INVESTIGATION - PHASE 2
DEVELOPMENT APPLICATION CHECKLIST

The following are suggested inclusions of a full site investigation report, with an explanation of the importance of the material requested noted in italics.

A. State and Local Zoning Regulations

1. Submit letter from city or county planning staff and/or engineer certifying that the proposed development site plan conforms with applicable city or county zoning regulations or plan designations.

2. Same letter must indicate approval of conformance with any special code provisions.

3. If an exception to a statewide planning goal or a variance has been previously approved for the particular locale, substantiate accordingly.

B. Identified Set Back Line or Designations

1. Identify on plot plan the 100-year floodplain line.

2. Identify on plot plan all established set back lines.

C. Identified Hazardous Conditions

1. Map to approximate scale all identified areas of wind erosion, water erosion, and slide activity.

2. Provide written details on extent of hazard as follows:

   a. Wind Erosion

      (1) Size and slope of active sand area.
      Size and slope of open sand areas indicate required stabilization methods, development location, and probable length of time elapse between intitial stabilization and development construction.

      (2) Delineate areas of sand loss or accretion.
      Areas of sand loss or accretion indicate probable continued erosion. Their size and location indicate probable rate of erosion. Location and wind exposure will dictate appropriate stabilization methods required.

(3) Identify off-site source of sand and probable movement patterns and rate of movement.
Off and on site wind data is used to determine continued sand movement problems and their extent.

(4) Indicate wind exposure and estimated fetch length.
Wind exposure is all importnat in determining possible problems with existing wind erosion or possible new erosion potential caused by development activities. Road and path location are in some cases determined by wind exposure at the site. Temporary stabilization of open areas must be immediate if they are located in northwest wind exposures in the summer or southwest wind exposures in the fall and winter. The fetch length is all importnat in weighing probable wind erosion relative to average wind velocity. Normally the shorter the fetch length, the less problem with wind erosion.

(5) Indicate height of water table in relation to ground surface.
Water table height is important to plant species selection and stabilization method selection.

(6) Identify plant species present and general location.
Plant identification is used to evaluate status of dune movement and indicate seasonal water table influence.

b. Water Erosion

(1) Size and slope of areas affected.
Size and degree of slope are indicators of rate of erosion and wave energy present. (The steeper cut banks indicate severe erosion needing corrective action. If height of cut bank is twenty feet or more in sand, then special setbacks should be considered if corrective measures cannot be taken.

(2) Delineate areas of material loss or deposit.
Areas of loss or deposit indicate possible future problems from water erosion. Careful study of those areas will also indicate possible rate and extent of future erosion. This information will then dictate proper corrective measures to be taken.

(3) Identify off site conditions contributing to past or continuing water erosion problems.
Off site conditions causing continuing water erosion might be related to drainage, adjoining structures, jetties, groins, riprap, construction activities, vegetation removal, driftwood deposit or removal, etc. Assessment must be made to determine if on site corrective measures will be sufficient to protect the site.

(4) Submit photographic or other evidence of type of erosion (i.e., wave, current, storm runoff, etc.)
Clearly identified photos of areas of water erosion should allow for a determination of type and severity of water erosion on the site. All photos should be dated. To ensure current conditions, up to date photos taken within the past thirty days should be submitted along with any historic photo record.

(5) Indicate width and slope of beach from mean low water to beach line.
The width and slope of a beach influences the wave energy delivered to the beachfront site. This information is essential for proper design specifications in placement of riprap.

(6) Identify all water present causing erosion (i.e., ocean, rivers, lakes, seasonal flooding, etc.)
Photos of wave run-in during severe storms would be valuable, especially if taken at high tide. All potential significant water areas need to be identified so that water management plans can be developed to minimize problems.

(7) Produce evidence, if possible, of past erosion rates and give investigator's prediction of future erosion rates.
All areas that are currently "conditionally stable" foredunes have past histories of active water erosion. Historical aerial photographs with scale and date will provide evidence of past erosion rates and cycles.

(8) Indicate areas of vegetative cover on front of foredune area.
Vegetative cover limited to the upper slopes of foredune areas often indicates previous erosion that has been restored at the base of the slope by windblown sand. Caution must be taken in such cases as active foredune or unstable open dune areas might be present. Also, look for sloughing, including leaning vegetation, usually associated with slides.

(9) Provide complete location mapping and actual work specifications for all corrective measures proposed to alleviate future water erosion problems. Furnish detailed cost estimates and post performance bonds in that amount with the local jurisdiction.
Location, time schedule, and work specifications allow for determination of probable success and provide legal documentation for ensuring compliance. Specifications should be compared with U.S. Corps of Engineers suggestions for similar work. Cost estimates should be compared with similar type work performed within the last years to ensure that funds are adequate to complete the job. The performance bond should be adequate to allow the local unit of government to perform all work not completed by the developer. Failure to do this might lead to damage lawsuits against the local jurisdiction filed by on or off site tenants or owners.

c. Slide Areas

(1) Identify areas affected by slide or sloughing on site plan and furnish dated photographs and/or other evidence showing all such activity.
Identification of slide activity areas can be used to identify areas safe for development. Photographs can be used to help identify slide type and level of threat.

(2) Identify type of slide: rotation block, rockfall or soil creep and nature of the instability.
Type of slide indicates degree of hazard and course of corrective action needed.

(3) Identify area of occurrence such as foredune, sea cliff or interior dunes.
Location of slide activity in dune sheet helps to identify causes and assists in selection of course of corrective action.

(4) Describe width, height, and degree of slope. Include types of soil and underlying bedrock.
Width, height and slope of slide help in establishing on-site construction setback line. Type of soil and underlying bedrock helps to determine projected future movement rates.

(5) Describe location and measurements of cracks, drainage patterns, driftwood deposits, bedrock outcrops, wave undercutting, or other major features.
Descriptions of visible cracks, drainage patterns, driftwood deposits, etc. are all indicators used in determining historical movement and predicting future movement.

(6) Describe probable cause and investigator's prediction of future slide activity.
Description of cause of slide activity allows for quick decision on possible corrective action.

D. Existing Site Vegetation

1. Map all major areas of vegetation and provide lists of dominant species in each area.

   Dominant species indicate stage of plant succession and indicate wet or dry conditions.

2. Provide investigator's assessment of age, condition, and stability of all vegetated areas.

   Information on age and condition of species will indicate probability of continued survival. In some cases, vegetation may indicate that the area is returning to an open dune area unless carefully managed.

3. Identify on site plan any removal or modification of vegetative cover.

   Identification of areas of vegetative removal or modification is necessary to determine probable success of stabilization or restoration efforts.

4. Give brief description of vegetative cover on adjoining lands.

   It is necessary to determine the possible impacts of development on adjoining lands. Cutting of pine forest on adjoining lands might increase wind erosion and storm run-off damage. Unmanaged beach grass or gorse stands on adjoining lands can pose serious threats to development. Vegetation fire break plans using fire retardant species is one possible solution.

5. Identify and describe areas where vegetative cover poses a fire hazard. List species and condition. Propose solution to fire hazard problem. Furnish dated photographs of such areas.

   Lee slopes of foredunes or high dunes with older stands of European beachgrass (Ammophila arenaria) pose extreme fire hazards throughout Oregon coastal dunes. the south coast has heavy stands of gorse (Ulex europaeus) that is a significant fire hazard.

E. Fish and Wildlife Habitat

1. Describe and identify any rare or endangered species or unique habitats present on the site.

   Rare and endangered species and unique habitat protection is a priority requirement of Oregon's Coastal Management Program. Federal and state permits depend on resolving problems encountered by development in such areas.

2. Describe any adverse impacts on significant habitat to be caused by the proposed development.

   Other habitat, if it is mapped as significant in Oregon by the Oregon Department of Fish and Wildlife, should be addressed and may cause similar permit approval problems if not addressed.

3. If adverse impacts are anticipated, describe plans for minimizing such impacts.

   It is important to anticipate all potential problems and suggest solutions.

4. Describe possible benefits to adjoining habitats to be realized as a result of the project.

   Negative impacts, such as loss of open sand, might be offset by stabilization of open dunes that are inundating wetlands, lakes, woodlands, estuarine habitats, etc.

F. Floodplain Elevation

1. Identify on site plan 100 year floodplain or storm tide line. Give elevation of same.

   Information will assist in determining if applicant must meet HUD Floodplain Insurance Program requirements.

2. Identify on site plan the State of Oregon Beach Zone line.

   Any work west or seaward of the established Oregon Beach Zone Line must receive prior approval from the State of Oregon. Protective structures such as riprap or seawalls that are identified as being located seaward of the Oregon Beach Zone Line must have proof of written approval.

3. Give evidence that elevation of the lowest habitable floor will be raised above the top of the highest predicted storm wave or 100 year floodplain. Registered surveyor or engineer signed report will suffice.

   This information is needed to ensure HUD building requirements are met (the object being to minimize unnecessary risk to life and property).

G. Historical and Archaeological Sites

1. Describe and locate on site plan any identified historical or archaeological sites.

2. Describe any protection measures that may be needed to protect the site(s).

   The requirement to protect historic areas for future generations is a requirement of the LCDC "Open Spaces, Scenic and Historic Areas, and Natural Resources" Goal (LCDC, 1977). Unless an exception is taken or the local comprehensive plan designates otherwise, historical and archaeological areas should be protected.

H. Condition of Adjoining Areas

a. Open Dunes

(1) Give location of open dunes in relationship to the development site.
Open dunes located adjacent to the site may pose insurmountable problems to the proposed development project.

(2) Indicate approximate size (acres), maximum elevation, direction of movement, and predicted rate of movement of adjoining open dune areas.
The location and size will indicate the probable time a problem might occur. In some cases the adjoining dune might bury the development (from one to twenty years). The estimated rate of movement allows for determination of needed stabilization and when it should occur.

(3) Indicate ownership of adjoining dunes and proposed future management, if known.
Ownership and proposed future management of adjoining dune areas is necessary to verify that corrective action, if needed, will indeed take place. Without this assurance, a development permit should not be allowed.

(4) Indicate investigator's assessment of probable threat to development site. Furnish aerial photographs if possible.
Some person, in this case the investigator, must make a value judgement based on the information gathered as to the potential long or short term threat posed by adjoining areas. Aerial photos assist the reviewer in his judgement of the investigators conclusions.

b. Active Foredunes

(1) Describe size (height and width) of active foredunes on adjoining areas.
Height and width of active foredunes on adjoining areas indicates possible continuing accretion or erosion. This allows for predicted impact on the development area. Stabilizing areas within the development site may not alone alleviate the threat posed by adjoining property.

(2) Describe any threat they pose to development site.
Will the identified water or wind erosion on adjoining foredunes spread to the development site? Could wave overtopping on adjoining foredunes pose flood threat to structures on adjoining site? Will wind blown sand move from adjoining active foredune areas and bury the development?

(3) Describe any plans for cooperative measures to alleviate problems.
Corrective actions must be coordinated in order to avoid adverse impacts. Riprap on adjoining active foredunes might cause increased erosion and slope failure on development site, or vice versa. Corective measures must be consistant if desired protection is to be achieved.

c. Storm Run-off Erosion

(1) Describe any known storm run-off or flood velocity hazards on adjoining property that might adversely affect the site. Examples might be stream, river, denuded watershed, etc.
These identified problems could lead to wash outs, gullies, slope failures, structure undermining, etc.

(2) Describe any plans for cooperative measures to alleviate problems.
Proof of cooperative efforts to alleviate serious problems identified above should be required.

d. Wave Undercutting or Wave Overtopping

(1) Describe extent of recent or historic undercutting, length of area and height of cut.
Length and height of current or historic wave undercutting will indicate measures that must be taken to correct the problem before development is allowed. Height of cut is useful in determining proper setback recommendation.

(2) Describe area of wave overtopping and furnish photographs or other evidence.
Look for water flattened vegetation, new driftwood deposit and erosion channels on back side of foredune. Be careful of using old driftwood deposits as a gauge. Remember driftwood deposits were present on all Oregon Beaches and deflation plain areas before the recent formation of most foredunes by European beachgrass. Wave overtopping evidence is distinctly different to the trained eye. It is recommended that great care be taken in evaluating this potential danger!

(3) Describe historic stability of beaches in the general area. *Look for any slow or sudden changes in beach erosion and identify causes if possible. It is possible that a man-made action caused a short term severe erosion problem. It is also possible that historic erosion cycles are evident and the proposed development will have predictable problems.*

(4) Furnish investigator's assessment of possible threat to the site. *The investigator's opinion is all important in determining if the level of hazard can be overcome.*

I. Development Impacts

1. Report should include the investigator's assessment of the site's overall capability and suggest maximum use level that will not cause weight slope failure, vegetation problems from too high a density of human population, damage to aquifer, etc.

   This is a judgement of extreme importance because the cumulative effect of minor impacts could result in a total dune project failure.

2. Describe any projected off site adverse impacts on adjoining or nearby properties as a result of the development.

   Anticipated off site adverse impacts should be identified before construction in order to avoid hard feelings and possible law suits. For example, say that Area A is stabilized and developed, thus cutting off the sand supply to Area B. This results in sand loss and what was a buildable elevation is now deflation plain. Another example might be that stabilization efforts in Area A were not timed properly, so Area B received fifteen feet of sand deposit in one southwest storm and all windows were sandblasted and paint was removed.

3. Identify and list all benefits of the project:

   (a) new jobs created (temporary construction and permanent);
   (b) increased tax base or assessed valuation of completed project;
   (c) Describe any newly created or restored habitat resulting from development; and
   (d) Describe any improvement to public access provided by the project.

(Information needed to evaluate social economic gains as required by the Oregon Economy of the State Goal (#9) and coordination with possible area recreation plan.)

4. Evaluate the impact of the proposed development on seasonal surface water and drainage flow patterns and the potential impact of flooding problems resulting from the development. If the development proposes to lower the groundwater in the deflation plain, plans must accommodate problems associated with changes in the landform. The SIR should address groundwater considerations including high water table, ponding, saltwater intrusion, drawdown on sand spits, and pollution potential.

   Failure to address various groundwater considerations could result in hazard to the development and/or adjoining area. It is important to plan appropriately for projected changes to the groundwater condition proposed by the project. For example, drainage of the deflation plain necessitates that the plan accommodate upland situations resulting from a change in the vegetation community (marsh to upland habitat).

J. Proposed Design

1. Furnish a site plan map using scale required by local planning office. Show in detail exact location and size of all proposed structures. Scale drawing of front, back and side views are required as well.

   Scale of required plans should be consistent for ease of review. Man-made structures, roads, paths, buildings, utilities, and drainage systems should be included on site plan. Artists conception of back, front and side views are useful in making determination of development's impact on aesthetic values.

2. Submit detailed plans and specifications for structure foundation and identify materials to be used.

   Due to extreme variability in dune and cliff foundation strength, foundations must be adequate to support the structure.

3. Furnish detailed plans and specifications for the placement of all protective structures proposed.

   Protective structures are in many cases the very foundation of the continued existence of the landform on which the development takes place.

4. Provide complete location mapping and actual work specifications for all initial, temporary, or maintenance stabilization plans proposed.

   Location, time schedule, and work specifications allow for determination of probable success and provide legal documentation for ensuring compliance.

5. Furnish detailed cost estimates and post performance bond in that amount with local jurisdiction to accomplish stabilization or restoration proposed.

   Cost estimates should be checked against comparable type work performed within the last year. Performance bond should be adequate to allow local unit of government to perform all needed stabilization or restoration in case of developer default.

6. Identify legal responsibilities for long range vegetation maintenance programs.

   Dune vegetation at best is a fragile cover requiring substantial maintenance. Who will have responsibility to maintain vegetation once it is established (e.g., developer or purchaser)? Will local government be obligated if both the developer and purchaser fail to maintain vegetation? This point needs to be clarified within the application for development, and should be legal and binding.

7. Describe any benefits realized from dune stabilization or restoration measures proposed.

   Dune stabilization may improve wildlife habitat, or afford protection to other features such as lakes, rivers, harbors, wetlands, or highways. The Oregon coast experiences extreme seasonal wind and wave energy. Work performed must follow specifications approved or disasters will follow.

8. Furnish copies of necessary shorefront protection permits or completed permit applications.

   Pilings, fills, removals, and/or riprap usually require permits from the Oregon Division of State Lands, the U.S. Army Corps of Engineers and/or other agencies.

9. Furnish detailed plans and specifications for interim stabilization, permanent re-vegetation, and vegetative maintenance as proposed.

   While stabilization work is fairly simple, the complex nature of Oregon's beaches and dunes demands precise methods for many different situations. Only proven specifications should be used. The developer should name in advance the firm proposed to do the work and furnish his record of experience. Careful field checking of major proposals will be necessary in order to determine if special problems exist.

10. Furnish detailed plan for off-road vehicle and pedestrian management.

    Off-road vehicles, motorcycles, and horses constitute the largest threat to vegetative cover. Plans should detail access road or path location and type of material used in construction. Motorcycles should be prohibited in all areas except older stabilized dunes. Horses should not be allowed in deflation plains or conditionally stable dunes. Off-road vehicles should be assigned to carefully selected open sand areas.

11. Furnish detailed plan for required reclamation of areas disturbed for sand removal, road construction, logging, etc.

    Due to the sensitive nature of dune areas some consideration should be given to reclamation. In some instances, this is required by state law.

K. LCDC Coastal Goal Requirements

1. Identify potential conflicts with Coastal Goals or LCDC-acknowledged comprehensive plan, and Oregon's Coastal Management Program.

2. Identify efforts made in development design to resolve or minimize identified conflicts.

   Each applicant should be familiar with the Coastal Goals and other statewide planning goals, and be encouraged to read the goals before initiation of the site investigation report. First hand knowledge of the content of the goals should help alleviate many problems for all concerned. The applicant's written record of efforts made to resolve identified conflicts will speed up the review process and will afford the decision-making body insight into the method used in preparing the SIR.

IV. A PROCEDURE FOR IMPLEMENTING BEACH AND DUNE PLANNING REQUIREMENTS

The following procedures should be observed in applying for, reviewing and approving or disapproving a proposal for an activity within an identified beach or dune area (see Figure 1).

1. Applicant prepares and submits a Phase 1 site investigation report to the local planning agency.

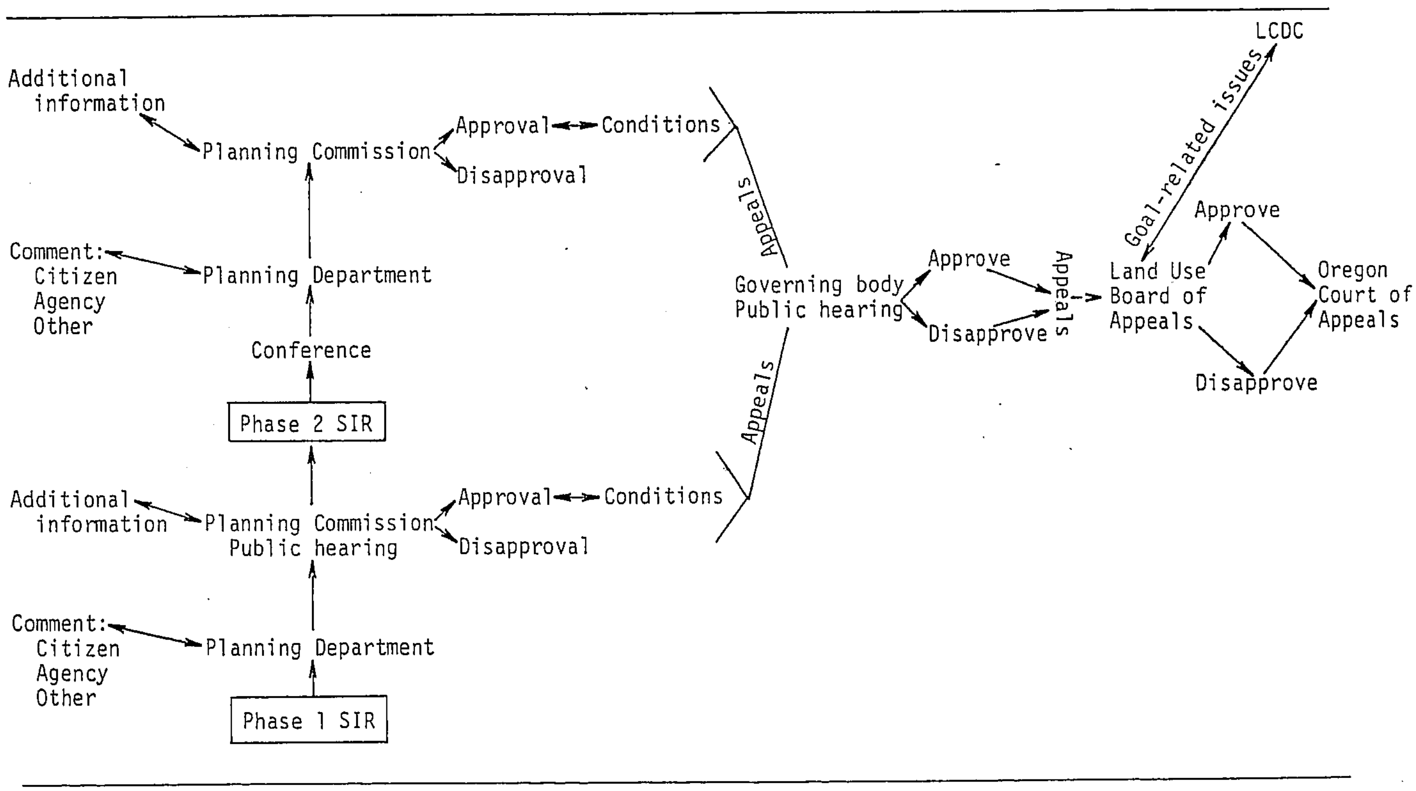

Figure 1. Procedural flowchart.

2. Planning staff distributes copies of the SIR to affected governmental units and agencies, citizen involvement committees, and other interested parties, giving them a specific length of time (at least three weeks) to review and respond to the development proposal.

3. Following the staff's review of the proposal and related comments, the proposal is submitted to the Planning Commission for consideration and public hearing. Staff recommends that SIR is adequate and decision should be based on SIR as submitted, or staff recommends that SIR appears inadequate and that further information is appropriate or that a Phase 2 SIR should be undertaken.

4. The Planning Commission reviews the application at a public hearing and develops findings-of-fact based on <u>at least</u> the following requirements of the Beaches and Dunes Goal, weighing Beach and Dune Goal requirements with other planning goals or comprehensive plan requirements:

   (1) the type of use proposed and the adverse impacts it might have on the site and adjacent areas;
   (2) temporary and permanent stabilization programs and the planned maintenance of new and existing vegetation;
   (3) methods for protecting the surrounding area from any adverse effects of the development; and,
   (4) hazards to life, public and private property, and the natural environments which may be caused by the proposed use.

5. The Planning Commission either approves the proposal based on the Phase 1 SIR, requires the applicant to provide further information within the Phase 1 SIR, or requires the applicant to prepare a Phase 2 SIR.

6. If the applicant is asked to prepare a Phase 2 SIR, at the applicant's request, an informational conference between the applicant and planning staff should be arranged. The purpose of such an informational conference is to make the applicant aware of available inventory material and other information relative to the site, to explain the purposes and requirements of the Phase 2 SIR, and to discuss the critical issues involved with the proposed activity in relation to the local plan or statewide planning goals.

7. The process would be repeated for the Phase 2 SIR, as with the Phase 1 SIR, (e.g., SIR sent out for review, staff recommendation formulated, Planning Commission conducts public hearing and arrives at a decision based on findings-of-fact).

8. If the proposal is approved, the Planning Commission may attach conditions <u>consistent with local zoning ordinances</u> if it finds that such conditions are necessary to carry out the purposes and policies of the Beaches and Dunes Goal or local comprehensive plan relating to beach and dune areas.

9. All permits issued pertaining to an approved proposal should be issued only in accordance with the approved final proposal. Major changes to the approved final proposal should be considered as a new application. Minor changes in the approved final proposal may be approved by the staff provided that such changes do not in any way raise a question as to whether the project is still compatible with the Beaches and Dunes Goal, other statewide planning goals, or the local comprehensive plan.

10. The decision made by the Planning Commission for the Phase 1 SIR or Phase 2 SIR is appealable to the City Council or County Board of Commissioners.

11. The decision of the governing body (county or city) can be appealed to the Land Use Board of Appeals and thence to the Oregon Court of Appeals.

V. ROLES AND RESPONSIBILITIES IN THE PREPARATION AND REVIEW OF SITE INVESTIGATION REPORTS

There are four basic avenues by which the site investigation report may be prepared. One alternative is that used in the State of Minnesota whereby local governments file an environmental assessment worksheet (EAW) with the Minnesota Environmental Quality Council which is subject to agency and interested party review. The other alternatives are similar to those utilized within the State of California pursuant to the California Environmental Quality Act of 1970. They are: (1) the jurisdiction's staff conduct and evaluate an environmental impact report; (2) the developer pays for the EIR, but the EIR is prepared under contract with the local jurisdiction; and (3) the developer contracts and pays for the EIR. Within California, EIRs must be prepared for all projects having a "significant" environmental impact. The California Resources Agency has prepared guidelines addressing the contents of the EIR, but the method used to produce an EIR is left up to local discretion. According to Norman Hill, Assistant Secretary for Resources, all three of the alternatives are widely used throughout the state.

While the environmental impact report approach utilized in California is for environmental impact of development proposals within the entire State of California, the approaches suggested in obtaining needed information for findings-of-fact are applicable to the approaches Oregon coastal jurisdictions may wish to pursue in obtaining information pertinent to the Beaches and Dunes Goal. Table 1 lists the pros and cons of the various approaches based on the applicability of the approach to Oregon's Coastal Management Program within the context of the Beaches and Dunes Goal.

Table 1. Pros and cons of various approaches in the preparation and review of site investigation/environmental impact reports

Approach	Pros	Cons
1. central office of State conducts assessment	--control over investigation --consistency in evaluations	--not consistent with Oregon's Coastal Management Program of planning and implementing plans at the local level --sporadic review of proposals; not a comprehensive approach
2. jurisdiction's staff prepares assessment and conducts evaluation; jurisdiction may charge developer to recoup cost	--gives jurisdiction control over document, time and effort expended --allows for the compilation of data useable for other assessments; --cost is generally lower than hiring private consultant	--appears as a larger budget item on local budgets (despite collection of fees to offset cost) --necessitates larger staff --requires constant work load and thus is generally unsuitable for smaller jurisdictions
3. developer pays cost of assessment; jurisdiction oversees investigation and evaluation	--allows for non-constant work load, thus is suitable for smaller jurisdictions --does not require expansion of staff --allows jurisdiction's interjection of local views	--contract administration selection process --extra administrative steps --jurisdiction may experience problems with quality of the product --in many instances, developer hires own consultant anyway
4. developer responsible for preparation of assessment; jurisdiction responsible for evaluation	--easiest method for local government to administer --no added cost to jurisdiction	--difficult to control quality of product --product may be slanted to project developer's perspective

Within the State of Oregon, the fourth alternative is the approach that is presently accepted and used, and for this reason, the following is a breakdown of the various responsibilities of affected parties utilizing this approach.

A. Applicants Responsibility

1. Preparation of Site Investigation Report.

2. Selection of any investigators with demonstrated field experience needed to complete report outline requirements.

3. Determine if investigator(s) are properly qualified.

4. Furnish all maps, photographs, soil tests and development specifications required to meet Goal or plan requirements

5. Appear on request at Planning Commission meeting to answer questions about content of Site Investigation Report.

6. All costs of the evaluation. (depending on local established policy)

7. Prepare modifications the Planning Commission deems necessary to make the proposed development compatible with the LCDC Beaches and Dunes Goal, other statewide planning goals and local requirements.

8. File any appeal if applicant disagrees with the decision of the Planning Commission. (Appeals may be filed with appropriate city council or county commission.)

9. File further appeal to the Land Use Board of Appeals or through the judicial system.

B. Planning Staff and Commission Responsibility

1. Furnish detailed outline of all information that will be needed in the site investigation report before a decision can be considered.

2. Identify number of days that staff will need for evaluation.

3. Immediate notification of possible delay and reasons why.

4. All costs of evaluation. (Depending on local established policy.)

5. Provide applicant with list, if known, of qualified investigators. Meet with applicant for informational conference as appropriate.

6. Verification of purported factual data contained in report.

7. Render objective decision approving or denying the development proposal based on findings-of-fact developed from the SIR.

8. Verify compliance with the Beaches and Dunes Goal element of the local comprehensive plan, or the Beaches and Dunes Goal if the local plan is not yet acknowledged.

9. Provide opportunity for citizen comment consistent with local program for citizen's involvement.

C. Citizen's Input

1. Review and comment on SIRs as circulated for review.

2. Submit oral or written testimony to planning commission, governing body, the Land Use Appeals Board or judicial body as appropriate.

As called for in the LCDC Citizen's Involvement Goal (#1), opportunities for citizen review and input before the decision to grant the development permit is essential. Published notice of all meetings where major or controversial projects will be discussed should contain project name. All information pertinent to the project should be available at the planning office for citizen review. Comments, written or verbal, should be made a part of the record of the project review.

D. Local City Council or County Commission Responsibility

1. Review all material used by the plannning commission in arriving at findings-of-fact on which they based their decision if appeal is made.

2. Generate other findings-of-fact that would justify modifying or overturning the planning commission decision.

3. Provide opportunity for citizen comment consistent with local program for citizen's involvement.

4. Ultimate legal responsibility for implementing the intent of the LCDC Goals and local comprehensive plan.

E. Land Use Appeals Board

1. Review on appeal any purported violation of the Beaches and Dunes Goal or other Goals in the local comprehensive plan or the Goal itself if plan is not in compliance.

2. Seek comment and recommendation from the Oregon Land Conservation and Development Commission on any Goal policy issue.

3. Render a decision based on their own findings-of-fact.

VI. EVALUATION OF SITE INVESTIGATION REPORTS

It is not reasonable to assume that coastal planning staffs will have the time or expertise to fairly evaluate the Phase II site investigation reports. In such cases, outside consultation may be mandatory. In view of this, it might be appropriate to have such evaluations performed by an inter-disciplinary team of experts available to all coastal jurisdictions. Conversely, a pre-approved list of such experts could be made available to coastal jurisdictions, with the jurisdiction hiring a reviewer on an on-call basis. Finally, a permanent coastal implementation team could assist coastal jurisdictions. Such an approach has been suggested through the pooling of any implementation funds received from the federal Office of Coastal Zone Management (Bartl, 1978; Vian, 1979). Whatever the approach, it should be clearly spelled out in contractual agreements that any reviewer may be called upon to appear in court to substantiate conclusions.

Likewise, it is not reasonable to assume that coastal jurisdictions can afford the financial burden of reviewing the Phase II SIRs. An interdisciplinary team of experts could be made available to jurisdictions with assistance from the State of Oregon; a permanent coastal implementation team would likely qualify for federal Coastal Zone Management assistance. If jurisdictions are faced with reviewing Phase II SIRs, they may elect to consult with outside experts with the financial burden placed on the applicant. If the cost of such an evaluation is to be paid by the applicant, he should be notified in advance.

The following evaluation criteria and process are presented to assist the local jurisdiction in evaluating site investigation reports:

Evaluation Criteria

Before a building or use is established within an area identified as under the provisions of the LCDC Coastal Beaches and Dunes Goals, the petitioner must demonstrate that the development will meet the following criteria:

1. The operating characteristics and intensity of land use shall be compatible with and shall not adversely affect the site or adjacent land uses.

2. The site planning and design shall be as attractive as the nature of the use and setting will allow.

3. The development shall not adversely affect access to or land partitioning of abutting properties.

4. The development shall include temporary and permanent stabilization programs, and the planned maintenance of new and existing vegetation.

5. The development shall not subject hazards to life, public or private property or the remaining natural environment.

6. The development shall be consistent with the Management Objectives of the particular dune type.

7. The development shall be compatible with the general purpose and intent of the governing comprehensive plan.

Determination of Appropriate Use or Uses

It is suggested that the governing body consider the following format when arriving at a decision of appropriate use.

1. Staff report on project:

    a. General proposal statement.
    b. Site investigation report on determination of dune type.
    c. Recommendation on how the project relates to each of the Evaluation Criteria.

2. The governing body shall make a finding-of-fact and approve or deny the proposal by:
   a. Evaluating the recommendations of staff and accepting or rejecting the staff appraisals (rejected appraisals should be replaced by appraisals acceptable to the governing body).
   b. Evaluating the proposal statement by the applicant.
   c. Consideration of public testimony.

3. Motion shall be made to approve or deny the proposal requested by stating the findings of the governing body after consideration of 2 a., b., and c.

VII. QUALIFICATIONS FOR CONSULTANTS OR INVESTIGATORS

Information in the site investigation report provided by the consultant will probably be the evidence used by the local planning commission to arrive at findings-of-fact. In the event of a legal challenge to these findings-of-fact, the consultant may be called upon as an expert witness in court proceedings.

There is no cut-and-dry method of determining expertise. The following are factors that indicate degree of expertise which the developer and jurisdiction may find useful:

1. college degree(s)
2. publications on the subject
3. membership in related national or international professional dune management groups
4. proof of consultation or information exchange with other recognized experts
5. proof of past actual in-field dune management or evaluation work. This should include a complete list of projects worked on, the part the consultant played, and the nature of the project.

Due to the complex nature of coastal landforms and dune management problems, several fields of expertise may be needed and may include any of the following:

1. geologist
2. oceanographer
3. hydrologist
4. botanist/agronomist
5. biologist
6. engineer
7. lawyer
8. stabilization specialist

It is doubtful that any one person will be knowledgeable in all fields of dune management. Bear in mind that in a court situation, the opposing attorney has the right to challenge the qualifications of any expert witness. If the judge sustains his objection, the witness cannot testify.

The applicant has a legal right to hire a consultant of his choice; it is the applicant's responsibility to assess the qualifications of the consultant. In some instances, local government might assist the developer by providing a suggested list of names of firms or individuals. However, local government cannot legally force the hiring of a particular firm or individual.

VIII. PERFORMANCE STANDARDS

The Beaches and Dunes Goal suggests that "local government should adopt strict controls for carrying out the Implementation Requirement of this (Beaches and Dunes) goal. The controls could include... posting of performance bonds to assure that adverse effects can be corrected;" (LCDC, 1977).

Assuming that the site investigation report has been found complete and satisfactory, there is one other tool needed to ensure implementation. All major and minor development projects should require the posting of a performance bond before the development permit is issued. The dollar amount of the bond should equal the amount estimated to carry out the intended restoration or protective measures noted within the SIR.

All phases of actual construction should be closely monitored by the local jurisdiction. Any departure from the proposed development plan should be approved in writing and signed by both parties with opportunity availed for review and comment by the appropriate agencies, jurisdictions and citizens.

In the case of vegetation restoration or stabilization, the performance bond should not be relaeased until one growing season following the planting activities to provide an opportunity to assess the effectiveness of the stabilization effort.

IX. THE DISCLOSURE STATEMENT

Once the local comprehensive land use plans are acknowledged by LCDC, they are considered to embody the requirements of the various statewide planning goals, including the provisions of the Beaches and Dunes Goal where appropriate. The Beaches and Dunes Goal very clearly sets forth criteria whereby local jurisdictions will "conserve... the resources and benefits of coastal beach and dune areas (while) reducing the hazard to human life and property from natural or man-induced actions associated with these areas" (LCDC, 1977).

In this context, the local land use plan plays a determining role in the reduction of hazardous situations and ensuring safe living conditions. Because of this, local jurisdictions may find themselves in the position of being legally responsible for catastrophes which occur in areas of known hazard if it was the local governing body's decision which allowed or provided for habitation of the area.

In areas of known geologic hazard where development is allowed to take place or continue (vested rights, design modification minimizes threat, etc.), it is strongly recommended that local jurisdictions require signing of a disclosure statement in view of possible future legal dilemmas. It is further recommended that such a disclosure statement become an official portion of the deed for a particular parcel of land.

Following preparation and review of the Phase 1 or Phase 2 SIR, the local jurisdiction should maintain the authority (within zoning ordinances) to require that all property sold within the area of discussion be accompanied by a signed disclosure statement at the time of sale. The disclosure statement would note that the buyer recognizes that the potential for hazard exists at the site, and that although protective measures may be taken (pursuant to the approved project design) there is still some degree of risk involved. Such a disclosure statement would be required of developers or real estate personnel when acquiring or selling property, and of purchasers.

In areas where development has taken place prior to acknowledgement of local comprehensive plans, it is suggested that local jurisdictions enact zoning ordinances giving them authority to require similar disclosure statements prior to issuance of a building permit. Such statements should note that the building permit is issued because of vested rights in the property, and in no way implies that the jurisdiction has evaluated or considered the potential of the area to accommodate the proposed activity in light of hazardous conditions. Alternatively, a jurisdiction may require submission of a registered professional engineer's, registered professional geologist's or specially certified engineering geologist's certification as to the safety of the project, as is the case in Lincoln County, which forms the basis for decision-making (Granger, 1979).

X. REFERENCES CITED

Bartl, Rainmar. 1978. Memo to Coastal Planners, October 16, 1978. 2 pp.

Granger, Oscar. Personal Communication. 1979. Director Lincoln County Planning Department, Newport, Oregon.

Hill, Norman. Personal Communication. 1979. California Resources Agency, Sacramento, California.

Nelson, W. Todd. 1976. "Geologic and Engineering Geology Guidelines - City of San Jose." California Geology. November, 1976. California Division of Mines and Geology, Sacramento, California. pp. 249-251. 3 pp.

Oregon Land Conservation and Development Commission. 1977. "Statewide Planning Goals and Guidelines." Salem, Oregon. 24 pp.

Vian, Bill. 1979. Letter to Wes Kvarsten, Director of Department of Land Conservation and Development, January 23, 1979. 2 pp.

Vian, Bill. 1979. Letter to Dick Gervais, Chariman of Land Conservation and Development Commission, May 29th, 1979. 2 pp.

Beach & Dune

Planning & Management:

An Annotated Bibliography

Oregon Coastal Zone Management Association, Inc.

This report was prepared as part of a larger document addressing various beach and dune planning and management considerations and techniques. Other segments of the document and additional materials are:

I. BACKGROUND ON BEACH AND DUNE PLANNING:

Background of the Study

An Introduction to Beach and Dune Physical and Biological Processes

Beach and Dune Planning and Management on the Oregon Coast: A Summary of the State-of-the-Arts

II. BEACH AND DUNE IDENTIFICATION:

A System of Classifying and Identifying Oregon's Coastal Beaches and Dunes

III. PHYSICAL AND BIOLOGICAL CONSIDERATIONS:

Physical Processes and Geologic Hazards on the Oregon Coast

Critical Species and Habitats of Oregon's Coastal Beaches and Dunes

IV. MANAGEMENT CONSIDERATIONS:

Dune Groundwater Planning and Management Considerations for the Oregon Coast

Off-road Vehicle Planning and Management on the Oregon Coast

Sand Removal Planning and Management Considerations for the Oregon Coast

Oregon's Coastal Beaches and Dunes: Uses, Impacts and Management Considerations

Dune Stabilization and Restoration: Methods and Criteria

V. IMPLEMENTATION TECHNIQUES:

Beach and Dune Implementation Techniques: Findings-of-Fact

Beach and Dune Implementation Techniques: Site Investigation Reports

*Beach and Dune Implementation Techniques: Model Ordinances**

VI. ANNOTATED BIBLIOGRAPHY:

Beach and Dune Planning and Management: An Annotated Bibliography

VII. EDUCATIONAL MATERIALS:

Slide show: *Managing Oregon's Beaches and Dunes*

Brochure: *Planning and Managing Oregon's Coastal Beaches and Dunes*

*Prepared under separate contract between Oregon Department of Land Conservation and Development and the Bureau of Governmental Research, Eugene.

BEACH AND DUNE PLANNING AND MANAGEMENT:

AN ANNOTATED BIBLIOGRAPHY

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PREFACE

The following annotated bibliography presents the results of selected references pertaining to planning for and managing beaches and dunes on the Oregon Coast conducted by the Oregon Coastal Zone Management Association, Inc. This report constitutes one element of an overall analysis of planning for and managing coastal beaches and dunes as required by Oregon's Beaches and Dunes Goal.

This report was prepared by Timms Fowler, WICHE Intern and Arlys Bernard, OCZMA Beaches and Dunes Study Team Project Secretary, with assistance from Carl Lindberg, Project Director, Christianna Crook, Research Associate, and Kathy Fitzpatrick, Project Administrator.

This product represents the finalization of a preliminary bibliography submitted to the Oregon Department of Land Conservation and Development in December of 1978. In this regard, OCZMA acknowledges and extends appreciation to Bob Cortright, Coastal Specialist for the Oregon Department of Land Conservation and Development for his review.

TABLE OF CONTENTS

I. BEACH AND DUNE PLANNING AND MANAGEMENT IN OREGON

Baldwin, Ewart M., John D. Beaulieu, Len Ramp, Jerry Gray, Vernon C. Newton, Jr. and Ralph S. Mason. 1973. Geology and Mineral Resources of Coos County, Oregon. Bulletin 80. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 82 pp. + maps.
This bulletin presents the geology of all of Coos County and its mineral potential.

Battelle Institute. 1973. Oregon: Areas of Environmental Concern. Battelle Pacific Northwest Laboratories, Richland, Washington. 104 pp.
A "701" report initiated by the State Executive Department in 1972 to describe and depict Oregon's areas of environmental concern on a statewide basis.

Beaulieu, J. D. and P. W. Hughes. 1976. Land-Use Geology of Western Curry County, Oregon. Bulletin 90. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 148 pp.
The report describes the geology of western Curry County, Oregon as it pertains to land-use.

Economic Consultants Oregon, Ltd. 1978. "State of Oregon Shorefront Access and Preservation Planning Process." Executive summary. State Department of Transportation, Parks and Recreation Division, Salem, Oregon. 15 pp.
This paper summarizes the major findings of an evaluation of existing policies and programs for providing public access and protection to beaches and other coastal areas. The paper includes a section on "Areas Not Covered and Suggested Improvements."

Fitzpatrick, Kathy, Ed. 1979. Beaches and Dunes Handbook for the Oregon Coast. Oregon Coastal Zone Management Association, Inc., Newport, Oregon. 679 pp.
The document is a compendium of the following reports: Introduction to Beach and Dune Physical and Biological Processes: A Summary of the State-Of-The-Arts; A System of Classifying and Identifying Oregon's Beaches and Dunes; Physical Processes and Geologic Hazards on the Oregon Coast; Critical Species and Habitats of Oregon's Coastal Beaches and Dunes; Dune Groundwater Planning and Management Considerations; Off-road Vehicle Planning and Management on the Oregon Coast; Sand Removal Planning and Management Considerations for the Oregon Coast; Oregon's Coastal Beaches and Dunes: Uses, Impacts, and Management Considerations; Stabilization; Beach and Dune Implementation Techniques: Findings-of-Fact and Site Investigation Reports.

Oregon Coastal Conservation and Development Commission. 1973. "Policies and Standards for Fragile Sand Areas." Florence, Oregon. 10 pp.
This is a report to aid development of policies and standards for management of fragile sand areas. It contains general policy statements expressed by participants at OCCDC public involvement workshops and suggested policies developed by the staff of SCS.

Oregon Coastal Conservation and Development Commission. 1975. Progress Report. Florence, Oregon. 209 pp.
A report presented to the Governor's Office to provide an accounting of the progress and scope of the OCCDC overall work program. Pages 43 to 62 cover the beaches and dunes resources and comprise the basic data from which Goal #18 Beaches and Dunes was derived.

Oregon Land Conservation and Development Commission. 1976. "Draft No. 3, Coastal Planning Goals and Guidelines." Salem, Oregon. 20 pp.
The third and final draft of the coastal goals before their adoption on December 18, 1976; included the Beaches and Dunes Goal.

Oregon Land Conservation and Development Commission. 1977. "Statewide Planning Goals and Guidelines." Salem, Oregon. 24 pp.
This publication presents nineteen statewide planning goals for Oregon. A list of definitions is also included.

Oregon Land Conservation and Development Commission. 1977. "Coastal Goals: Response to Concerns." Salem, Oregon. 4 pp.
An explanation of why the Commission changed certain wording within the four coastal goals prior to adoption. The two changes to the Beaches and Dunes Goal explain the change of the site investigation from a goal requirement to a guideline - replaced by mandated findings-of-fact and secondly the rewording to clearly prohibit residential, commercial or industrial development on active or wave overtopped foredunes.

Oregon State Highway Department, State Parks and Recreation. 1966. Public Use Study: Oregon's Coastal Beaches. Salem, Oregon. 78 pp.
Provides information concerning recreational interests, significance and physical characteristics on thirty-nine sections of beach. Noted as a preliminary and limited study it provides basic data and aerial photos on beach use in 1966.

Stembridge, James E., Jr. 1975. "Shoreline Changes and Physiographic Hazards on the Oregon Coast." PhD dissertation. Department of Geography, University of Oregon, Eugene, Oregon. 202 pp.
This study analyzes, classifies, and inventories the shoreline changes on the Oregon coast.

U.S. Army Corps of Engineers. 1971. National Shoreline Study: Inventory Report Columbia-North Pacific Region Washington and Oregon. Portland, Oregon. 101 pp.
An inventory of the physical characteristics, historical changes, ownership, and shoreline uses are provided for the Washington and Oregon coast generally and by county. Many useful illustrated maps are included.

U.S. Army Corps of Engineers, Portland District. 1974. Coastal Reconnaissance Study: Oregon and Washington. Battelle Pacific Northwest Laboratories, Richland, Washington. 478 pp.

This is a reconnaissance level survey of fifteen Oregon and Washington coastal projects to determine their potential recreation and conservation use. Characterisitcs of each site presented related to recreation, wildlife, land use, open space, and historical and archaeological values.

U.S. Department of Agriculture, Forest Service, Siuslaw National Forest. 1977. Final Environmental Impact Statement, Oregon Dunes National Recreation Area Management Plan. Washington, D.C. 80 pp. + appendices.

The statement is a review of the Oregon Dunes National Recreation Area within Coos, Douglas and Lane Counties. The results were that none of the lands in the Oregon Dunes National Recreation Area met the requirement for designation as wilderness.

U.S. Department of Agriculture, Soil Conservation Service and Oregon Coastal Conservation and Development Commission. 1975. Beaches and Dunes of the Oregon Coast. U.S. Department of Agriculture, Soil Conservation Service, Portland, Oregon. 161 pp.

This study was produced for and with OCCDC to provide resource data for land use decision making and for educational information concerning the beach and dune environment. Beach and dune landforms are explained and identified on aerial photos of the Oregon coast. Proposed management policies are presented.

Warrenton Dune Soil and Water Conservation District Clatsop County, Oregon. 1966. "Thirty-one Years of Progress, 1935-1966." Astoria, Oregon. 17 pp.

This is an illustrated history of the Warrenton Dune Soil and Water Conservation District dune management program with some very good before and after photographs.

Wilsey and Ham. 1978. Lane County: Coastal Resource Inventory. Portland, Oregon. 180 pp.

This book includes a forty-two page section on beaches and dunes covering topics such as topography, nature and stability of the dunes area, hydrologic conditions, land use, public access and recreation, economic significance and past and future development.

II. GENERAL INFORMATION ON BEACH AND DUNE SYSTEMS

Barnes, R. K. S., Ed. 1977. The Coastline. John Wiley and Sons, New York, New York. 356 pp.

A highly useful systematic examination of the ecology and physiography of coastal aquatic and terrestrial environments. Land use and management problems are highlighted.

Bascom, W. 1964. Waves and Beaches. Doubleday, Garden City, New York. 267 pp.

A basic introduction to the wave and beach processes from a west coast study that included Oregon.

Bird, E. C. F. 1969. Coasts. The MIT Press, Cambridge, Massachusetts. 246 pp.

The fourth and last volume of a series on landforms treating landforms as parts of systems in which the interacting processes are almost completely produced and altered by solar energy. Thus the coastal situation is viewed in terms of waves, currents and wind as agents in fashioning the coastal forms. Chapter V-Beaches, Spits, and Barriers and Chapter VI-Coastal Dunes give a general introduction to the morphology of these landforms.

Buckler, William R. 1978. Dune Type Inventory and Barrier Dune Classification Study of the Lake Michigan Shore. Preliminary Draft submitted to the Michigan Department of Natural Resources. Lansing, Michigan. 74 pp.

A dune morphology classification is developed for the Great Lakes and dune assemblages are mapped. The classification is based on the dune form, relief, orientation, and relationship to the underlying formation.

Bush, George. 1976. "Soils Management Services Report, Sand Lake Recreation Area." United States Department of Agriculture, Forest Service. Siuslaw National Forest, Hebo Ranger District, Corvallis, Oregon. 16 pp.

Describes geo-environmental changes which have occurred at Sandlake in historic times. Management recommendations designed to enhance and protect the dunes and associated recreational facilities are offered.

Carefoot, Thomas. 1977. Pacific Seashores: A Guide to Intertidal Ecology. University of Washington Press, Seattle, Washington. 208 pp.

This work is a broad, well-illustrated guide to intertidal ecology. There is one generally useful section on sand dunes.

Cooper, W. S. 1958. Coastal Sand Dunes of Oregon and Washington. Geological Society of America Memoir 72, New York, New York. 169 pp.

Classic geomorphic description and interpretation of sand dune morphology evolution, and historic development in coastal Oregon and Washington; also, subdivides the Oregon coast into four geomorphically dissimilar sand dune regions.

Inman, Douglas L. and Birchard M. Bush. 1973. "The Coastal Challenge." Science. Washington, D.C. 181:20-32. 13 pp.
This article considers the coastal processes of currents, etc. and man's interference with the natural processes. Highlighted are shoreline stabilization, sand budget and transport.

Katz, Barbara A. and Stephen R. Gabriel. 1977. "Oregon's Ever-Changing Coastline." Extension Marine Advisory Program. 5G 35. Oregon State University, Corvallis, Oregon. 7 pp.
This work provides a good non-technical introduction to the ocean shore processes.

Komar, Paul. 1976. Beach Processes and Sedimentation. Prentice-Hall, Inc. Englewood Cliffs, New Jersey. 429 pp.
A recent text that describes the physical processes of beaches and the resulting sedimentary deposits on the Pacific Coast.

Lund, Ernest H. 1971. "Coastal Land Forms Between Florence and Yachats, Oregon." The Ore Bin. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 33(2)21-44. 24 pp.
The article provides an overview of the headland basalt structures and the differential erosion. Sand dunes are briefly mentioned.

Lund, Ernest H. 1973. "Oregon Coastal Dunes Between Coos Bay and Sea Lion Point." The Ore Bin. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 35(5)73-92. 24 pp.
The article offers a good, short overview of the sand dune types including useful photographs.

Lund, Ernest H. 1974. "Rock Units and Coastal Landforms Between Newport and Lincoln City, Oregon." The Ore Bin. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 36(5)69-92. 24 pp.
The article offers a useful, short background on the land forms and basic geology including good photographs.

Pinto, Carlos, Eugene Silovsky, Fred Henley, Larry Rich, Jack Parcell and Don Boyer. 1972. The Oregon Dunes NRA Resource Inventory - Siuslaw National Forest. U.S. Department of Agriculture, Forest Service, Portland, Oregon. 294 pp.
This report provides excellent descriptions, environmental baseline data and carrying capacity guidelines for sand landforms represented in the Oregon Dunes National Recreation Area. Maps, text and matrices are included.

Ranwell, D. S. 1975. Ecology of Salt Marshes and Sand Dunes. Halsted Press, New York, New York. 258 pp.
This work is a detailed ecological study and considers management of both salt marshes and sand dunes. Sand dune management includes water extraction, species introduction, and other factors.

Ruef, Michael H. 1975. Coastal Sand Dunes Study: Pacific and Grays Harbor Counties, Washington. State Department of Ecology, Olympia, Washington. 31 pp.

A detailed study of Washington's coastal dunes that relates vegetation to the sand landforms; provides analysis on ocean-dune relationship, impacts of man, natural areas, and suggests some management considerations.

Starr, Richard M., Richard A. Marston, and Madeline J. Hall. 1975. Environmental Sensitivity of Oregon's Coastal Sand Areas. Department of Geography Resource Paper 7. Oregon State University, Corvallis, Oregon. 48 pp.

Coastal sand area types are placed in sensitivity classes. These classes are given performance standards to guide development. The specific study area is north of Florence and is mapped by sensitivity class.

Weideman, Alfred M., Dennis J. LaRea, and Frank H. Smith. 1974. Plants of the Oregon Coastal Dunes. Oregon State University Book Stores, Inc., Corvallis, Oregon. 117 pp.

A very useful work which includes a brief but highly informative introduction to the physical geography of Oregon's coastal dunes. The primary emphasis is on the description of sand dune plants with taxonomic key included.

Zenkovick, V. P. 1962. Processes of Coastal Development. J. A. Steers, Ed. Translated by D. G. Frey. Oliver and Boyd, London. 738 pp.

The most thorough discussion of shore processes found in any one single publication. The author adopts a wide regional approach to the subject. Chapter 12, "Aeolian Processes on Sea Coasts" is concise and covers the literature as well as the worldwide variants of sand beaches and dunes.

III. BEACH AND DUNE PLANNING AND MANAGEMENT CONSIDERATIONS

A. Sand Removal

Bernewitz, M. W. von. 1930. "Treatment and Sale of Black Sands." Information Circular 7000. U.S. Department of Interior, Washington, D. C. 21 pp.

The author provides background information on the nature of black sands and experiences in mining and processing it from several case studies.

Carter, George, Hal J. Kelly and E. W. Parsons. 1962. "Industrial Silica Deposits of the Pacific Northwest." Information Circular No. 8112. U.S. Department of the Interior, Bureau of Mines, Washington, D.C. 57 pp.

An evaluation report of data derived from field and laboratory examinations of 82 silica deposits. The Coos Bay dune sands was one of five samples taken in Oregon. These sands were found to be not of high quality but could be used as a source for the manufacture of ceramic ware and amber container glass.

Carter, G. J., H. M. Harris and K. G. Strandbert. 1964. "Beneficiation Studies of the Oregon Coastal Dune Sands for Use as Glass Sand." RI 6484. U.S. Department of the Interior, Bureau of Mines, Washington, D.C. 21 pp.

This study found the sand deposits in the Coos-Umpqua dunes area to be suited for foundry, sand blasting, filler, ceramic use, and for certain types of glass if properly treated.

Dasher, John, Foster Fraes and Alton Gabriel. 1942. "Mineral Dressing of Oregon Beach Sands, 1. Concentration of Chromite, Zircon, Garnet and Ilmenite." Report of Investigation 3668. U.S. Department of the Interior, Washington, D.C. 19 pp.

On the coast of southwestern Oregon, particularly in Coos and Curry Counties, are numerous pockets of heavy sand that have been deposited on the back of old beaches. The investigation found certain levels of materials that could be extracted depending on the market demands.

Department of Civil Engineering, Oregon State University. 1978. "Notes From Brainstorming Meeting on Coastal Aggregates." Oregon State University, Corvallis, Oregon. 21 pp.

A series of notes outlining the goals of a three year research project to study coastal aggregates. The goals as presented were: a. identify promising marginal aggregates, b. evaluate benefication methods, c. develop specifications, and d. establish economic limits for the use of these aggregates.

Erickson, Robert, Roger Iwasaki, Russ Kellogg, Brian Mostue, and Lawrence Walker. 1974. Visual Resource Analysis of the Oregon Coastal Zone: Experimental Qualities of Oregon Coastal Environments. The Oregon Coastal Conservation and Development Commission, Florence, Oregon. 135 pp.

This report is one of ten for use in developing a resource management plan for the Oregon Coastal Zone. The purpose of this report is to identify the significant visual values on the coast and their management problems.

Inman, Douglas L. 1978. "The Impact of Coastal Structures on Shorelines." Proceedings of Coastal Zone 78. American Society of Civil Engineers, New York, New York. pp. 2265-2272. 8 pp.

This article discusses the present crisis situation of man's impingement upon the shoreline and his need to rapidly develop new technology and understanding of the problems.

Magoon, Orville T., John C. Haugen, and Robert L. Sloan. 1972. "Coastal Sand Mining in Northern California, U.S.A." Proceedings of the 13th Coastal Engineering Conference. American Society of Civil Engineers, New York, New York. pp. 1571-1597. 26 pp.

This paper describes the history and character of sand mining in California. Noting that sand removal is significant at specific locations, the authors point out that the beaches represent a major recreational asset.

Stephenson, E. L. 1945. "Magnetometer Surveys on Black Sands of the Oregon Coast." RI 3814. U.S. Department of the Interior, Washington, D.C. 18 pp.

This investigation located deposits of black sands in Coos and Curry Counties, Oregon.

Sterrett, Chester K. 1958. "Industrial Silica for Pacific Northwest Industries." Resource Report No. 1. Raw Materials Survey, Inc., Portland, Oregon. 14 pp.

In a section of "Oregon Beach Sands" the report notes that no specific studies on beach sands as a source of industrial silica have been conducted. It was noted, however, that no extensive deposits of pure white sands exist with a low quartz content (forty percent with partial iron staining).

U.S. Department of the Interior, Bureau of Mines. 1978. "Minerals in the Economy of Oregon." SMP-21. Washington, D.C. 14 pp.
This is a report on the mineral resources of Oregon. It includes tables on the quantity and value of mineral production in 1976 and 1977 as well as Oregon's role in the U.S. mineral supply in 1977.

B. Stabilization and Restoration Methods

Brown, Robert L., and A. L. Hafenrichter. 1962. "Stabilizing Sand Dunes on the Pacific Coast With Woody Plants." Misc. Publication No. 892. U.S. Department of Agriculture, Soil Conservation Service, Washington, D.C. 18 pp.
This describes the uses of woody plants as stabilizers, the planning required, and the species used for stabilization.

Davis, John H., Jr. 1975. Stabilization of Beaches and Dunes by Vegetation in Florida. Sea Grant Program Report No. 7. University of Florida, Gainesville, Florida. 52 pp.
The report discusses the role and methods of vegetation in stabilizing beaches and dunes, with guidelines for property owners and managers.

Georgia Department of Natural Resources. 1974. Methods for Beach and Sand Dune Protection. Conference Report. Georgia Department of Natural Resources, Atlanta, Georgia. 48 pp.
This is a collection of papers delivered during the conference that relate to three basic topics: The Natural Functioning of the Beach and Sand Dune System, Methods for Beach and Sand Dune Protection, and Workshop Discussions and Recommendations. Emphasis on East Coast experiences.

Green, Diantha L. 1965. "Developmental History of European Beachgrass (*Ammophila arenaria*) Plantings on the Oregon Coastal Sand Dunes." MS Thesis, Oregon State University, Corvallis, Oregon. 64 pp.
The development from initial planting to takeover of natural species is discussed. Data on the plots studied south of Florence included various measurements of *Ammophila*, *Pinus*, and *Cytisus* and the frequency of native species present.

Hafenrichter, A. L. 1967. "Lassoing the West's Rampaging Dunes." Outdoors USA. U.S. Department of Agriculture Yearbook, U.S. Department of Agriculture, Soil Conservation Service, Washington, D.C. pp. 317-321. 5 pp.
A good introduction to the USDA Soil Conservation Service's dune stabilization program on the Pacific Coast that includes the Warrenton Soil Conservation District project.

Hafenrichter, A. L., John L. Schwendinan, Harold L. Harris, Robert S. MacLauchlan, and Harold W. Miller. 1968. Grasses and Legumes for Soil Conservation in the Pacific Northwest and Great Basin States. Agriculture Handbook 339. U.S. Department of Agriculture, Soil Conservation Service, Washington, D.C. 69 pp.

They explored various grasses and legumes for stabilization projects including beaches and dunes.

Illinois Department of Conservation. 1977. Illinois Beach State Park Duneland Vegetation Rehabilitation and Restoration Feasibility Study. Springfield, Illinois. 57 pp.

A study of existing duneland degradation and destruction with alternative policies to solve identified problems. Many problems identified are common to the Oregon coastal dunes and proposed solutions may be of interest.

Knutson, Paul L. 1978. "Planting Guidelines for Dune Creation and Stabilization." Proceedings of Coastal Zone '78. Volume II. American Society of Civil Engineers, New York, New York. pp. 762-779. 18 pp.

Several West Coast examples are given including the Clatsop Plains.

McLaughlin, Willard T., and Robert L. Brown. 1942. "Controlling Coastal Sand Dunes in the Pacific Northwest." Circular No. 660. U.S. Department of Agriculture, Washington, D.C. 46 pp.

This describes the various techniques and the background of the stabilization of the Pacific Northwest started in 1935.

Oertel, George F., and James L. Harding. 1977. Sand Stabilization on the Dunes, Beach and Shoreface of a Historically Eroding Barrier Island; Wassaw Island Erosion Study Part III. Technical Report Series Number 77-3. Georgia Marine Science Center, University System of Georgia, Skidaway Island, Georgia. 46 pp.

This is a study of Wassaw Island, Georgia and the testing of three synthetic methods (snow fences, sand bags, and patches of beach straw) to modify the sediment budget of an historically eroding shore area.

Swingle, Charles F. 1939. Seed Propogation of Trees, Shrubs and Forbs For Conservation Planting. U.S. Department of Agriculture, Soil Conservation Service, Washington, D.C. 198 pp.

A compilation of information on number of seeds per pound, germination percentages, recommended handling, and yield of plants.

Woodhouse, W. W., Jr. 1978. Dune Building and Stabilization With Vegetation. Special Report No. 3. U.S. Army, Corps of Engineers, Coastal Engineering Research Center. Fort Belvoir, Virginia. 112 pp.

The report discusses dune stabilization including the use of fences, vegetation and matting based on twenty years experimentation in coastal areas.

Woodhouse, W. W., Jr., and R. E. Hanes. 1967. Dune Stabilization With Vegetation On the Outer Banks of North Carolina. Technical Memorandum No. 22. U.S. Army, Corps of Engineers, U.S. Coastal Engineering Research Center, Fort Belvoir, Virginia. 45 pp.

This memorandum provides results on experiments to develop a more effective revegetation program. Plant species and methods for planting are provided.

Woodhouse, W. W., Jr., E. D. Seneca, and S. W. Broome. 1976. Ten Years of Development of Man-initiated Coastal Barrier Dunes in North Carolina. Bulletin 453, North Carolina Sea Grant Program Publication No. 77-01. North Carolina University Agricultural Experiment Station, Raleigh, North Carolina. 55 pp.

Development of dunes by planting various vegetation is described along with the results of such experiments. Dune grasses, American beachgrass and sea oats were used.

C. Groundwater

Brown, G. S. and R. C. Newcomb. 1963. Ground-Water Resources of the Coastal Sand-Dune Area North of Coos Bay, Oregon. U.S. Department of the Interior, Geological Survey Water Supply Paper 1619-D. U.S. Government Printing Office, Washington, D.C. 32 pp.

This report provides information on the hydrology of the sand dune aquifer north of Coos Bay, Oregon including water quality and water supply.

California Pollution Control Board. 1954. Investigation of Travel of Pollution. Publication 11. Sacramento, California. 218 pp.

The capabilities of some soils and subsurface materials as filtering agents of various pollutants are investigated.

Dugan, Patrick, Y. R. Nayudu, Daniel Bottom, and Kathy Fitzpatrick. 1976. A Study of Shoreland Management Alternatives - Inventory of Five Shoreland Areas. Oregon Coastal Conservation and Development Association, North Bend, Oregon. 280 pp.

This study provides basic environmental baseline data on five shoreland areas representative of Oregon coastal environments. The following areas are examined: The Nehalem River, Woahink and Siltcoos Lakes, the shoreline of Curry County, Yaquina Bay and the Siletz River.

Frank, F. J. 1970. Ground Water Resources of the Clatsop Plains, Sand Dune Area, Clatsop County, Oregon. U.S. Department of the Interior, Geological Survey Water Supply Paper 1899-A. U.S. Government Printing Office, Washington, D.C. 41 pp.
This study provides a good picture of characteristics of the Clatsop aquifer; includes geohydrology, water quality and development problems.

Hampton, E. R. 1961. "Ground Water From Coastal Dune and Beach Sands." Geological Survey Research. U.S. Department of the Interior, Geological Survey Professional Paper 424B. U.S. Government Printing Office, Washington, D.C. pp. B204-B206. 3 pp.
A brief but informative introduction to Oregon coastal dune groundwater characteristics is presented in this article.

Hampton, E. R. 1963. Ground Water in the Coastal Dune Area Near Florence, Oregon. U.S. Department of the Interior, Geological Survey Water Supply Paper 1539-K. U.S. Government Printing Office, Washington, D.C. 36 pp.
The occurrence, quantity and general quality of dunal groundwater near Florence are investigated in this report. Duneland aquifer characteristics are described and practical withdrawal methods and considerations are discussed.

Larson, Douglas W. 1974. A Water Quality Survey of Selected Coastal Lakes in the Sand Dune Region of Western Lane and Douglas Counties, 1972-1973. Final Report, Western Quality Studies. Oregon Department of Environmental Quality, Portland, Oregon. 152 pp.
A technical study of thirteen coastal lakes to document existing limnological characteristics to establish a baseline for future planning and management.

Larson, Douglas William. 1970. "On Reconciling Lake Classification With the Evolution of Four Oligotrophic Lakes in Oregon." PhD Dissertation, Oregon State University, Corvallis, Oregon. 135 pp.
This study considers the responses of four Oregon lakes, including Woahink Lake in coastal Lane County, to the ambient physical environment and cultural use interactions; assesses factors which encourage or inhibit eutrophication in each lake and; proposes an alternative, diagnostic lake classification system.

Robison, J. H. 1973. Hydrology of the Dunes Area North of Coos Bay, Oregon. U.S. Department of the Interior, Geological Survey, Portland, Oregon. 62 pp.
A detailed study of the hydrology of a twenty square mile area of dunes along the central Oregon coast. Within the study an analog model was used to analyze current and projected water levels.

Smith, David L. 1962. Lake and Stream Formation on Sand Dunes in the Florence District, Oregon. University of Oregon, Eugene, Oregon. 90 pp.
This study deals with the description and interpretation of lake and stream forms near Florence, Oregon.

Sweet, Randy H. 1977. Carrying Capacity of the Clatsop Plains Sand-Dune Aquifer. A report for the Clatsop County Commission and Oregon Environmental Quality Commission, Clatsop County, Oregon. 73 pp.
This study assesses the physical hydrogeological characteristics of this area and proposes management recommendations.

D. Off-road Vehicles

Baldwin, Malcolm R., and Dan H. Stoddard, Jr. 1973. The Off-Road Vehicle and Environmental Quality. 2nd Edition. The Conservation Foundation, Washington, D.C. 61 pp.
Environmental concerns as well as other ORV problems are discussed and good recommendations are offered.

Bennett, Shaun. 1973. A Trail Rider's Guide to the Environment. American Motorcyclists Association, Westerville, Ohio. 60 pp.
The booklet is geared for the "biker" and is humorously illustrated pointing out responsible use is a must to ensure off-road opportunities. Environmental considerations are mentioned regarding soil and other elements.

Bess, Fred H. 1973. "The Effectiveness of Helmets for EAR Protection." Proceedings of the 1973 Snowmobile and Off the Road Vehicle Research Symposium. Donald F. Holecek, Ed. Department of Parks and Recreation Resources Technical Report No. 9 (147-149). Michigan State University, East Lansing, Michigan. 3 pp.
The potential hazards of ORV noise were mentioned and various helmet brands were tested. None were particularly effective.

Blodget, Bradford G. 1978. The Effect of Off-Road Vehicles on Least Terns and Other Shorebirds. National Park Service Cooperative Research Unit Report No. 26. University of Massachusetts. 79 pp.
A carefully conducted study specifically on Least Terns, and other shorebirds. The study took place in an area of extremely high ORV management.

Bury, Richard L., Robert C. Wendling, and Stephen McCool. 1976. Off-Road Recreation Vehicle - A Research Summary, 1969-1975. MP-1277. Texas Agriculture Experiment Station, Texas A & M University, College Station, Texas. 84 pp.
This review is very useful to rapidly become oriented in ORV literature and problems. It covers all major areas.

California Department of Parks and Recreation. 1975. Pismo State Beach and Pismo Dunes State Vehicular Recreation Area -- General Development Plan and Resource Management Plan. Sacramento, California. 83 pp.

This plan is a good example of management of high use areas. Many ORV problems are considered.

California Department of Parks and Recreation. 1978. Off-Highway Vehicle Recreation in California. Sacramento, California. 96 pp.

A complete overview of the California system is provided. It serves as a good example of an off-road vehicle system.

Carter, James E. 1977. "Use of Off-Road Vehicles on Public Lands." U.S. Presidential Executive Order 11989. Government Printing Office, Washington, D.C. 1 p.

This order allows federal land managers to close an area to certain ORVs if there are real or potential adverse environmental effects.

Godfrey, Paul J., Stephen P. Leatherman, and P. A. Buckley. 1978. "Impact of Off-Road Vehicles on Coastal Ecosystems." Coastal Zone '78 Symposium on Technical, Environmental, Socioeconomic and Regulatory Aspects of Coastal Zone Management. Volume II. American Society of Civil Engineers, New York, New York. pp. 581-600. 20 pp.

This summarizes the ORV effects on several coastal ecosystems and appears to be the most comprehensive research effort in that regard. It is very informative and serves to launch one into the specific studies it summarizes.

Harrison, Rob. 1973. "ORV Noise Effects and Measurements." Proceedings of the 1973 Snowmobile and Off the Road Vehicle Research Symposium. Donald F. Holecek, Ed. Technical Report No. 9. Michigan State University, East Lansing, Michigan. pp. 135-145. 11 pp.

ORV noise measurement techniques are discussed as are effects. ORV noise detectability is considered.

Lodico, Norma Jean. 1973. Environmental Effects of Off-Road Vehicles: A Review of the Literature. Bibliography Series No. 29. Office of Library Services, U.S. Department of the Interior, Washington, D.C. 112 pp.

This work is useful and shows areas of environmental concern. At the time it was published, the number of authoritative studies on ORV impacts was limited.

McCool. S. F., and J. W. Roggenbuck. 1974. Off-Road Vehicles and Public Lands: A Problem Analysis. Department of Forestry and Outdoor Recreation and Institute for the Study of Outdoor Recreation and Tourism, Utah State University, Logan, Utah. 109 pp.

This work comprehensively organizes the questions about ORVs to identify the areas most needing research. It provides a quick background on the multitude of ORV related problems.

McEwen, Douglas N. 1978. Turkey Bay Off-Road Vehicle Area at Land Between the Lakes: An Example of New Opportunities for Managers and Riders. Research Report Number 1. Department of Recreation, Southern Illinois University, Carbondale, Illinois. 28 pp.

The work shows many examples of how to successfully plan and manage an ORV area.

Motorcycle Industry Council. 1978. 1978 Motorcycle Statistical Annual. Newport Beach, California. 46 pp.

Statistics on the motorcycle market, manufacturers, use, and ownership are presented. Off-road use is considered.

Muntz, E. P., T. L. Deglow, and D. H. Campbell. 1972. "Public Lands and Off-Road Motorized Recreation." Environmental Engineering Programs Bulletin 100. School of Engineering, University of Southern California, Los Angeles, California. 18 pp.

The area of disturbance for a trail biker and a hiker is quantified, compared, and related to the finite resource base.

Neidoroda, A. 1975. Geomorphological Effects on ORVs on Coastal Systems of Cape Cod, Massachusetts. National Park Service Cooperative Research Unit Report No. 17. University of Massachusetts. 100 pp.

The study considers the causes and results of ORV downslope sand transport. It suggests ways to limit such transport and ORV related erosion.

Nixon, Richard M. 1972. "Use of Off-Road Vehicles on the Public Lands." U.S. Presidential Order 11644. U.S. Government Printing Office, Washington, D.C. 2 pp.

The order required federal agencies to develop management plans for ORVs on their lands and consider several factors in doing so.

Oregon Department of Environmental Quality. 1978. DEQ Handbook for Environmental Quality Elements of Oregon Local Comprehensive Land Use Plans. Portland, Oregon. 28 pp.

This loose-leaf work provides background on noise restrictions that apply to ORVs.

Oregon Department of Transportation, Parks and Recreation Branch. 1977. Oregon Outdoor Recreation Needs Bulletin 1977. Technical Document III of the State Wide Comprehensive Outdoor Recreation Plan. Salem, Oregon. 183 pp.

This document considers the recreational statewide needs and includes ORV use. The figures on availability of trails are questionable, however, it does recognize ORV use.

Peine, John D. 1973. "Off-Road Vehicle Use in Tucson, Arizona." Proceedings of the 1973 Snowmobile and Off the Road Vehicle Research Symposium. Donald F. Holecek, Ed. Technical Report No. 9. Department of Parks and Recreational Resources, Michigan State University, East Lansing, Michigan. 202 pp.

The paper is based on Peine's unpublished thesis. It describes the ORV activity and develops a model for ORV preference.

Rasor, Robert. 1978. Five State's Approaches to Trailbike Recreation Facilities and Their Management. American Motorcycle Association, Westerville, Ohio. 64 pp.

Different systems for trail bike areas are discussed and useful examples of management are provided. It shows trail bikes can be a manageable form of recreation. The Appendixes are very useful including the ORV legislation from the States of Washington and California.

Stupay, Arthur M. 1971. "Growth of Powerized Vehicles in the 1970's." Proceedings of the 1971 Snowmobile and Off the Road Vehicle Research Symposium. Michael Chubb, Ed. Technical Report No. 8. Michigan State University, East Lansing, Michigan. 196 pp.

It provides a background on the growth of ORVs.

U.S. Department of Agriculture, Forest Service. 1976. "Travel Plan Off-Road Vehicle Use -- Siuslaw National Forest." Corvallis, Oregon. 4 pp. + maps.

It describes the various vehicle designations and operating conditions for each open area; the basis for these policies is mentioned.

U.S. Department of the Interior, Bureau of Land Management. 1970. Operation ORVAC: Recommendations and Guidelines for the Management of Off-Road Vehicles on Public Domain Lands in California. Sacramento, California. 40 pp.

General guidelines are provided that are useful as is the approach to the ORV problem through an advisory council.

Visco, Christopher. 1977. "The Geomorphic Effects of Off-Road Vehicles on the Beach, Fire Island, New York." MA Thesis. State University of New York, Binghamton, New York. 74 pp.
Describes how different factors relating to ORV travel on beaches, such as speed, affect the net amount of sediment moved down slope by vehicle tracks.

Washington Department of Natural Resources. 1976. "Operating All-Terrain Vehicles in the State of Washington." Olympia, Washington. 14 pp.
This is an informational booklet on the all-terrain program in Washington.

E. Sand Movement--Erosion and Accretion

Aguilar-Tunon, N. A., and P. D. Komar. 1978. "The Annual Cycle of Profile Changes of Two Oregon Beaches." The Ore Bin. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 40(2)25-39. 14 pp.
This study compares two beaches, Gleneden Beach and Devil's Punchbowl Beach. The purposes of the study were to examine annual changes and relate these changes to wave conditions.

Beaulieu, John D. 1974. Geologic Hazards Inventory of the Oregon Coastal Zone. Misc. Paper 17. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 94 pp.
This publication provides an excellent introduction to the geologic hazard potentials along the Oregon coast. It is aimed at the planner and planning official and includes test, maps and matrices.

Beaulieu, John D. 1978. "Surfical Geologic Hazard Concept for Oregon." The Ore Bin. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 40(3):41-56. 16 pp.
This article deals with hazards such as mass movement, slope erosion, flooding, and stream erosion. It is a general introduction to such hazards.

Beaulieu, John D. and Paul W. Hughes. 1975. Environmental Geology of Western Coos and Douglas Counties, Oregon. Bulletin 87. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 148 pp + maps.
The purpose of this report is to provide a data base concerning land capabilities and limitations of coastal Coos and Douglas Counties to allow for safe and responsible development.

Byrne, John V. 1963. "Coastal Erosion, Northern Oregon." Essays in Marine Geology in Honor of K. O. Emery. University of Southern California Press, Los Angeles, California. pp. 11-33. 24 pp.
The article discusses erosion on the Oregon coast including the climatic, oceanographic and geologic features which control erosion.

Byrne, John V. 1964. "An Erosional Classification for the Northern Oregon Coast." Association of American Geographers Annals. Association of American Geographers, Chicago, Illinois. 54:329-335. 7 pp.
The article proposes a classification procedure which subdivides the northern coast of Oregon according to the geologic factors which control erosion.

Collier, Courtland A., Kamran Eshaghi, George Cooper, and Richard S. Wolfe. 1977. Guidelines for Beachfront Construction with Special Reference to the Coastal Construction Setback Line. Report No. 20. Department of Civil Engineering, University of Florida, Gainesville, Florida. 72 pp.
The report discusses and illustrates problems encountered in beachfront construction and criteria for evaluating variances that will uphold the purpose and philosophy of the Florida Coastal Construction Setback Line Law whenever construction seaward of that line is justified.

Cooper, William S. 1967. Coastal Dunes of California. Memoir No. 104. Geological Society of America, Boulder, Colorado. 131 pp.
This work completed a geomorphic investigation of the coastal dunes of California which was originally published in 1958; includes areas of northern Baja California.

Davis, J. L. 1977. Geographical Variation in Coastal Development. Longman Group Ltd., London, England. 204 pp.
This publication includes generalized patterns of coastal morphology and introduces the idea of climatic controls on regional coastal geomorphology.

Davis, Richard A., Jr., Ed. 1978. Coastal Sedimentary Environments. Springer-Verlag, New York, New York. 420 pp.
This publication is a thorough academic treatment of offshore, beach, dune and riverine coastal sedimentary environments, with geomorphological emphasis.

Dicken, S. N. 1961. Some Recent Physical Changes of the Oregon Coast. Office of Naval Research Contract Nonr-2771(04). Department of Geography, University of Oregon, Eugene, Oregon. 151 pp.
This report is concerned with the physical changes of the Oregon Coast since white settlement, with special emphasis on beaches, dunes, and tidal marshes in the estuaries.

Dickson, Samuel N., Carl L. Johannessen, and Bill Hanneson. 1961. Some Recent Physical Changes of the Oregon Coast. Department of Geography, University of Oregon, Eugene, Oregon. 151 pp.

The factors causing shoreline changes are discussed with the emphasis being on the historical changes of the beaches, nearby dunes, and estuaries since the time of white settlement. Vegetation changes are considered in this rather comprehensive work.

Flawn, Peter T. 1970. Environmental Geology: Conservation, Land-Use Planning, and Resource Management. Harper and Row, New York, New York. 313 pp.

A good introduction into planning rationales and the geologic system. The author specifically deals with beaches and man's impacts in various sections of the document.

Hamilton, Stanley F. 1973. "Oregon Estuaries." Oregon Division of State Lands, Salem, Oregon. 49 pp.

This publication presents maps and aerial photographs along with information on Oregon's estuaries.

Hanneson, Bill. 1961. "Vegetation Changes of the Oregon Coastal Dunes." Some Recent Physical Changes of the Oregon Coast. Office of Naval Research Contract Nonr-2771(04). Department of Geography, University of Oregon, Eugene, Oregon. pp. 77-99. 23 pp.

This article documents the alteration of the Oregon sand dunes by man and discusses the processes by which man makes these changes.

Komar, P. D. 1977. "Beach Profiles Obtained With an Amphibious DUKW on the Oregon and Washington Coasts." The Ore Bin. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 39(11):169-180. 12 pp.

During a Navy study in 1945 and 1946 beach profiles were collected at 15 Oregon and Washington locations using a DUKW. Included is information on the outer bars and troughs and extends across the entire nearshore zone.

Komar, P. D. 1978. "Wave Conditions On the Oregon Coast During the Winter of 1977-78 and the Resulting Erosion of Nestucca Spit." Shore and Beach. American Shore and Beach Preservation Association, Miami, Florida. 46(4):3-8. 6 pp.

This article describes the wave erosion of Nestucca Spit during unusually intense storm waves in the winter of 1977-78.

Komar, P. D., J. R. Lizarraga-Arciniega and T. A. Terich. 1976. "Oregon Coast Shoreline Changes Due to Jetties." Journal of Waterways, Harbors and Coastal Engineering Division. American Society of Civil Engineers, New York, New York. 102(WW1) Paper 11933:13-30. 18 pp.

This article discusses the role of jetties in erosion and deposition, primarily in an area of zero net littoral sand drift. The jetty systems of Nehalem River, Tillamook Bay, Yaquina Bay, Siuslaw River mouth, the Umpqua River, Coos Bay entrance, the Coquille River, Rogue River, and Chetco River mouth are included.

Lizarraga-Arciniega, J. R. and Paul D. Komar. 1975. Shoreline Changes Due to Jetty Construction on the Oregon Coast. Publication Number ORES4-T-75-004. Oregon State University Sea Grant College Program, Corvallis, Oregon. 85 pp.

All nine jetty systems on the coast are included except those on the Columbia River. The relationship between beach erosion, accretion and jetty construction is discussed. A computer model is provided to simulate shoreline changes resulting from the Siuslaw River jetties.

McKinney, B. A. 1977. "The Spring 1976 Erosion of Siletz Spit, Oregon, With an Analysis of the Causative Wave and Tide Conditions." MS Thesis, School of Oceanography, Oregon State University, Corvallis, Oregon. 66 pp.

This study documents the 1976 erosion of Siletz Spit and contrasts it with early occurrences. The role of tides was investigated and it was determined that storm surges did not contribute to the spit erosion.

North, W. B. 1964. "Coastal Landslides in Northern Oregon." MS Thesis, Oregon State University, Corvallis, Oregon. 85 pp.

This thesis explores the contributions of landslides to the erosion of the northern Oregon Coast.

Phipps, John B. and John M. Smith. 1978. "Pacific Ocean Beach Erosion and Accretion Report." Grays Harbor College, Aberdeen, Washington. 75 pp.

Historical shorelines of southwestern Washington are mapped, and the factors affecting erosion/accretion are considered in light of a sand budget. A projected shoreline map is provided and dune management is discussed.

Prestedge, G. K. 1977. "Stabilization of Landslides Along the Oregon Coast." Engineering Report, Department of Civil Engineering, Oregon State University, Corvallis, Oregon. 53 pp.

This paper studies the landslide problem on the Oregon coast in order to propose methods of stabilization for potential landslides. An analytical model of the landslide mechanism is presented.

Rea, Campbell C. 1974. "The Erosion of Siletz Spit, Oregon." MS Thesis, Oregon State University, Corvallis, Oregon. 105 pp.

A paper viewing the history of erosion and accretion with comments on changes of the shoreline and sand budget. Recommendations for controlling erosion are presented.

Rea, Campbell C. and Paul D. Komar. 1975. "The Erosion of Siletz Spit, Oregon." Reference 75-4. School of Oceanography, Oregon State University, Corvallis, Oregon. 105 pp.

This paper examines the history of erosion on Siletz Spit to determine whether the erosion is long term or cyclical and to suggest causes and remedies.

Schatz, C. 1965. "Source and Characteristics of the Tsunami Observed Along the Coast of the Pacific Northwest on 28 March 1964." MS Thesis, Department of Oceanography, Oregon State University, Corvallis, Oregon. 39 pp.

The thesis discusses the possibility that the 1964 tsunami was caused by uplift and subsidence of submarine crustal blocks. The degree and type of transformation of the waves as they reached estuaries was based on the underwater and coastal features at the estuary.

Schatz, Clifford E., Herbert Curl, Jr., and Wayne V. Burt. 1964. "Tsunamis on the Oregon Coast." The Ore Bin. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 26(12):231-232. 2 pp.

The article reviews the effects of the tsunami of 1964. It explains that the coast will probably be struck again and the estuaries are the areas most susceptable to damage.

Schlicker, Herbert G. and Robert J. Deacon. 1974. Environmental Geology of Coastal Lane County, Oregon. Bulletin 85. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 116 pp.

A geological background is provided along with geological hazards and a well-illustrated section on sand dunes within this work.

Schlicker, Herbert G., Robert J. Deacon, John D. Beaulieu and Gordon W. Olcott. 1972. Environmental Geology of the Coastal Region of Tillamook and Clatsop Counties, Oregon. Bulletin 74. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 164 pp.

A substantial geological background is provided along with geological hazards, mineral resources including sand and gravel, and engineering characteristics of the geological units.

Schlicker, Herbert G., Robert J. Deacon, Gordon W. Olcott, and John D. Beaulieu. 1973. Environmental Geology of Lincoln County, Oregon. Bulletin 81. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 171 pp.

A substantial geological background is provided along with groundwater, geological hazards, and mineral resources.

State Soil and Water Conservation Commission. 1978. Inventory: Oregon Coastal Shoreline Erosion. Volume I. Salem, Oregon. 109 pp.

A study of the shoreline erosion problem and related sources of information including an annotated bibliography. The processes and historic patterns are presented with a county by county approach.

Stembridge, James E. 1976. Recent Shoreline Changes of the Oregon Coast. Accession No. ADA048436. National Technical Information Service, Springfield, Virginia. 51 pp.

An analysis and classification of shoreline erosion along Oregon's pacific coastline based on earlier research for PhD dissertation at University of Oregon.

Terich, T. A. 1973. "Development and Erosion of Bayocean Spit, Tillamook." PhD Thesis, Department of Geography, Oregon State University, Corvallis, Oregon. 145 pp.

The thesis discusses the development of a resort on Bayocean sand spit on the northern Oregon coast and the reasons for its abandonment, primarily erosion of the spit due to construction of a jetty.

Terich, T. A., and P. D. Komar. 1974. "Bayocean Spit, Oregon: History of Development and Erosional Destruction." Shore and Beach. American Shore and Beach Preservation Association, Miami, Florida. 42(2):3-10. 8 pp.

The article describes the development of Bayocean Park on Bayocean Spit and its failure due to erosion of the Spit after construction of a jetty in 1914-17.

F. Biological Information

Amos, William H. 1959. "The Life of a Sand Dune." Scientific American. Scientific American, Inc. New York, New York. 201:91-99. 9 pp.

This article discusses the community of plants and animals which live on a sand dune.

Byrd, N. L. 1950. "Vegetation Zones of Coastal Dunes Near Waldport, Oregon." MS Thesis. Oregon State University, Corvallis, Oregon. 44 pp.

This thesis discusses the effects of physical factors on the zonation of vegetation on sand dunes in the area north of Alsea Bay near Waldport Oregon.

Dyrness, C. T., J. F. Franklin, C. Maser, S. A. Cook, J. D. Hall, and G. Faxon. 1975. Research Natural Area Needs in the Pacific Northwest. U.S. Forest Service General Technical Report, PNW-38 U.S. Department of Agriculture, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. 231 pp.

The publication is a guide to describe a system of natural areas for Oregon and Washington and to help coordinate the preservation of natural areas and alert land planners to their value.

Eilers, Peter, III. 1974. "Plants, Plant Communities, Net Production and Tide Levels; Ecological Biogeography of the Nehalem Salt Marshes, Tillamook County, Oregon." PhD Thesis, Department of Geography, Oregon State University, Corvallis, Oregon. 368 pp.

This is a detailed study of the coastal salt marsh at Nehalem estuary in Oregon. The primary purpose is to understand and establish the importance of these types of areas.

Hitchcock, C. Leo and Arthur Cronquist. 1973. Flora of the Pacific Northwest. University of Washington Press, Seattle, Washington. 730 pp.

This is an illustrated, condensation of the five-volume work, Vascular Plants of the Pacific Northwest, (below).

Hitchcock, C. Leo, Arthur Cronquist, Marion Ownbey, and J. W. Thompson. 1955-1969. Vascular Plants of the Pacific Northwest. University of Washington Press, Seattle, Washington. 5 volumes.

This is a five-volume technical description and discussion of the vascular plant families of the Pacific Northwest including keys for their identification.

Kumler, M. L. 1969. "Plant Succession on the Sand Dunes of the Oregon Coast." Ecology. Duke University Press, Durham, North Carolina. 50:695-704. 10 pp.

Perhaps the most thorough and comprehensive recent study of coastal dune dynamics; especially appropriate for the central Oregon coast.

Macdonald, Keith B., and Michael G. Barbour. 1974. "Beach and Salt Marsh Vegetation of the North American Pacific Coast." Ecology of Halophytes. W. H. Queen and R. J. Reimold, Eds. Academic Press, New York. pp. 175-234. 60 pp.

The paper surveys beach and salt marsh vegetation between Point Barrow, Alaska and Cabo San Lucas at the southern tip of Baja California.

Oosting, H. J. and W. D. Billings. 1942. "Factors Affecting Vegetation Zonation on Coastal Dunes." Ecology. Duke University Press, Durham, North Carolina. 23:131-142. 12 pp.

This article discusses the development of blow-outs along areas of unconsolidated sands on the coast of North Carolina. Several types of beach plants were planted on the dunes with various treatments of the plants tried. The characteristics of the sand and atmosphere were also discussed.

Wiedemann, Alfred Max. 1966. "Contributions to the Plant Ecology of the Oregon Coastal Sand Dunes." PhD Thesis, Oregon State University, Corvallis, Oregon. 255 pp.

This thesis investigates the ecological and economic aspects of Oregon coastal dunes. A literature review is included on the botanical and ecological aspects of the dunes. The deflation plain is discussed in detail.

IV. BEACH AND DUNE MANAGEMENT TECHNIQUES

A. Hazard Management

Coastal Zone Management. 1976. Natural Hazard Management in Coastal Areas. U.S. Department of Commerce, NOAA. Washington D.C. 286 pp.

A handbook geared to provide guidance and information to coastal planners and decision-makers on major natural hazards. The handbook presents the material as: Major Coastal Hazards, Problems and Recommendations, Hazard Management in the Coastal States, Annotated Bibliography and a Directory of Selected Agencies.

Georgia Department of Natural Resources. 1975. Handbook: Building in the Coastal Environment. Atlanta, Georgia. 118 pp.

The handbook provides site specific guidelines including site analysis, planning/design, construction, and land exchange. The concepts are highly illustrated.

Kates, Robert W. 1978. Risk Assessment of Environmental Hazard. John Wiley and Sons, New York, New York. 112 pp.

A technical report that examines the present state of the art with respect to coping with environmental risks. Existing methods and modes of risk assessment along with the observed trends and attitudes in assessing environmental threat are presented.

State Soil and Water Conservation Commission. 1978. Oregon Coastal Management Program: Shoreline Erosion Management Policies and Procedures. Volume II. Salem, Oregon. 113 pp.

A description of the Oregon Coastal Zone Management program with a focus on management techniques for shoreline erosion is presented. An evaluation of the current program is given with suggestions for policy changes.

The Conservation Foundation. 1977. Physical Management of Coastal Floodplains: Guidelines for Hazards and Ecosystems Management. Council on Environmental Quality, Washington, D.C. 179 pp.

A technical report that offers development and conservation guidelines for the following coastal areas: coastal watersheds, shoreland water systems, coastal floodlands, saltwater wetlands, bluffs, dunes, beaches, basin floor, and coastal waters.

U.S. Army Corps of Engineers. 1966. Beach Erosion Control and Shore Protection Studies. Engineering Manual No. 1110-2-3300. Office of the Chief of Engineers, Washington, D.C. 19 pp. + appendices.

This manual discusses the types of information needed to conduct beach erosion studies, such as program development and data collection, to serve as a basis for planning remedial measures.

U.S. Army Corps of Engineers. 1975. Shore Protection Manual Volume I. Second edition. U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia. 508 pp.

This is the first volume of a three volume manual. It describes the physical environment of the coastal zone and discusses coastal engineering, wave mechanics, wave and water predictions, and littoral processes.

U.S. Army Corps of Engineers. 1975. Shore Protection Manual Volume II. Second edition. U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia. 505 pp.

This volume of a three volume manual deals with planning and structural design in relation to the physical factors of Volume I. An example is provided.

U.S. Army Corps of Engineers. 1975. Shore Protection Manual Volume III. Second Edition. U.S. Army Coastal Engineering Research Center, Fort Belvoir, Virginia. 141 pp.

This volume of the three volume manual contains the appendixes (glossary, list of symbols, tables and plates, and subject index) for the first two volumes.

U.S. Department of Housing and Urban Development. 1977. Elevated Structures/Reducing Flood Damage Through Building Design: A Guide Manual. HUD-FIA-184(2). Washington, D.C. 108 pp.

The manual provides background information on the National Flood Insurance Program and the hazards associated with building in the floodplain. It reviews the existing alternatives to house construction on raised foundations and offers performance criteria for such foundation systems.

B. Considerations and Impacts

Alen, Ray, David Brower, B. J. Copeland, D. Frankenberg, and Francis Parker. 1976. Ecological Determinants of Coastal Area Management. Volume II. North Carolina State University, Raleigh, North Carolina. 392 pp.

A comprehensive work that covers both the coastal ecological systems and tools and techniques for coastal area management. While having a bias for the North Carolina situation, this work does offer valuable insight into the application of many tools upon several coastal ecosystems.

Battelle Institute. 1971. Shoreland Management Guidelines to Grays Harbor Regional Planning Commission. Battelle Pacific Northwest Laboratories, Richland, Washington. 95 pp.

A detailed study of the shorelands of Grays Harbor County, Washington, that described the natural systems, land-use activities and presented management guidelines including a checklist for shoreland policy decisions.

Bella, David A. 1973. "Environmental Planning Methods." Coastal Zone Management Problems. Water Resources Institute, Oregon State University, Corvallis, Oregon. pp. 53-60. 8 pp.

An approach to coastal zone management planning that places a high value on environmental variety is presented. The key to this method is the preservation of future options enabling the management authority to adjust decisions in relationship to changing value systems and unanticipated environmental impacts.

Brahtz, J. F. Peel, Ed. 1972. Coastal Zone Management: Multiple Use With Conservation. John Wiley and Sons, Inc. New York, New York. 351 pp.

This book addresses a wide range of resource uses, conflicts and problems of coastal zone management, each from the particular viewpoint of a specialist in one of the classical problem areas.

Bright, Donald B. 1973. "Local Land Use: Management Concepts and Problems." Proceedings of Coastal Zone Management and the Western States Future. William B. Merselis, Ed. Marine Technology Society, Newport Beach, California. pp. 222-226. 5 pp.

The author presents three management concepts: ethical changes, land as a resource and a commodity, and a cross-matching scheme.

Brower, David, Dirk Frankenberg, and Francis Parker. 1976. Ecological Determinants of Coastal Area Management--An Overview. Volume 1. Sea Grant Publication UNC-SG-76-05. North Carolina State University Raleigh, North Carolina. 133 pp.

The work analyzes the ecological processes of the barrier island system and lagoon-estuary system. Various management tools are provided to preserve the components of the two main systems.

Canter, Larry. 1977. Environmental Impact Assessment. McGraw-Hill Book Company, New York, New York. 331 pp.

An introductory text that presents a systematic approach to the prediction and assessment of impacts on the physical, chemical, biological, cultural and socioeconomic factors in the environement.

Dickert, Thomas and Jens Sorensen. 1978. Collaborative Land-Use Planning for the Coastal Zone: A Process for Local Program Development. Volume I. IURD Monograph No. 27. Institute of Urban and Regional Development, University of California, Berkeley, California. 120 pp.

Collaborative planning in this work is presented as a midpoint compromise between centralized and decentralized approaches in which state and local units of government work jointly to prepare and implement local, regional and state land use plans.

Dilton, Robert B., John L. Seymour, and G. C. Swanson. 1977. Coastal Resources Management: Beyond Bureaucracy and the Market. Lexington Books, Lexington, Massachusetts. 196 pp.

An overview of the main issues involved in coastal zone management. The authors review current practices, future needs and describe several case histories. The main emphasis is on improved management for multiple use.

Harrison, Pete. 1977. "The Pressure for Shoreline Development: Spatial Concepts in Review." Coastal Zone Management Journal, New York, New York. 3(3):319-322. 4 pp.

The relationships between dispersed and concentrated shoreline development, environmental carrying capacity and public access are developed in a broad conceptual scheme.

Harvard University Graduate School of Design. 1967. Three Approaches to Environmental Resource Analysis. The Conservation Foundation, Washington, D.C. 102 pp.

An excellent view of three major approaches to environmental planning. Included are the works of G. Angus Hills, Philip H. Lewis, Jr. and Ian L. McHarg. Although the work is dated, it is still a basic source and contains an annotated bibliography.

Hendler, Bruce. 1977. Caring for the Land: Environmental Principles for Site Design and Review. Report No. 328. American Society of Planning Officials, Chicago, Illinois. 94 pp.

A generalized approach to planning is provided including environmental, site, and design considerations. It is a well-illustrated and useful overview to thoughtful development.

Hermon, Barbara A. 1975. "The Environmental Review Team." Planners Notebook. Volume 5. American Institute of Planners, Cambridge, Massachusetts. 5(5). 6 pp.

A report on the history and methodology of an interdisciplinary environmental review team that was established in Eastern Connecticut in 1968 to assist local governments and developers in assessing the environmental impacts of proposed large scale projects.

Jain, R. K., L. V. Urban, and G. S. Stacey. 1977. Environmental Impact Analysis: A New Dimension in Decision-Making. Von Nostrand Reinhold Company, New York, New York. 330 pp.

A technical look at environmental impact statements that gives insight into how to determine which of forty-nine bio-physical and socio-economic factors may be affected by a given project. The authors present methods on how to identify and measure in advance impacts on these forty-nine attributes.

Komar, P. D. and B. A. McKinney. 1977. "The Spring 1976 Erosion of Siletz Spit, Oregon, With an Analysis of the Causative Storm Conditions." Shore and Beach. American Shore and Beach Preservation Association, Miami, Florida. 45(3):23-30. 8 pp.
This study documents erosion on Siletz Spit, Oregon and contrasts it with earlier winter erosion periods. Tide levels and storm surges are analyzed.

Komar, P. D., W. Quinn, H. C. Creech, C. C. Rea, and J. R. Lizarraga-Arciniega. 1976. "Wave Conditions and Beach Erosion on the Oregon Coast." The Ore Bin. Oregon Department of Geology and Mineral Industries, Portland, Oregon. 38(7):103-112. 10 pp.
Data from November, 1971 through June, 1975 has been analyzed concerning the wave height at Newport, Oregon every six hours, measured by a recording device that detects microseisms.

Komar, P. D. and C. C. Rea. 1976. "Erosion of Siletz Spit, Oregon." Shore and Beach. American Shore and Beach Preservation Association, Miami, Florida. 44(1):9-15. 7 pp.
This article explains the erosion of Siletz Spit, Oregon due to rip currents eroding embayments on the beach.

Komar, Paul and Thomas A. Terich. 1976. "Changes Due to Jetties at Tillamook Bay, Oregon." Proceedings 15th Coastal Engineering Conference. American Society of Civil Engineering, New York, New York. Chapter 104:1791-1811. 21 pp.
This paper explains that physical changes on the Bayocean Spit are the results of local rearrangement of the beach, not from a change in the net littoral drift.

Kulm, L. D. and J. V. Byrne. 1966. "Sedimentary Response to Hydrography in an Oregon Estuary." Marine Geology. Elsevier Publishing Company, Amsterdam. 4:85-118. 34 pp.
This article discussed two major realms of deposition of Yaquina Bay, Oregon - marine and fluviatile and a third - marine-fluviatile transition realm. Sediment transport and deposition is discussed as it relates to climatic and hydrographic variations.

Louisiana Coastal Resources Program. 1976. A Process for Coastal Resources Management and Impact Assessment. Louisiana State Planning Office, Baton Rouge, Louisiana. 72 pp.
The report is presented as a management handbook for elected and appointed officials, citizens and private sector interests to provide suggested methods of approaching some of the unique planning problems of the Louisiana coastal zone.

Roberts, William H. 1978. "Environmental Developmental Trade-offs in the Coastal Zone." Proceedings of Coastal Zone '78. Volume IV. American Society of Civil Engineers, New York, New York. pp. 2773-2790. 18 pp.

The author presents environmental and developmental functions in the planning process as mutually exclusive or conflicting (where a potential for accommodation or trade-off exists) in an approach to make coastal zone management programs effective.

Schoenbaum, Thomas J. and Kenneth G. Silliman. 1976. Coastal Planning: The Designation and Management of Areas of Critical Environmental Concern. University of North Carolina Sea Grant Publication UNC-SG-76-09. Chapel Hill, North Carolina.

This study reviews general legal limitations and suggests a process to designate and manage areas of particular environmental concern. Oregon's approach is included as are all states involved with such legislation.

Schoenbaum, Thomas J. and Ronald H. Rosenberg. 1976. "The Legal Implementation of Coastal Zone Management: The North Carolina Model." Duke Law Journal. Durham, North Carolina. 1:1-37. 37 pp.

The authors review several policy areas that affect coastal management (planning, impact analysis, land use controls, permits, various tax programs, and government acquisition and ownership). Authors conclude that traditional land use legal tools are inadequate and that they should be enhanced by new techniques coupled with a strong intergovernmental cooperation strategy.

Sorensen, Jens C. 1971. "A Framework for Identification and Control of Resource Degradation and Conflict in the Multiple Use of the Coastal Zone." MA Thesis, University of California, Berkeley, California. 50 pp.

A useful introductory work that provides an approach to the development of coastal planning policy. The paper is divided into five parts: (1) resource conflict and degradation, (2) development of an impact system framework, (3) description of the parts (4) applications of the framework, and (5) future needs to improve the framework.

Stockhom, John. 1974. Performance Standards: A Technique for Controlling Land Use. Extension Service Special Report 424. Oregon State University, Corvallis, Oregon. 50 pp.

This paper examines performance standards as a land use control technique available to supplement or replace zoning for plan implementation.

Thurow, Charles, William Toner, and Duncan Erley. 1975. Performance Controls for Sensitive Lands: A Practical Guide for Local Administrators. ASPA Planning Advisory Service Report Nos. 307 and 308. American Society of Planning Officials, Chicago, Illinois. 156 pp.
This manual advocates the protection of environmentally sensitive areas (streams and creeks, aquifers, wetlands, woodlands, and hillsides) by using the police powers of local jurisdictions. Also provided is information on the importance of such areas, performance standards, examples of existing ordinances, and a list of technical assistance resources.

V. GENERAL INFORMATION (INCLUDING BEACHES AND DUNES)

A. Coastal Zone Management Issues

American Society of Civil Engineers. 1978. Coastal Zone '78, Proceedings of the Coastal Zone '78 Symposium. Volumes I - IV. New York, New York. 3091 pp.
This symposium proceedings contains 218 articles in twenty-six general subject areas (i.e., Coastal Ecosystems, Environmental Engineering, Impact Assessment Methodology, Coastal Hazards and Coast Processes, etc.).

Ketchum, Bostwick H., Ed. 1972. "The Water's Edge - Critical Problems of the Coastal Zone." Proceedings of the Coastal Zone Workshop. Woods Hole Oceanographic Institution, Massachusetts. 393 pp.
This work provides a good overall basic introduction to the many issues of coastal zone management including several sections on beaches and dunes.

B. Coastal Zone Management Bibliographies

Ditsworth, George R. 1966. Environmental Factors in Coastal and Estuarine Waters Bibliographic Series, Coast of Oregon. Volume 1. Pacific Northwest Water Laboratory, Federal Water Pollution Control Administration, Corvallis, Oregon. 62 pp.
A bibliography pertaining to the marine waters indexed under; Marine Biology, Climate, Fisheries, Geology, Hydrology, Chemical and Physical Oceanography, and Bibliographies. Useful but somewhat dated.