DRAFT PACIFIC COASTAL BARRIERS STUDY

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EXECUTIVE SUMMARY

Coastal barriers are unique landforms which provide protection for diverse aquatic habitats and serve as the mainland's first line of defense against the impacts of coastal storms and erosion. Examples of coastal barriers on the Pacific coast include bay barriers, tombolos, barrier spits, barrier islands, dune or beach barriers, and fringing mangroves. Most barriers consist entirely of unconsolidated sediment composed of sand or gravel, thus their geological composition makes them highly unstable areas on which to build. However, despite their instability, many coastal barriers have undergone increased development in recent years. Some of this development has been encouraged by the availability of National Flood Insurance and other types of Federal financial assistance.

Congress recognized the vulnerability of coastal barriers to development by passing the Coastal Barrier Resources Act in 1982 (CBRA). By restricting Federal expenditures and financial assistance which have the effect of encouraging development of coastal barriers, Congress aimed to minimize the loss of human life, wasteful expenditure of Federal revenues, and damage to fish, wildlife, and other natural resources associated with coastal barriers along the Atlantic and Gulf of Mexico coasts. The CBRA, while not prohibiting privately financed development, prohibits most new Federal financial assistance within a designated Coastal Barrier Resources System (System). The System is comprised of units which encompass undeveloped coastal barriers and their associated aquatic habitats. Undeveloped coastal barriers along the Atlantic and Gulf of Mexico coasts were identified and mapped by the Department of the Interior and designated by Congress as units of the System.

In 1990, Congress passed the Coastal Barrier Improvement Act (CBIA). The CBIA tripled the size of the System by adding coastal barriers of the Great Lakes as well as additional areas along the Atlantic and Gulf of Mexico coasts. The System currently includes 560 units, comprising almost 1.3 million acres and about 1,200 shoreline miles. The CBIA also directed the Secretary of the Interior to prepare a study which examines the need for protecting undeveloped coastal barriers along the Pacific coast of the United States south of 49 degrees north latitude through inclusion in the System. This area includes the States of California, Hawaii, Oregon, and Washington; American Samoa; Guam; the Northern Marianas; and all other territories and possessions of the United States in the Pacific Ocean. In addition, the Secretary was directed to prepare maps identifying the boundaries of undeveloped coastal barriers within this area. The Secretary of the Interior delegated the authority to develop the study and the accompanying maps of the undeveloped coastal barriers of the Pacific coast to the U.S. Fish and Wildlife Service. This document satisfies the study requirement and summarizes to date the mapping project.

During the identification and mapping of coastal barrier units on the Pacific coast, no units which met the definition of an undeveloped coastal barrier were identified in the territories or possessions of the United States in the Pacific Ocean. Therefore, this study focuses on the undeveloped coastal barriers identified in the States of California, Hawaii, Oregon, and Washington. However, the Department of the Interior is soliciting input and recommendations from the local governments of the United States territories and possessions. Additionally, coastal barrier units which occur on tribal lands were not included in this study or on the accompanying maps. Neither the CBRA nor the CBIA provide guidance regarding the inclusion of Tribal lands in the System. However, inclusion of units which occur on Tribal lands in the System would meet the purposes of the Act, particularly given the sensitive living resources associated with these areas. Recognizing the sovereignty of the Native American nations, the Department of the Interior intends to solicit the input and recommendations of each affected Tribe. These recommendations will be submitted to Congress with the Department's final study recommendations or at a later date following appropriate coordination.

A total of 195 units encompassing 107,728 acres have been identified as being eligible for inclusion in the System. Upon studying the biological, economic, and climatic factors associated with Pacific coastal barriers, the Secretary of the Interior recommends that all undeveloped coastal barriers on the Pacific coast, regardless of ownership, be included in the System. Inclusion of these barriers into the System will decrease the loss of human lives associated with development on hazardous coastal barriers, minimize Federal expenditures and financial assistance in dynamic coastal areas which are subject to natural hazards, provide for the protection of fish, wildlife, and other natural resources associated with coastal barriers, and promote State coastal management goals.

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INTRODUCTION

The Coastal Barrier Resources Act of 1982 (CBRA, P.L. 97-348) established the Coastal Barrier Resources System (System), a system of undeveloped coastal barriers along the Atlantic and Gulf of Mexico coasts. Coastal barrier units included in the System were made ineligible for direct or indirect Federal financial assistance and expenditures which would support development, including Federal flood insurance. Exceptions for certain activities, such as fish and wildlife research and emergency life-saving activities, were provided for in the CBRA. Areas such as National Wildlife Refuges which are considered to be otherwise protected areas were excluded from the System.

The scope of the CBRA was further expanded when Congress passed the Coastal Barrier Improvement Act of 1990 (CBIA, P.L. 101-591). The CBIA amended the CBRA by expanding the definition of a coastal barrier and including in the System undeveloped coastal barriers located on all the coastlines of the United States. The CBIA also called for the development of a Pacific coastal barrier protection study by the Department of the Interior (DOI) to examine the need for protecting undeveloped coastal barriers along the Pacific coast of the United States. In addition to the study, Congress directed the DOI to identify and prepare maps of the undeveloped coastal barriers bordering the Pacific Ocean south of 49 degrees north latitude. The DOI delegated the authority for preparing the study and maps to the U.S. Fish and Wildlife Service. This document satisfies the study requirement and summarizes to date the mapping project.

BACKGROUND

The Coastal Barrier Resources Act of 1982 was the product of a number of initiatives by Congress and the DOI to assess Federal programs and their effects on the development of coastal barriers. Beginning in 1977, the DOI assessed options for modifying about 40 Federal programs which impact coastal barriers. The most notable program examined was the National Flood Insurance Program. These efforts resulted in the release of a draft Environmental Impact Statement in January 1980. Congressional action followed in 1981 with the enactment of the Omnibus Budget Reconciliation Act (OBRA).

Section 341 of the OBRA amended the National Flood Insurance Act of 1968 to prohibit the issuance of new Federal flood insurance after October 1, 1983, "for any new construction or for substantial improvements of structures located on undeveloped coastal barriers." The OBRA further directed the Secretary of the Interior (Secretary) to designate coastal barriers based on the definition contained in the OBRA and to make recommendations to Congress regarding the term "coastal barrier." In response to this directive, the Secretary established a Departmental Coastal Barrier Task Force to meet the requirements of the OBRA. Recommendations on coastal barrier definitions, criteria

to delineate coastal barriers, and a list of 188 units (i.e., the barrier and its associated aquatic habitats) for designation as undeveloped coastal barriers along the Atlantic and Gulf of Mexico coasts were submitted to Congress in August 1982.

In order to build on the achievements of the Federal flood insurance prohibition, Congress passed the CBRA in the fall of 1982. The law embodied three major goals:

(1) minimize loss of human life by discouraging development in high-hazard areas;

(2) reduce wasteful expenditure of Federal revenues; and

(3) protect fish, wildlife, and other natural resources associated with coastal barriers.

The CBRA established the Coastal Barrier Resources System (System) which consists of those undeveloped coastal barriers that are identified and generally depicted on the maps on file with the Secretary. The CBRA is unique in that it does not define the specific areas included in the System. Instead, the law references a series of maps which depict the specific boundaries of the individual units which were set by Congress.

The System originally consisted of 186 individual coastal barrier units totaling 666 miles of shoreline and 452,834 acres of undeveloped coastal barriers on the Atlantic and Gulf of Mexico coasts. In addition to a ban on Federal flood insurance, the CBRA also prohibited new Federal expenditures and new financial assistance for a wide range of other programs which encourage development of coastal barriers. Examples of prohibited Federal expenditures include structural development projects and cost-sharing programs for the construction of new or expanded roads, bridges, water supply systems, and sewers. However, certain Federal activities, such as the maintenance of existing Federal navigation channels, essential military activities, emergency disaster relief, research, and fish and wildlife related projects, may be permitted under Section 6 of the CBRA after consultation with the Secretary.

Congress did not originally include undeveloped coastal barriers which are considered to be "otherwise protected" in the System. As defined by the CBRA, otherwise protected areas are barriers which are "included within the boundaries of an area established under Federal, State, or local law, or held by a qualified organization as defined in Section 170(h)(3) of the Internal Revenue Code of 1954, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes." Examples of these areas include National Wildlife Refuges, National Parks and Seashores, State parks and conservation lands, and local parks and recreation areas. Congress originally felt that coastal barriers within these areas were already predominantly protected for conservation purposes, so these areas were not included in the System.

Section 10 of the CBRA directed the Secretary to submit to Congress a report containing recommendations for changes to the CBRA. In December 1983, the DOI published an outline of the studies it was undertaking to prepare the Section 10 Report. A draft inventory of undeveloped coastal barriers on all U.S. coastlines (including the Pacific coast, the Virgin Islands, and Puerto Rico), and a draft report on conservation alternatives for the System, was issued in the spring of 1985. A final report was submitted to Congress in December 1988.

Section 4 of the CBRA was amended to allow for the inclusion of barriers along the Great Lakes under the Great Lakes Coastal Barrier Act of 1988 (P.L. 100-711). The 1988 law did not include any specific units, but required the DOI to map the undeveloped coastal barriers along the shores of the Great Lakes and make recommendations to Congress for inclusion of these areas within the System.

In 1990, the CBRA was again amended to allow for the inclusion of undeveloped coastal barriers throughout the United States. This legislation is known as the Coastal Barrier Improvement Act of 1990 (CBIA). The CBIA amended the CBRA in several ways. Among other amendments, it tripled the size of the System established by the CBRA and it amended Section 1321 of the National Flood Insurance Act of 1968 to prohibit the issuance of new Federal flood insurance within "otherwise protected areas" identified on maps referred to in the CBIA. The System was expanded to include units in Puerto Rico, the U.S. Virgin Islands, Great Lakes States, New Jersey, Maryland, and the Florida Keys, as well as many new areas in States that already contained units within the System.

Section 6 of the CBIA directed the Secretary to prepare a study examining the need for protecting undeveloped coastal barriers along the Pacific coast of the United States and to prepare maps identifying undeveloped coastal barriers bordering the Pacific Ocean south of 49 degrees north latitude which the Secretary and the Governors of the affected States consider to be appropriate for inclusion in the System. Specifically, Congress directed the DOI to examine:

(1) the potential for loss of human life and damage to fish, wildlife, and other natural resources, and the potential for the wasteful expenditure of Federal revenues given the geologic differences of the coastal barriers along the Pacific coast as opposed to those found along the Atlantic and Gulf coasts; and

(2) the differences in extreme weather conditions which exist along the Pacific coast as opposed to those found along the Atlantic and Gulf coasts.

The DOI delegated the authority for preparing the study and the accompanying maps to the U.S. Fish and Wildlife Service. The areas to be studied and mapped included the States of California, Oregon, Washington, and Hawaii; American Samoa; Guam; the

Northern Marianas; and all other territories and possessions of the United States in the Pacific Ocean south of 49 degrees north latitude.

COASTAL BARRIERS

General Description of Coastal Barriers

Coastal barriers are unique landforms which provide protection for diverse aquatic habitats and serve as the mainland's first line of defense against the impacts of severe coastal storms and erosion. Located at the interface of land and sea, the dominant physical factors responsible for shaping coastal landforms are tidal range, wave energy, and sediment supply from rivers and older, pre-existing coastal sand bodies. Relative changes in local sea level also profoundly affect coastal barrier diversity.

As part of the Section 10 study for the CBRA, the DOI identified six characteristics which definitively and consistently define coastal barriers (U.S. Department of the Interior, Coastal Barriers Study Group 1988). These characteristics, which are listed below, were identified on the basis of scientific literature and communication with prominent coastal scientists.

(1) Coastal barriers are subject to the impacts of coastal storms and sea-level rise and are, in varying degrees, hazardous for permanent human use and occupancy;

(2) coastal barriers buffer the mainland from the impact of storms;

(3) many coastal barriers protect and maintain productive estuarine systems which support the Nation's fishing and shellfishing industries;

(4) most coastal barriers consist primarily of unconsolidated sediments;

(5) coastal barriers are subject to wind, wave, and tidal energies; and

(6) coastal barriers include associated landward aquatic habitats which the fastland (non-wetland) portion of the coastal barrier protects from direct wave attack.

Most barrier islands, barrier spits, bay barriers, and tombolos share these characteristics and therefore represent variations in coastal barrier landforms.

Coastal barriers protect the aquatic habitats between the barrier and the mainland which contain resources of extraordinary scenic, scientific, recreational, natural, cultural,

historical, and economic value. Together with their adjacent wetland, estuarine, inlet, and nearshore water habitats, coastal barriers support a tremendous variety of organisms. Millions of fish, shellfish, birds, mammals, and other wildlife depend on barriers and their associated wetlands for vital feeding, spawning, nesting, nursery, and resting habitat. These habitats are also critically important for many species harvested in the Nation's commercial fish and shellfish industries. The barrier and its associated habitats are one ecological system, and the health and productivity of the entire system depend on the rational use of all the component parts.

If a suitable sediment source and sufficient wind, waves, and tidal energy exist, a secondary barrier may occasionally form behind the seaward coastal barrier (U.S. Department of the Interior, Coastal Barriers Study Group 1988). Secondary barriers are located in large, well-defined bays or in lagoons on the mainland side of coastal barrier systems. These barriers are maintained primarily by internally generated wind waves rather than open ocean waves. Consequently, secondary barriers are generally smaller and more ephemeral than barriers along the open coast. Nonetheless, these barriers are formed of unconsolidated sediments just like most oceanic barriers and, more importantly, they also protect important fish and wildlife habitat and provide substantial protection for the mainland during major storms.

Under normal weather conditions, only aquatic habitats immediately adjacent to coastal barriers are exposed to direct wave attack. However, major coastal storms routinely affect the entire landward aquatic habitat. This habitat survives major storms because coastal barriers receive the brunt of the ocean's energies. Storm waves break on the barrier beach, leaving a diminished wave to travel into the wetland. At the same time, the wetland stores storm floodwaters, easing the flood pressure on the mainland. Without extensive sand beaches protecting many bluffs and terraces, damages from violent storms would be much greater. Sand acts as a brake or drag on waves. Where there are barrier beaches fronting embayments, the sand adsorbs the energy much as it does at the base of cliffs. The principal danger to beaches and barriers is not intense storms but a steady reduction in the sand supply caused by dams on tributary streams and the diversion or interruption of littoral transport along the seaward edge of beaches and barriers by bulkheads, groins, and jetties. In some situations, mining of beach sand has contributed to the problem.

Spits and low-lying barrier beaches survive severe storms with relatively slight effects as long as there is a supply of sand available to restore the beach. A severe storm is a short-term phenomenon, repeating the annual cycle of changing width and slope of the beach within a few hours. Sometimes a spit is eroded back or shortened and the dunes reduced or moved, but the sand begins to build up again towards its equilibrium condition almost as soon as the storm ends. The entrance to a bay and/or river mouth may be relocated or shoaled, but this sometimes also happens without storms, as it has done at

the entrance to Willapa Bay, Washington. Shoaling of harbor entrances may be dangerous to navigation and require dredging to restore an entrance channel.

Coastal barriers occur on all the coastlines of the United States. One of the longest and best defined chains of coastal barriers in the world occurs along the United States shoreline bordering the Atlantic Ocean and the Gulf of Mexico. This chain contains over 400 barriers and totals about 2,700 miles of shoreline. The coastal barriers from Maine to Texas show a high degree of regional diversity which is controlled by differences in climate and in the physical processes shaping barrier shorelines (U.S. Department of the Interior, Coastal Barriers Study Group 1988). Long, continuous barriers with small ebb-tidal deltas are produced by longshore currents along wave-dominated coasts. These barriers are typified by the coastal barrier islands along the south Texas coast which are long, generally narrow, and cut by widely separated tidal inlets with large sand accumulations in the back-barrier bays, and small or nonexistent seaward shoals. Similar barrier islands are also found in parts of Louisiana, the Florida panhandle, southeast Florida, North Carolina's Outer Banks, the south shore of Long Island, and the Cape Cod segment of the Massachusetts coast. Tide-dominated coastlines support large ebb-tidal deltas. The Georgia coastal barrier islands typify a tide-dominated coastline: they are relatively short and stubby and are separated by stable tidal inlets with an average spacing of nine miles. Tide dominated barriers also occur in northeast Florida, most of South Carolina's coast, along the Delmarva Peninsula, Massachusetts, and in some areas of Louisiana and Texas.

The differing coastal barrier patterns between the Atlantic and Pacific coasts is due to their geological setting. The Atlantic coast consists of a broad low-lying coastal plain sheltered by offshore barriers and a wide Continental Shelf. These features are replaced on the Pacific coast by an abrupt and mountainous shoreline with small interspersed reaches of sandy beaches and a narrow Continental Shelf. In contrast to the pattern of numerous barrier islands fronting extensive bays and tidal marshes on the Atlantic and Gulf of Mexico coasts, Pacific coastal barriers generally consist of small bay-mouth barriers and sand spits that block small permanent streams in the north and small intermittent streams in the south (U.S. Department of the Interior, Coastal Barriers Study Group 1988). The sand spits and tombolos form embayments, several of them without permanent, year-round streams to provide estuarine conditions. Extensive barrier beach and dune complexes, pocket beaches, and crescent-shaped sand spits also occur along the mainland Pacific coast.

The coastal barriers of Hawaii are much different than those of the Atlantic and Gulf of Mexico coasts because of the tropical climate and volcanic origin of the islands. These barriers consist of bay barriers, beach barrier/fish ponds (naturally occurring wetlands protected by a depositional barrier beach), barrier beaches, barrier spits, and coral reefs in association with fringing mangroves (U.S. Department of the Interior, Coastal Barriers Study Group 1988).

The coastal region is the focus of many competing demands, including National defense, commerce, energy development, real estate development, recreation, and conservation. Pressures for certain uses of coastal habitats can lead to significant deterioration of coastal barrier resources. Construction and development, alteration of primary dunes, beach stabilization measures, maintenance of navigation channels, and groundwater extraction and contamination are all examples of human activities which can disrupt natural coastal processes and the ecological functions of coastal barriers.

The dynamic nature of coastal barriers makes these areas generally unsuitable for permanent development. Certain actions and programs of the Federal Government have subsidized and permitted development on coastal barriers and the result has been the loss of barrier resources, threats to human life, health, and property, and the expenditure of millions of tax dollars each year. During the past three decades, residential development on coastal barriers has proceeded rapidly, and substantial development pressure now affects most regions of the coastal United States. Continuation of this trend will have significant environmental impacts on dynamic coastal barrier environments, and will result in significant and recurring public costs for disaster assistance as well as reconstruction and repair of utilities, bridges, and roads.

The Nation's coastal areas include some of the most rapidly growing and densely populated counties in the United States (National Oceanic and Atmospheric Administration 1990). From 1960 to 2010, the coastal population will have grown from 80 million to more than 127 million people, an increase of almost 60 percent. The largest coastal populations occur in the Northeast and Pacific regions of the United States. The coastal population in the Pacific region is expected to more than double between 1960 and 2010, adding more than 6 million persons. California shows the highest population growth and density of the four States in the study area.

Many environmental problems are the result of general coastal development patterns which disrupt the natural processes of coastal ecosystems and threaten the ecological and economic values of coastal areas (National Oceanic and Atmospheric Administration 1990). Fundamental changes are occurring in the way natural systems work and look. As coastal populations grow, many of the qualities which initially attracted people to the coast are diminishing. As many coastal areas become more crowded, the short-comings of management actions which focus on site-by-site and permit-by-permit decisions, while failing to address the more ubiquitous problems of growth and development, become more obvious.

Definition of Undeveloped Coastal Barriers

General Definition

The CBIA defines an "undeveloped coastal barrier" to mean:

A. a depositional geologic feature (such as a bay barrier, tombolo, barrier spit, or barrier island) that --

(i) is subject to wave, tidal, and wind energies, and

(ii) protects landward aquatic habitats from direct wave attack; and

B. all associated aquatic habitats, including the adjacent wetlands, marshes, estuaries, inlets, and nearshore waters; but only if such feature and associated habitats contain few human-made structures and these structures, and human activities on such feature and within such habitats, do not significantly impede geomorphic and ecological processes.

The Federal definition and delineation of coastal barriers has evolved gradually since 1977. Delineation criteria for determining the boundaries of coastal barrier units (i.e., the depositional geologic feature and its associated aquatic habitats) was expanded during the development of the Section 10 Report to Congress required by the CBRA. The definitions were broadened to reflect the guidance by Section 3 of the CBRA and the resource conservation goal of the CBRA (Section 2). Revised criteria were established regarding the minimum size, development status, composition, wind, wave, and tidal energies, secondary barriers, associated aquatic habitat, delineation of landward and seaward boundaries, and otherwise protected areas. These revised criteria were published in the Federal Register (Vol. 50, No. 42, March 4, 1985, pp. 8,698-8,702). These criteria were used in the current study to identify potential Pacific coastal barriers for inclusion in the System. The criteria are summarized below.

Types of Coastal Barriers

Coastal barriers may be described generally, as in the CBIA definition, with respect to their relationships to the mainland as bay barriers, tombolos, barrier spits, and barrier islands. Additional areas which function as coastal barriers on the Pacific coast include dune and beach barriers, and fringing mangroves. The "mainland" includes the continental land mass as well as large islands such as Long Island, New York and the Hawaiian Islands. The classification of these features is as follows:

(1) Bay Barriers - coastal barriers that connect two headlands, and enclose a pond, marsh, or other aquatic habitat. The terms bay mouth bar or bay bar are considered to be synonymous.

(2) Tombolos - sand or gravel beaches which connect one or more offshore islands to each other or to the mainland. The terms connecting bar, tie bar, and tying bar are synonymous.

(3) Barrier Spits - coastal barriers which extend into open water and are attached to the mainland at only one end. They can develop into a bay barrier if they grow completely across a bay or other aquatic habitat. On the other hand, bay barriers can become spits if an inlet is created.

(4) Barrier Islands - coastal barriers completely detached from the mainland. Barrier spits may become barrier islands if their connection to the mainland is severed by creation of a permanent inlet. The barrier island represents a broad barrier beach, commonly sufficiently above high tide to have dunes, vegetated zones, and wetland areas.

(5) Dune or Beach Barriers - broad sandy barrier beaches, with hills or ridges of sand formed by winds, which protect landward aquatic habitats.

(6) Fringing Mangroves - bands of mangrove along subtropical or tropical mainland shores in areas of low wave energy. Many of these areas are located behind coral reefs, which, together with the mangroves themselves, afford significant protection for the mainland from storm impact.

Definition of an Undeveloped Coastal Barrier

A coastal barrier is considered undeveloped if it contains fewer than one structure per five acres of fastland. A structure is defined as a walled and roofed building constructed in conformance with Federal, State, or local legal requirements, with a projected ground area exceeding 200 square feet. Additionally, the structures and human activities must not significantly impede geomorphic and ecological processes in order for the barrier to be considered undeveloped.

A coastal barrier is not considered to be undeveloped when it is altered to the extent that the long-term perpetuation of the coastal barrier is threatened by one or more of the following:

(1) extensive shoreline manipulation or stabilization:

(2) pervasive canal construction and maintenance;

(3) major dredging projects and resulting sedimentary deposits; or

(4) intensive capitalization development projects, such as condominiums, which effectively establish a commitment to stabilize an area even though there are few actual structures.

Size of Barriers

The CBRA did not require an entire coastal barrier to be included as a unit in the System, and it specifically allows for the inclusion of undeveloped portions of coastal barriers. An undeveloped portion of a coastal barrier is included if there exists a minimum of approximately one-quarter mile of shoreline on the unprotected (seaward) side of the coastal barrier. This length was chosen to prevent the inclusion of portions which would be too small to function as natural geological and ecological units. Each unit must also include an undeveloped area extending through the fastland from the beach to the associated landward aquatic habitat, and must independently satisfy the definitional criteria in Section 3(1)(A) of the CBRA. For units which comprise only a portion of a barrier, the boundary line is drawn along the "break" in development.

Composition of Coastal Barriers

Coastal barriers generally consist entirely of unconsolidated sediment composed of sand or gravel. However, the sediments may sometimes contain silt, clay, cobbles, or large rocks, or they may be consolidated. The Section 10 study expanded the definition of coastal barriers to include barriers composed of carbonate-cemented deposits (such as local deposits of beach rock, cemented dunes, and the limestone islands in the Florida Keys), silt and clay (such as fringing mangroves and cheniers), and discontinuous outcrops of bedrock or coarse glacial deposits which function as coastal barriers. This expanded definition was reflected in the CBIA by striking the clause in the CBRA which defined a coastal barrier as consisting of unconsolidated sedimentary materials.

Secondary Barriers

Wind, waves, and tides are the immediate forces that maintain and modify coastal barriers. The action of wind, wave, and tidal energy on unconsolidated sedimentary materials generally results in continuous linear or curvilinear features such as a beach ridge or berm located along the unprotected side of the coastal barrier. This kind of beach provides evidence that sufficient wind-, tidal-, and wave-energies, as well as an adequate supply of sediment, exist to satisfy the statutory definition. Where a suitable sediment source and sufficient wind, wave, and tidal energy exist, secondary coastal barriers occasionally develop on the mainland side of large bays or lagoons behind coastal barrier systems. These secondary coastal barriers are also included in the inventory.

Associated Aquatic Habitat

In addition to the actual fastland, coastal barrier units also include all associated aquatic habitats. The Section 10 Report (U.S. Department of the Interior, Coastal Barriers Study Group 1988) considered associated aquatic habitat as the entire area subject to diminished wind, wave, and tidal energy during a major storm because of the presence of the coastal barrier. Associated aquatic habitats include all wetlands (e.g., tidal flats, swamps, mangroves, and marshes), lagoons, estuaries, coves between the barrier and the mainland, inlets, the nearshore waters seaward of the sand-sharing system, and in some tropical areas, the coral reefs associated with the nearshore mangroves. This definition reflects the specific conservation purposes of the CBRA to protect the fish, wildlife, and other natural resources of coastal barriers. These habitats are inseparable parts of the coastal barrier ecosystem.

All aquatic habitat between a coastal barrier and the mainland is protected by the coastal barrier from direct wave attack. The protection offered these habitats by coastal barriers has long been recognized as a fundamental function of coastal barriers. Although the amount of protection of landward aquatic habitat from wave attack diminishes with increasing distance behind the coastal barrier, this condition does not preclude the basic protection function. Under normal weather conditions, only aquatic habitat immediately adjacent to the coastal barrier is afforded protection from wave attack. However, major coastal storms routinely affect the entire landward aquatic habitat, which is protected in varying degrees during these events by the coastal barrier. The protected area is considered to comprise those areas protected from wind, wave, and tidal energy due to the presence of the coastal barrier during a storm.

Fringing mangroves and associated coral reef systems are considered as coastal barriers in tropical and subtropical areas because the protection afforded the associated aquatic habitat and mainland are comparable to coastal barriers which contain a linear or curvilinear beach.

Delineation of Coastal Barrier Units

Undeveloped coastal barriers of at least one-quarter mile in shoreline length and their associated aquatic habitats were delineated using primarily color infrared aerial photography, U.S. Fish and Wildlife Service National Wetlands Inventory maps, and U.S. Geological Survey 7.5' quadrangle maps. The coastal barrier delineation was drawn perpendicular to the unprotected (seaward) side of the fastland and extends landward to include the protected aquatic habitat. For partially developed coastal barriers, the boundary was drawn at the edge of the development. The entire associated aquatic habitat was included in cases where the coastal barrier is 50 percent or more undeveloped, as determined by the perpendicular projection of developed versus undeveloped portions of the unprotected shoreline. Seaward boundary lines were not depicted on the unit maps.

Landward Boundaries

The landward boundary is a continuous line which follows the interface between the aquatic habitat and the mainland (Federal Register, Vol. 57, No. 158, August 14, 1992, pp. 36,668-36,671). In areas with aquatic habitats extending inland for many miles, geologic features such as the next dune line or natural constrictions in aquatic habitats and human-made features such as highways, dikes, and levees were used to determine landward boundaries. In addition, landward boundaries were normally drawn not to exceed an elevation of 20 feet above the mean high water level of the system. The maximum extent of the landward boundary was five miles for wetlands and was measured from the high water line on the unprotected side of the coastal barrier. For open water, the maximum landward extent was one mile and was measured either from the farthest landward extent of wetlands on the protected side of the barrier or from the mean high water line on the unprotected side of the barrier.

Seaward Boundaries

Seaward boundaries contain the entire sand-sharing system, including the beach, shoreface, offshore bars, and littoral drift zone. The sand-sharing system of coastal barriers is normally defined by the 30-foot bathymetric contour. In large coastal embayments, the sand-sharing system is more limited in extent. In these cases, the sand-sharing system is defined by the 20-foot bathymetric contour or a line approximately one mile seaward of the shoreline, whichever is nearer the coastal barrier.

Otherwise Protected Areas

Coastal barriers held for conservation purposes were mapped but ownership or other trust status was not identified on the unit map. A coastal barrier or portion thereof is defined as an otherwise protected area if it has been withdrawn from the normal cycle of private

development and dedicated for conservation, wildlife management, public recreation, or scientific purposes. Specifically, the CBRA defines an otherwise protected area as "an area established under Federal, State, or local law, or held by a qualified organization as defined in Section 170(h)(3) of the Internal Revenue Code of 1954, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes." Protected status requires that there be evidence of an intent on the part of the administrator to protect the coastal barrier. Examples of otherwise protected areas include National Wildlife Refuges, National Parks and Seashores, State parks and conservation lands, and local parks and recreation areas.

Pacific Coast Study Area

Congress directed the DOI to identify and prepare maps of the undeveloped coastal barriers bordering the Pacific Ocean south of 49 degrees north latitude. This area includes the States of California, Hawaii, Oregon, and Washington; American Samoa; Guam; the Northern Marianas; and all other territories and possessions of the United States in the Pacific Ocean. Only barriers which met the technical criteria of an undeveloped coastal barrier were identified and mapped within this study area. During the identification and mapping phase of this study, no coastal barrier units which met the technical criteria were found in the territories or possessions of the United States in the Pacific Ocean. Therefore, this study focuses on the undeveloped coastal barriers identified in the States of California, Hawaii, Oregon, and Washington.

THE PACIFIC COAST

The Pacific coast of the continental United States is remarkably different from the Atlantic and Gulf of Mexico coasts. While the Atlantic and Gulf coasts contain numerous barrier islands fronting extensive bays and tidal marshes, Pacific coastal barriers are characterized by small bay-mouth barriers and sand spits which block small permanent streams in the north and small intermittent streams in the south. The tectonic origin of the Pacific coast has resulted in extensive cliffs and rocky headlands, often several hundred feet high, which drop with a sheer vertical surface to the sea or to very narrow beaches or reefs at their base. Of the more than 1,500 miles of shoreline from Cape Flattery, Washington to the Mexican border, about 950 miles are rocky. Cliffs, headlands, and rocky areas comprise about 61 percent of the Washington coastline, 40 percent of the Oregon coastline, and 70 percent of the California coastline (U.S. Department of the Interior, Coastal Barriers Study Group 1988). Other parts of the coast consist of well-developed terraces or benches of interglacial age. These features are composed, in part, of soft sandstones or unconsolidated, water-borne sediments which overlie harder formations of older geological age.

The structure and variety of coastal features along the western shore of the contiguous Pacific States is related to the complex geological processes at work along the western edge of the continent. Three crustal plates converge on the coast north of Cape Mendocino, California: the Juan de Fuca Plate, the Gorda Plate, and the North American Plate. The Juan de Fuca and Gorda Plates are colliding with and being subducted underneath the advancing North American Plate. The resulting uplift on the mainland is responsible for the Olympic Mountains of northern Washington, the Coast Range of southern Washington and Oregon, and the Klamath Mountains of Northern California. South of Cape Mendocino, the Pacific Plate abuts the North American Plate forming a shear zone known as the San Andreas Fault. The submarine Mendocino Escarpment, another shear zone, extends westward of Cape Mendocino and north of the 40th parallel. The subduction zones associated with the converging plates may cause large earthquakes every 300 to 400 years.

The markedly different morphology of the east and west sides of the North American continent is related to their relative positions on the moving North American Plate. The eastern Atlantic coast, which lies on the trailing edge of the plate, is characterized by a broad coastal plain and wide Continental Shelf; on the western, collision edge of the plate, the coast is mountainous and has a narrow shelf. Thus, much of the Pacific coast is mountainous, with rocky headlands segmenting the shore into pocket beaches of varying lengths while much of the east coast consists of low-lying coastal plains sheltered by offshore barriers.

On the Pacific coast only three major breaks in the coastline provide sea-level access to the interior valleys: (1) the Strait of Juan de Fuca which leads into Puget Sound, (2) the Columbia River and its tributary, the Willamette River, are part of the larger Puget-Oregon lowland between the Coast Range mountains and the Cascades, and (3) the Golden Gate (San Francisco) through which flow the rivers that drain the Sierra Nevada Range and the southern part of the Cascades. Several smaller bays also occur at river mouths such as the San Diego, San Pedro, and Humboldt Bays in California, Coos and Yaquina Bays in Oregon, and Grays Harbor and Willapa Bay in Washington.

Puget Sound comprises the majority of the Washington coastline including approximately 2,300 miles of shoreline, 2,500 square miles of water, and some 200 or more islands in Washington State. The Sound was formed by glacial forces during the Pleistocene about 10,000 years ago and it is the only glaciated area in the coastal region of the three contiguous Pacific States. Glaciers scoured the major basins of Puget Sound during several cycles of advance and retreat during the Pleistocene. When the last glacier melted, heavy sediment deposits were dropped from the ice and were transported by meltwater streams. The Puget lowland rebounded from the weight of the glacial ice by uplifting up to 460 feet and sea level rose from the additional water added to the oceans worldwide.

The sand, gravel, and scattered patches of cobbles and larger rock left by the glacier molded the beaches of Puget Sound. Bedrock is exposed as outcrops in some places, and there are also deltaic and marshy shores. Many rivers and streams enter Puget Sound and contribute sediment for the formation of these deposits in the Sound. All the usual beach forms occur in Puget Sound: sandy barrier spits, tombolos, pocket beaches, deltas, mudflats, and narrow beaches at the base of bluffs. Most of these are on a smaller scale than on the open coast because the wave energy is lower; however, damage to coastal landforms and property from winter storms may be severe.

Coastal barriers on the continental Pacific coast are most commonly sand spits built up against or in front of coastal streams, forming bays or lagoons behind them. The sands which form the beaches and dunes are primarily derived from the erosion of cliffs, bluffs, and other formations by wave attack, and from the outflows of rivers (Cooper 1958). The sediment derived from rivers is roughly proportional to their average discharge. The largest river of the three contiguous Pacific States is the Columbia. Massive dunes were formed near the Columbia's mouth since it discharged sediment faster than it could be moved along the coast by littoral currents. Substantial beach and dune development has also occurred at the mouths of the Umpqua and Siuslaw Rivers in Oregon. On the California coast, the largest river flowing directly into the sea is the Klamath. Beach development at the mouth of the Klamath River, however, is restricted to a comparatively small sand spit due to the bordering high hills on either side. In contrast, the Columbia River exits across a region of low hills recessed from the shoreline and supports several barrier beaches.

North of the Columbia River, the barrier beach and dune complex fronting Willapa Bay and Grays Harbor in Washington stretches more than 50 miles. From the Columbia River south to Tillamook Head, the Clatsop Plains beach system extends to the upland, formerly a coastal bluff, with a series of narrow lakes parallel to the shore and one small river-mouth embayment. Farther south, the coastal dune fields are more closely associated with bluffs and terraces. The most spectacular beach on the Pacific coast is that fronting the Oregon Dunes between Heceta Head and Coos Bay 50 miles to the south. There are some freshwater impoundments behind these dunes, suggestive of an eastern barrier system; however, this dune field is an old structure composed of sands derived from previous high stands of sea level.

The essential difference between the Atlantic and Pacific coastal dunes is that on the Pacific coast the extensive dune fields were formed at higher stands of the sea on what are now coastal benchlands or terraces. Most of these dune fields were established at the last sea transgression, the Flandrian transgression, which began at the end of the last Ice Age about 17,000 years ago and has continued since then. Some dune fields, most notably the now obliterated El Segundo dunes in California, are the result of earlier transgressions.

The development and maintenance of these dune systems requires an abundant source of sand from an adjoining and accessible beach. The ultimate sources of beach sand are the rivers and the sandstone bluffs and terraces which are eroded by wave action. Storm waves may pile up sand from shallow offshore deposits, and littoral currents move sand from all sources along the beach. Submarine canyons, especially in southern California, act as traps or sumps for moving sand, which is then lost to the beach system. Rocky cliffs and headlands prevent littoral drift, trapping the sand in pocket beaches. It is characteristic of such beaches that sand nourishment is reduced and the system is maintained to a large degree by the back and forth movement of the sand. This situation can occur on a large scale: Oregon's largest beach, fronting the dunes between Heceta Head and Coos Bay, is classified as a pocket beach (Komar 1979). Approximately 40 percent of the Washington-Oregon coast is bordered by dunes, whereas in California only 23 percent of the coast is dune-bordered (Cooper 1967).

At the Oregon-California border, the rugged coastal mountain terrain gives way to a coastal plain with a shore of steep beaches and a series of lagoons at stream mouths. With a few interruptions, the high coastal hills between Crescent City and the Klamath River and a group of tombolos at Trinidad Head, this terrain extends as far south as the Eel River. A few miles below the mouth of the Eel River lies Cape Mendocino and the San Andreas fault. The geography of the coast from this area south to the San Francisco Bay region depends upon the position of the San Andreas fault line. Bold cliffs occur where the fault zone approaches the shore; low bluffs fronting a marine terrace occur where the fault zone is more landward.

The terrace system is well developed south of the Russian River to Bodega Head and along the San Mateo-Santa Cruz shores. Many pocket beaches and several larger beaches occur along this part of the coast as well as a conspicuous tombolo near the Russian River. Crescent-shaped sand spits, another type of bay formation, are the most conspicuous beach feature south of the Russian River. These barriers are built up by the counterclockwise currents south of headlands. The best examples of this formation are Bodega Harbor and Bolinas Lagoon in California.

From Bodega Head to Half Moon Bay, the fault zone lies close to the shore resulting in a notoriously unstable coast. The shoreline is characterized by extensive sandy shores and small pocket beaches as far south as Monterey. South of Monterey, the coast becomes rugged, with massive mountains and steep cliffs for about 45 miles in an area known as Big Sur. The only sandy beach in this area is the tombolo which ties the mass of Big Sur to the land.

South of Big Sur, the coastal terrace, with its characteristic broad beaches, reappears and becomes the principal feature of the coast. Occasional rocky interruptions occur around the headlands of Point Conception, Santa Barbara County, and southward toward Malibu. The conspicuous tombolo and sandspit formation at Morro Bay also occurs in this region.

Nearshore coastal hills, pocket beaches, and coves appear south of the Morro Bay sand spit.

From Point Conception, the coastal benchland broadens to the east. Sandy beaches, some with scattered cobbles, are the dominant feature of this west to east trending coast. As the coast bends southward again, the coastal terrace narrows. Extensive sandy beaches change to narrow, rocky beaches around the base of Palos Verdes. From Los Angeles to San Diego, the shoreline consists primarily of broad sandy beaches, occasionally interrupted by small lagoons and wetlands with a final rocky headland at Point Loma. The wetlands along the west coast differ significantly from their east coast counterparts. Pacific coastal wetlands are geologically younger, subject to greater salinity changes, less abundant, smaller, biologically different, tremendously diverse, and they experience a high degree of natural instability in their physical, chemical, and biological environments (California Coastal Commission 1992a).

Undeveloped coastal barriers in the Hawaiian Islands differ from those found on the coasts of the continental United States due to their volcanic origin and tropical climate (Holthus 1988). The Hawaiian Islands are the exposed tops of large undersea volcanic mountains formed by successive flows of basaltic lavas that erupted from vents in the ocean floor. Each volcano was formed over the same "hot spot" of magma in the earth's crust. Due to the movement of the Pacific Plate, the volcanic islands were displaced to the northwest after formation. This has resulted in a sequence of island ages, from the oldest, in the northwest, to the youngest, in the southeast. The subsidence of some islands, together with climatically induced and glacially controlled sea-level changes during the Pleistocene, have left evidence of many former shorelines around Hawaii. These shorelines include stream-cut valleys which extend far below present sea level. The valleys now form drowned embayments with sediment-filled floors at the present-day coast. Sand dunes were formed when calcium carbonate sediments, such as coral and shell rubble, were blown inshore from coral reefs exposed by a lower sea level. These dunes have solidified into sandstone features at the coast and in nearshore waters (Moberly and Chamberlain 1964, Stearns 1978).

About two-thirds of Hawaii's coastline is composed of sea cliffs, rocky basalt shores, and other material of volcanic origin (Titcomb 1972). Volcanic activity inhibits the development of sandy beaches by: (1) covering existing sand beaches with lava, (2) destroying coral reefs and their calcareous sediment-producing organisms, (3) creating permeable surfaces which reduce surface runoff and subsequent sediment generation, and (4) forming steep, solid basalt shorelines which undergo extensive erosion before beaches can form (Moberly et al. 1963). Due to these processes, coastal barriers are less likely to be found along coastlines dominated by recent volcanic material.

The weathering and erosion of island interiors results in the deposition of terrestrially derived sediments at the coastline. These dark-brown basaltic sediments, primarily

removed and transported by streams, are important in the formation of wetlands and bay mouth barriers in drowned river valleys. This is the most common type of coastal barrier system in Hawaii, especially on the older islands such as Kauai, which have been exposed longer to erosional processes. At the shore, terrestrial sediments that were deposited by streams may be redistributed by wave activity or transported from the coast by nearshore currents (Moberly et al. 1963).

Biologically derived sediments are produced from the calcareous skeletons of corals and other organisms. These sediments are generated by coral reefs through a variety of means. Waves break off pieces of corals and other organisms with calcium carbonate skeletons and work the rubble into beach sand. Live coral is eaten by some reef fish and a fine sediment is defecated. Other organisms bore into the reef, creating fine calcareous debris and making the reef more susceptible to breakage. Foraminifera, one-celled protozoans with sand-sized calcium carbonate shells, occur in abundance on many reefs, and their shells contribute to coralline sediments. The skeletons of various other invertebrates, the shells of mollusks, and the skeletal fragments of coralline algae (particularly the genus *Halimeda*) all add to the calcareous sediment generated by coral reefs.

The distribution of coastal barriers in Hawaii, their calcareous sand supply, and their protection from erosion is related to the distribution, size, and status of the coral reefs around each island. Of the common reef types, those that are attached directly to the shore (fringing reefs) are dominant in Hawaii. They are better developed on the older islands, especially Kauai and Oahu, which consequently have more calcareous beaches. Conversely, the youngest island, Hawaii, has relatively fewer reefs and a much lower percentage of sandy beaches.

A dominant factor in coral reef development is wave exposure. Reefs are generally wide and shallow off coasts exposed to the northeast tradewinds, wide and very shallow along some leeward (south and west) or otherwise protected coasts, and deeper and more irregular off northern coasts exposed to seasonally large surf (U.S. Army Corps of Engineers 1971). Locally, beach deposits may be protected by outcrops of beach rock (cemented beach sand) or raised reef (exposed coral reef).

CLIMATE AND COASTAL HAZARDS

Climate

The States bordering the Pacific Ocean are subject to a range of environmental conditions. The heavy winter rainfall of Washington and Oregon changes to the "mediterranean" climate of central and southern California while the Hawaiian climate is tropical. Snowfall is generally limited to the coasts of Oregon and Washington. Along

the continental United States, fogs and cool weather dominate the summer months with no great peaks of heat or cold at any time of year.

Wind patterns vary seasonally. Around the Hawaiian Islands, the dominant winds are the northeast tradewinds from April to November and the Kona (west) winds from November to March. These winds produce the northeast trade waves and Kona storm waves. Along the west coast of the continental United States, Aleutian lows dominate the weather in the winter bringing heavy rains and strong south to southwesterly winds. Seasonal upwelling occurs when the winds change to the north in the spring and summer. The changing winds bring nutrient-rich water from depths of 500 to 1,000 feet to the surface. The nutrients associated with the upwellings create areas of high primary productivity in the nearshore waters. This productivity in turn supports economically important populations of fishes and crustaceans as well as a variety of other species. The myriad species dependent on these upwellings provide economic, cultural, and recreational benefits to the coastal States.

Coastal Hazards

Although coastal barriers along the Pacific, Atlantic, and Gulf coasts perform similar functions, Pacific coastal barriers differ in their geological make-up and are especially susceptible to a number of coastal hazards that are unique to the Pacific. The geological setting of the Pacific coast influences the evolution and character of coastal landforms as well as the oceanic and atmospheric processes which alter these features. Pacific coastal areas are characterized by a relatively straight shoreline, raised terraces, narrow continental shelf, volcanism, and seismicity.

Along the boundary between the westward-moving continental North American plate and the northeast-moving Juan de Fuca plate off the Oregon and Washington coasts, lies the 700 mile long Cascadia Subduction Zone. This subduction zone is thought to periodically release accumulated strain in large earthquakes measuring eight to nine on the Richter Scale every 300 to 400 years (see references in Good 1992). The probability and magnitude of major subduction zone earthquakes and resulting tsunamis is a uniquely Pacific coast geological condition with direct implications for coastal barriers. These events are completely unlike the episodic events which threaten the Atlantic and Gulf seaboards.

Hazards associated with subduction zone earthquakes include severe, sustained groundshaking; liquefaction of saturated, unconsolidated soils; numerous and possibly massive landslides; and a series of tsunamis arriving soon after the quake (Madin 1991 in Good 1992). Rapid, coastwide subsidence on the order of 0.5 to 1.5 meters may also occur (Oregon Coastal Management Program 1992). Subsidence may cause immediate flooding of low-lying areas as well as longer term increased flooding and coastal erosion during storms. Following the initial ground shaking is the likely occurrence of a locally

generated tsunami. The damage associated with earthquakes and resulting tsunamis can be tremendous. Tsunami waves, triggered by earthquakes or volcanic activity, may travel at speeds of 500 to 600 miles per hour, affect hundreds of miles of coastline, and cause tremendous damage. Shorelines of bays, estuaries, and low lying sand barriers would face the brunt of the tsunami and experience immediate flooding and erosion. In 1964, a tsunami triggered by an Alaskan earthquake caused severe damage along the Oregon and northern California coasts. The tsunami claimed the lives of 10 people, destroyed a large part of the downtown district of Crescent City, California, and caused over $27 million in damages (California Coastal Commission 1992a). Although it is unknown when the next subduction zone earthquake may occur, the last major catastrophic earthquake event occurred about 350 years ago (Oregon Coastal Management Program 1992) and there is a distinct possibility that such an event could happen in the near future.

In the Hawaiian Islands, volcanic activity often generates earthquakes which can cause severe damage to structures and the subsidence or uplifting of the earth. Changes in ground elevations along the coast can trigger locally-generated tsunamis. Since 1946, Hawaii has endured six tsunamis with a run-up of 6.6 feet or more. These tsunamis resulted in 222 deaths and nearly $57 million in property damage (Hawaii Coastal Zone Management Program 1992). In 1975, volcanic activity resulted in subsidence ranging up to 12 feet, two deaths, and over $3 million in damages (Hawaii Coastal Zone Management Program 1992). In addition to earthquakes, the lava flows associated with volcanic activity may inundate valuable habitat, roads, dwellings, and beaches.

More common hazards along the Pacific coast include storms, winds, currents, sea level fluctuations, and human activities, all of which contribute to shoreline erosion processes. Storms contribute directly to the erosion of coastal terraces and shorelines through wind, wave, and flooding action. The pattern of winter gales in the northern Atlantic and tropical hurricanes of the southern and Gulf coasts is replaced on the Pacific coast by storms of several different origins. The origins of major Pacific coast storm waves include winter storms, transpacific storms, tsunamis caused by earthquakes or volcanic action, and occasional hurricanes. In contrast to the almost "point source" aspect of some hurricanes along the Atlantic coast, Pacific coastal storms may affect the coastline along fronts of several hundred miles. Severe winter storms can cause extensive erosion and damage to coastal landforms and property, particularly when huge waves coincide with high tides. The higher seas result in higher storm surges and therefore greater shoreline damage. This is particularly true in areas which accumulate logs and sawed off stumps with roots. During heavy storms, these relics of logging, as well as other forms of debris, can be lifted and moved along the beach with violence causing severe damage on developed spits such as Siletz Spit, Oregon and Stinson Beach, California.

Flooding in coastal areas is attributable to several factors including heavy rainfall, steep topography, low bedrock permeability, and extensive flood plains. The heavy rainfall

associated with some winter storms in southern California may cause severe flooding and landslides which erode coastal terraces and produce bluff retreat. Heavy rainfall also increases the sediment load in coastal streams and provides sand nourishment to the beaches. Freshwater flooding during severe rain storms is a common hazard to Hawaiian coastal areas due to the topography of the islands and the tendency for development to concentrate in low-lying coastal areas (Hawaii Coastal Zone Management Program 1992). In Oregon, each coastal municipality is subject to a 100 year catastrophic flood. Projected elevations of such a flood along the Oregon coast range from 19 to 29 feet above mean sea level (Oregon Coastal Management Program 1992).

Seaward flowing rip currents and longshore currents are common causes of erosion. Rip currents form in areas with irregular offshore topography or where edge waves have developed beach cusps. The resulting rip embayments are important contributors to the erosion of coastal barriers since they can quickly cut through the beach and attack foredunes or the base of sea cliffs (Komar 1983, Shih 1992 in Good 1992). Longshore currents redistribute sand from sea cliffs and rivers on a seasonal basis by transporting it along the beach. Along the three contiguous Pacific State coasts, the northward-offshore transport of sand during the winter is offset by the southward-onshore transport of sand during the summer. This process is interrupted in areas where jetties have been built. The severe erosion and breaching of Bayocean spit opposite Tillamook Bay, Oregon, is a notable example of erosion due to jetty construction (Oregon Coastal Management Program 1992). Construction of the north jetty led to drift interruption which caused beach accretion on the north side of the jetty and beach erosion on the south side of the jetty. This process resulted in the complete destruction of the Bayocean Park community.

The currents and sea level rise associated with El Nino Southern Oscillations (ENSO) can have substantial impacts on shoreline erosion. Strong ENSOs occur on average every eight and one half years (Quinn et al. 1987 in Good 1992). During the 1982 to 1983 ENSO, unusually large amounts of sand were transported northward in the winter (see references in Good 1992). As a result, some shorelines were left without a buffering beach, making them more susceptible to erosion in subsequent winters. This same ENSO also increased winter sea level off the continental Pacific coast. Severe erosion occurred all along the west coast from the unusually high sea level combined with an unusual number of winter storms.

Both short- and long-term variations in sea level are important factors in coastal erosion. Exceptionally high spring tides are often associated with major coastal flooding. Sea level also tends to be higher in winter resulting in more damage to coastal areas in winter months. In addition to the increased sea level associated with ENSOs, are the predictions associated with increased sea level due to global warming. Scientists predict sea level could rise from 0.2 to 3.4 meters by the year 2100, with a typical mean of about one meter (see references in Good 1992). Sea level rise is a serious coastal hazard because it can lead to enhanced coastal erosion rates, increased storm frequency and severity,

saltwater intrusion into groundwater resources, loss of coastal wetlands and beaches, flooding of low lying lands, landward migration of barrier sand spits, damaged or drowned reefs, and increased wave energy. These effects would be magnified if an accelerated rise in global sea levels occurs during the next century in response to greenhouse warming.

Accelerated erosion resulting from sea level rise may also result in an increased demand for shoreline armoring. This practice is occurring in all Pacific coastal States. Shoreline armoring reduces sediment input to shoreline systems, thereby starving beaches of the necessary fine materials. This process leads to a transformation of sand beaches to cobble beaches. Shoreline armoring in Puget Sound has induced aggravated shoreline and beach erosion as well as habitat degradation (Washington Department of Ecology 1992). The cumulative impacts of shoreline armoring on shoreline physical processes and biological functions are unknown.

Landslides, including slumps, mudflows, soil creep, and debris avalanches are a common terrestrial natural hazard along the rocky Pacific coast. Landslides are often triggered by heavy rainfall and seismic activity. Other important contributors to sea cliff erosion include groundwater flow, wave undercutting, and weathering due to rain, wind, and surface runoff. Excessive watering of lawns and shrubbery in some areas of California have made the steep coastal hills unstable. Frequent summer wildfires along the coast result in direct resource impacts (loss of structures, vegetation, habitat, and short-term air pollution) and may trigger significant long-term impacts through increased runoff and nonpoint source pollution, mud and debris slides, stream clogging, and increased turbidity. Climate and rock type may also affect the amount of erosion due to weathering. For example, the volcanic basalt which makes up the Hawaiian Islands weathers more rapidly than other rock, particularly in the warm, humid climate of the tropics. A large percentage of Hawaiian beaches are eroding with the most severe erosion occurring along sandy shorelines (Hawaii Coastal Zone Management Program 1992).

Aside from the hazards associated with coastal erosion, hazards associated with the accumulation of sand on beaches and dunes are also of concern. Sand accumulation occurs primarily during the summer months when the southward-onshore transport of sand occurs. Sand inundation currently threatens homeowners at Pacific City, Oregon, as well as other locations along Oregon's north coast (Oregon Coastal Management Program 1992). The use of European beach grass (*Ammophila arenaria*) for dune stabilization may be contributing to the problem of sand inundation through the creation of unnaturally large, rapidly-built foredunes which trap sand in the frontal dune area.

Human activities may also exacerbate natural coastal hazards. Many of the beaches in southern California are eroding due to the damming or channelizing of intermittent streams for flood protection. The damming and dredging of the Columbia River on the

Washington/Oregon border has also substantially reduced its sediment contribution to the littoral system. These practices restrict nourishment of sandy beaches causing the beaches to become narrower. The heavy recreational use of these beaches also prevents the growth of stabilizing vegetation and causes sand to drift landwards. The construction of shoreline protection structures may lead to additional problems including accelerated erosion of the beach and adjacent properties, loss of cliff-supplied sand to the beach system, and gradual beach narrowing in the face of sea level rise (Good 1992). Increasing development also brings with it both point and nonpoint sources of pollution. Common nonpoint source problems in coastal streams include turbidity, erosion, sedimentation, and nutrients; whereas, pesticides and toxins affect many coastal lakes (Oregon Coastal Management Program 1992). Nearly all coastal streams in Oregon are affected by at least one nonpoint source problem or another and some coastal lakes are plagued by plant growth fed by nutrients from surrounding septic tank drainfields.

COASTAL ENVIRONMENT

The Pacific coastal environment supports an extraordinarily rich assortment of plants and animals. This diversity and complexity of life may be attributed to seasonal upwelling which brings nutrient-rich cold water to the surface and to the great variety of habitats occurring along the coast. The ecosystems associated with Pacific coastal barriers have been partitioned into five major systems: Marine, Estuarine, Riverine, Lacustrine, and Palustrine based on their associated aquatic habitats (Cowardin et al. 1979). Each of these systems is subdivided into subsystems and classes. Since coastal barriers contain uplands as well as aquatic areas, an upland subsystem has been added. While there are geomorphic and ecological differences between the Pacific coast of the continental United States and that of the Hawaiian Islands, the classification will remain the same (Table 1). Shaped by the common physical forces of winds, waves, tides, currents, precipitation, river flow, and temperature, each of these ecosystems represents a unique combination of geological and biological features. Each coastal barrier unit includes one or a combination of these ecosystems.

Pacific Coastal Ecosystems of California, Oregon, and Washington

A predominantly north-south wind direction from mid-March through mid-September along the Pacific coast serves to effectively push coastal surface water seaward. Cooler nutrient rich bottom waters upwell to replace the exiting surface water. At the same time, nutrient laden estuarine outflows are adding nutrients to the near coastal waters. The combined effect is an extremely high density of plankton which supports between 75 to 85 percent of the historically valuable commercial fish and shellfish harvests in this region (Rozengurt and Haydock 1991). The summer upwelling also serves to condense moisture in the warm summer air, thereby creating a summer coastal fog belt which is reflected in a variety of biotic responses.

Table 1. Classification of Pacific Coastal Barrier Ecosystems (based on Cowardin et al. 1979).

SYSTEM	SUBSYSTEM	DESCRIPTION
Marine	Upland Intertidal	The Marine System consists of the open ocean overlying the continental shelf and its associated high-energy coastline. Marine habitats are exposed to the waves and currents of the open ocean and the ebb and flow of oceanic tides. Salinity generally exceeds 30 parts per thousand (ppt).
Estuarine	Upland Intertidal	The Estuarine System consists of deepwater tidal habitats and tidal wetlands which are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land. Salinity generally is between 0.5 and 30 ppt.
Riverine	Upland Tidal Lower Perennial Upper Perennial Intermittent	The Riverine System includes all wetlands and deepwater habitats contained within a channel and adjacent uplands. A channel is an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water. Salinity is generally less than 0.5 ppt. Woody or persistent herbaceous vegetation in a channel would not be considered part of the Riverine System but as part of a Palustrine System.
Lacustrine	Upland Limnetic Littoral	The Lacustrine System includes wetlands and deepwater habitats (including adjacent uplands) with the following characteristics: (1) situated in a topographic depression or a dammed river channel, (2) lacking trees, shrubs, and persistent vegetation greater than 30 percent areal coverage, and (3) total area exceeds 20 acres and depth at deepest point exceeds 2 meters. Salinity is generally less than 0.5 ppt if an ocean source exists.
Palustrine	Upland Wetland	The Palustrine System includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands in tidal areas where the salinity is generally less than 0.5 ppt. It also includes those areas less than 20 acres and/or less than 2 meters deep.

Pacific coastal environments support a rich abundance of biota, including massive 100 foot long kelp (*Nereocystis luetkeana*) beds, a pseudo coastal barrier by themselves. Along central California, there are 440 species of seaweeds supporting large numbers of invertebrate and vertebrate fauna. Eelgrass (*Zostera marina* and *Z. japonica*) beds also contribute substantial habitat for invertebrates and a variety of fish.

Some of the larger, more conspicuous species on rocky shores are found for several hundred miles along the coast. These species include California mussels (*Mytilus californiensis*), seastars (*Pisaster ochraceus*), and the leaf barnacle (*Pollicipes polymerus*). All three of these species are rocky habitat indicators from Canada to southern California.

Pacific coast sandy shores provide habitat for the egg-shaped sand crab (*Emerita analoga*) which occurs intermittently on beaches from Vancouver Island, British Columbia to Baja California. Beach strands also provide habitat for the highly prized razor clams (*Siliqua patula*) of the north and the Pismo clams (*Tivela stultorum*) of the south.

Marine and Estuarine Intertidal Beach Strand Ecosystem

The beach strand and its associated bars are often the first interface between the consolidated shore and wind, wave, and tidal energy from the open ocean or bay. Subsequently, they tend to reflect the physical forces imposed on them. Offshore bars preceding the main beach are usually separated by intermittent longshore troughs. These areas provide habitat for a large variety of burrowing organisms and their predators. Shorebirds are often found feeding in these areas during low tides.

Because of the shifting nature of the sand, there are few macroscopic intertidal plants in this environment except those attached to the occasional stones or large beach debris. However, diatoms flourish on the sand surface in northwest Pacific intertidal reaches under conditions of cool fog laden summers. They are less abundant along southern California beaches. The diatoms provide an important source of carbon to the detrital food web which in turn supports dense populations of other biota such as surf clams. Clams provide an important recreational and commercial fishery.

One of the most conspicuous animals using these areas are the sand crabs. These crabs are found sparsely and intermittently in Washington and Oregon but are quite abundant in southern California. This crab has a four month larval stage that can be carried long distances by near offshore currents. This life stage helps explain its wide distribution along the coast.

Smaller crustacea, especially copepods and mysids, are common members of the surf plankton. Several species of polychaetes live in the lower intertidal reaches of the beach. At higher levels, there are abundant beach hoppers (amphipods of the genera *Orchestia*

and *Talorchestia*) living among the flotsam. These animals burrow into the sand during high tide and come out at night to feed during receding tides.

Predators at the top of the beach strand food chain include a large variety of shorebirds. After foraging in the strand, these birds often move into adjacent or nearby bays, lagoons, wetlands, and uplands, forming an energy link between the different habitats.

The California least tern (*Sterna albifrons browni*), an endangered species, nests on the beach and forages in the nearby coastal waters and wetlands. The snowy plover (*Charadrius alexandrinus*) is another endangered species which uses the beach strand for nesting. It is the only shorebird that is a year-long resident.

The beach strand habitat has been severely reduced by development, localized sediment starvation from groins and jetties, and introduced, invasive European plant species such as European beach grass, Scotch broom (*Cytisus scoparius*), and gorse (*Ulex europeaus*). Other critical infringements on this habitat include direct destruction of nests and continuous displacement of feeding birds by hikers, bathers, animals, and off-road vehicles.

Marine Upland Beach Strand and Dune Ecosystem

Sand dunes are expressed in the landscape through the interaction of sand, wind, water, and vegetation (Wiedemann 1984). The dune system on the Pacific coast has become less dynamic in this century as a result of the introduction of European beach grass. The characteristic beach strand, foredune, deflation plain, secondary dune transition is largely an artifact of the stabilization of sand by this species. European beach grass was introduced on the shores of San Francisco in 1869 and in Coos Bay, Oregon, in 1910. It has subsequently spread along the entire Pacific coast. There are, however, historic remnants of the unstabilized sand system in areas such as the Dunes National Recreation Area near Florence, Oregon. Vegetated plant communities (Marine Upland Dune-Herbaceous) typically found on or around foredunes on the north Pacific coast are typically dominated by European beach grass, American dune grass (*Elymus mollis*), bigheaded sedge (*Carex macrocephala*), salt rush (*Juncus lesuerii*), yellow sand verbena (*Abronia latifolia*), burweed (*Franseria spp.*), ragweed (*Ambrosia maritima*), morning glory (*Convolvulus soldanella*), sand strawberry (*Fragaria chiloensis*), sea rocket (*Cakile maritima*), sweet pea (*Lathyrus japonicus*), lupine (*Lupinus littoralis*), Pacific silverweed (*Potentilla pacifica*), dock (*Rumex acetosella*), and giant vetch (*Vicea gigantea*).

In many areas along the Pacific coast, a deflation plain occurs behind the primary dune. Deflation plains are areas where the wind has removed sand to or near the seasonal water table and they are typically Palustrine or Lacustrine freshwater systems. The foredune and deflation plain systems are under heavy pressure from commercial and residential development along the coasts of Oregon and Washington. Cranberry bog development is

also a threat to these systems. These activities are having direct impacts through displacement of habitat by buildings, roads, and other infrastructure as well as indirect impacts such as erosion, storm water contamination, and ground and surface water contamination from septic tank leachate.

Secondary or back dunes, depending on location, may also be classified as Marine or Estuarine Upland Dune Herbaceous or they may be a Forested class and support such species as Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophyla*) western red cedar (*Thuja plicata*), salal (*Gaultheria shallon*), evergreen huckleberry (*Vaccinium ovatum*), red huckleberry (*Vaccinium parvifolium*), and salmonberry (*Rubus spectabilis*). These areas are used for cover and browse by black-tailed deer (*Odocoileus hemionus*) and Roosevelt elk (*Cervus elaphus*). Old growth stands are used as breeding habitat by the threatened marbled murrelet (*Brachyramphus marmoratus*) and for nesting and feeding by the threatened spotted owl (*Strix occidentalis*). Mesic plant communities in the coastal barrier region also become established on coastal basalt or on sedimentary formations that are not of dune origin. These areas would be classified as Marine or Estuarine Upland Maritime. The forested community would not vary significantly from that described above.

Estuarine Ecosystem

An estuary largely consists of deepwater and tidal habitats and adjacent tidal wetlands which are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater from the land. Estuarine systems are subdivided into two subsystems, subtidal and intertidal, which are further partitioned into several classes (Cowardin et al. 1979). Estuarine wetlands act as nutrient traps and nursery grounds for fish and shellfish. They also serve as natural settling basins for storm runoff and, as such, protect coastal water quality.

Estuarine sediments are typically coarse near their mouths and finer in the more sheltered areas. Lower energy currents allow finer sediments to accumulate. In general, finer sediments are considered to be richer in benthic and epibenthic invertebrates. In shallow subtidal and intertidal areas with brackish salinity regimes, these sediments are often colonized by eelgrass which provides cover and feeding opportunities for a variety of invertebrates, fish, and crabs.

Pacific coast estuaries provide a buffer and acclimation zone for anadromous fish, notably various species of salmon. They provide an area for juvenile salmonids to make the physiological transitions necessary to move from a freshwater system to a marine system. For adult salmonids returning to spawn, they provide a staging area before their long arduous journey upstream.

The intertidal zone (mean higher high water to extreme low water during spring tides) of the estuary can be partitioned into three primary zones: (1) Emergent High Marsh, (2) Emergent Low Marsh, and (3) Unconsolidated Shore (sand and mud flats). These three zones are distributed along the coast and represented in a variety of different geomorphic patterns, salinity regimes, wave and current regimes, and other patterns.

In northern estuaries, the high marsh community is predominantly represented by tufted hairgrass (*Deschampsia ceaspitosa*), meadow barley (*Hordeum brachyantherum*), Pacific silverweed (*Potentilla pacifica*), gumweed (*Grindelia integrifolia*), Baltic rush (*Juncus balticus*), aster (*Aster subspicatus*,) and bentgrass (*Agrostis alba*). Wildlife use these areas for nesting and foraging. Northern harriers (*Cirus cyaneus*), common snipe (*Gallinago gallinago*) and, in some areas, Caspian terns (*Sterna caspia*) are often observed using this habitat.

The low marsh is often separated from the high marsh by a short escarpment (often less than one foot) called a "nick point". Low marsh plant communities contain such species as Lyngby's sedge (*Carex lyngbeii*), salt grass (*Distichlis spicata*), arrow-grass (*Triglochin maritimum*), pickleweed (*Salicornia virginica*), saltbush (*Atriplex patula*), bullrush (*Scirpus maritimus*), and jaumea (*Jaumea carnosa*). Canada geese (*Branta canadensis*), great blue herons (*Ardea herodias*), canvasbacks (*Aythya valisineria*), northern pintails (*Anas acuta*), and sora rails (*Porzana carolina*) are often observed feeding and resting in these areas.

Tidal sand and mud flats are a virtual smorgasbord for a large number of fish and wildlife species. Dominant species are often eelgrass and clams (*Macoma secta* or *Malacoceros glutaeus*). Amphipods (*Eohaustorius spp.*), polychaetes (*Pygospio elegans*), and ghost shrimp (*Callianassa californiensis*) are also common. The surfaces of these flats are coated with a gelatinous sheath of microscopic diatoms. They are highly productive nursery areas for young sand sole (*Psettichthys melanosticus*), Pacific staghorn sculpin (*Leptocottus armatus*), bay goby (*Lepidogobius lepidus*), and starry flounder (*Platichthys stellatus*). Juvenile chum (*Oncorhyncus keta*) and chinook salmon (*O. sawytscha*) also feed here. Migratory shorebirds depend heavily on these areas for feeding and resting. Shorebirds often sighted include wimbrels (*Numenius phaeopus*), dunlin (*Calidris alpina*), semipalmated plovers (*Charadrius semipalmatus*), and long-billed dowitchers (*Limnodromus scolopaceus*). Black brant (*Branta bernicla*) are often found feeding among the eelgrass beds.

Northern sand and mud flat environments are quickly being invaded by several introduced species of cordgrass (*Spartina alterniflora*), especially in Willapa Bay. At a slower rate, but at a wider distribution, Puget Sound is becoming infested with *Spartina alterniflora, S. pattens*, and *S. anglica*. These productive habitats are already diminished by development. Invasions by exotic species and development continue to negatively impact commercial fisheries and stress shorebird migrants.

Pacific coastal tidal flats and marshes are interlaced with tide channels, sloughs, and troughs that provide critical habitat for large numbers of invertebrates and fishes. They are also commonly used by shorebirds, herons, raccoons, otter, and mink. Dunlin (*Calidris alpina*), sanderlings (*Calidris alba*), and sandpipers are especially abundant. Eelgrass is found in many tidal channels. A common tide channel community could include the following species: chironomid larvae, amphipods (e.g., *Corophium salmonis, Paramoera columbiana* and *Eogammarus spp.*), polychaetes (e.g., *Hobsonia florida* and *Manayunkia aestuarina*), clams (*Macoma balthica*), shore crabs (*Hemigrapsus oregonensis*), tanaids, and mysids. Fishes may include fry of chum, coho, and pink salmon, three-spined stickleback, starry flounder, and staghorn sculpin.

Fish and wildlife in Pacific coastal estuaries and wetlands face a number of serious problems resulting from a variety of human related activities. San Francisco Bay has been influenced by human activity since the 1850's Gold Rush. More than 150 square miles of the bay have been filled. Nearly 95 percent of the bay's tidal marshes have been destroyed and 65 percent of the fresh surface water formerly reaching San Francisco Bay is now diverted to support agriculture. A review of the status of California's coastal wetlands and estuaries made the following findings: the natural values of 52 percent of California's 197,000 acres of coastal wetlands have been destroyed by dredging and filling; 62 percent of the remaining wetlands and estuaries have been subjected to severe damage and 19 percent had received moderate damage; and in southern California, 90 percent of the coastal wetlands and estuaries have been destroyed or severely altered by humans since 1900 (California Coastal Commission 1992). Because of fresh surface and groundwater diversions, many of our coastal communities are witnessing saltwater intrusion into domestic and municipal water sources.

Oregon has lost nearly 80 percent of its coastal wetlands primarily from the diking and draining of estuarine marshlands for agriculture (Oregon Coastal Management Program 1992). In the Columbia River estuary alone, 76 percent of its former tidal Forested wetlands and nearly 45 percent of its tidal Emergent wetlands have been lost as a result of diking and draining tidelands for agricultural conversion (Thomas 1983). Subsequent urban development has since sprawled over significant portions of the former tidelands. In addition, upstream forest and agricultural related chemical applications, along with industrial and municipal wastes, have contributed to significant sediment and water quality issues that appear to be finding their way into the food chain. The average nesting success of bald eagles nesting along the Columbia River is significantly lower than the average rates of bald eagle nesting success for the States of Oregon and Washington. Several species of Columbia River salmon are candidates or petitioned for listing as threatened or endangered under the Endangered Species Act. The status of these species is a result of the combined influences of habitat loss and degradation, migration impediments, and harvest patterns.

Puget Sound, one of the most biologically productive and recreationally important estuarine systems in the United States, with 2,000 miles of shoreline and 2,200 miles of bays and inlets, has witnessed large increases in population and urbanization within the last few years. These changes, in combination with historical water quality degradation, have resulted in severe water and sediment contamination problems. Significant concentrations of polychlorinated biphenyls (PCBs) and heavy metals such as mercury, arsenic, and lead have accumulated in the Sound's urban embayments. Many of these toxic elements can now be found in the tissues of fish and shellfish. Additionally, nonpoint source pollution from urban stormwater, rural septic systems, and farm operations has resulted in areas being closed to commercial harvesting.

Lacustrine and Palustrine Ecosystem

Lacustrine and Palustrine freshwater systems occur in the deflation plain areas behind primary dunes. Shallow lakes, Emergent wetlands or Scrub/Shrub wetlands typically form on the deflation plains. The lakes often support aquatic plants such as Indian pond lily (*Nuphar polysepalum*) and the wetlands support sedges such as *Carex obnupta*, shorepine (*Pinus contorta*), and, within a limited range, cobra-plants (*Darlingtonia californica*). These areas often provide habitat for waterfowl, shorebirds, and wading birds such as the great blue heron. However, these areas are under heavy commercial, residential, and agricultural development pressure along the Oregon and Washington coasts.

Endangered Species on the Pacific Coast

Substantial numbers of endangered and threatened species are associated with Pacific coastal barrier systems (Table 2). However, through a variety of protection efforts, some species are recovering. The California gray whale (*Eschrichtius robustus*), was nearly hunted to extinction in the last century. Now it is beginning to return to former population levels because of its protection under the Endangered Species Act. Whale watching has become a multi-million dollar tourist attraction on the Pacific coast. The gray whales calve in the large lagoons of western Baja California, and are often observed in San Francisco and Tomales Bays. The northern elephant seal (*Mirounga angustirostris*) has also made a remarkable recovery because of its protected status and it also helps sustain a vibrant coastal tourist economy.

Populations of other threatened and endangered species continue to remain depressed. The California brown pelican (*Pelecanus occidentalis californica*) once held a breeding range from Monterey through Baja California. This range has been drastically reduced to a couple of islands and Elkhorn Slough National Estuarine Sanctuary.

The endangered California least tern (*Sterna albifrons browni*), the smallest of the terns, breeds in California from early April to September and probably winters in Mexico. It

nests in bare areas of mixed sand, shells, and pebbles, mostly in southern California. There were only 1000 pairs in 1988 (Hedgpeth 1988). Breeding sanctuaries have been established in San Francisco, Bolsa Chica, and a number of military reservations.

The salt-marsh harvest mouse (*Reithrodontomys raviventris*) is restricted to salt marsh habitats bordering bays and estuaries of the San Francisco Bay region. It is predominantly found among the pickleweed (*Salicornia spp.*) and saltgrass (*Distichlis spp.*) upon which it feeds. Habitat loss and fragmentation continue to be a major threat to this species.

The light-footed clapper rail (*Rallus longirostris levipes*) is on both the Federal and State of California endangered species lists. It is a year round resident of the *Salicornia* marshes from Santa Barbara to San Quintin Bay, Baja California. It is protected in Newport Bay, Bolsa Chica, and several other areas set aside for the least tern. Sanctuaries in Tijuana, Mexico may also help protect the bird. There were about 200 remaining pairs left in California in 1988.

The California clapper rail (*Rallus longirostris obsoletus*) is also on both the Federal and State of California endangered species lists. It often nests in the pickleweed and the native cordgrass (*Spartina foliosa*) in the marshes of southern San Francisco Bay. Primary prey include salt marsh worms, crustaceans, and mollusks. Feeding generally occurs during low tides when tidal flats are exposed.

The Belding's savannah sparrow (*Passerculus sandwichensis beldingi*) is a candidate for the Federal endangered species list. This bird is a year long resident of the *Salicornia* marshes of southern California. It's distribution is restricted to about 40 percent of its former range due to habitat loss and degradation.

The Oregon silverspot butterfly (*Speyeria zerene hippolyta*) is a threatened species in northern Oregon and southern Washington which requires a combination of salt-spray meadows and old growth forests for food and shelter. Salt-spray meadows on old dunes and rocky headlands support the western blue violet (*Viola adunca*) upon which the butterfly feeds. These remaining open meadows are subject to residential and golf course development.

The peregrine falcon (*Falco peregrinus*) has been on the endangered species list since 1984. Peregrine falcons have been observed nesting on coastal cliffs in California, Oregon, and Washington. They have recently been observed in large urban areas using tall buildings as nesting or roosting sites and feeding on small birds and pigeons.

Table 2. Listed and proposed threatened and endangered species which may occur in potential Pacific coastal barrier units.

State[a]	Common Name	Scientific Name	Status[b]
BIRDS			
OR,WA	Aleutian Canada goose	*Branta canadensis leucopareia*	E
CA,OR,WA	Bald eagle	*Haliaeetus leucocephalus*	T (E in CA)
CA	Belding's savannah sparrow	*Passerculus sandwichensis beldingi*	Proposed E
CA	California clapper rail	*Rallus longirostris obsoletus*	E
CA	Light-footed clapper rail	*Rallus longirostris levipes*	E
CA	California least tern	*Sterna antillarum browni*	E
CA,OR,WA	Spotted owl	*Strix occidentalis caurina*	T
CA,OR,WA	Marbled murrelet	*Brachyramphus marmoratus*	T
CA,OR,WA	Peregrine falcon	*Falco peregrinus*	E
CA,OR,WA	Western snowy plover	*Charadrius alexandrinus nivosus*	T
WA	Harlequin duck	*Histrionicus histrionicus*	C1
CA,OR,WA	Brown pelican	*Pelecanus occidentalis*	E
HI	Hawaiian coot	*Fulica americana alai*	E
HI	Hawaiian gallinule	*Gallinula chloropus sandvicensis*	E
HI	Hawaiian stilt	*Himanpopus mexicanus knudseni*	E
HI	Hawaiian duck	*Anas wyvilliana*	E
HI	Hawaiian hawk	*Buteo solitarius*	E
REPTILES			
CA,WA	Green sea turtle	*Chelonia mydas*	T (E in WA)
WA	Leatherback sea turtle	*Dermochelys coriacea*	E
CA,WA	Loggerhead sea turtle	*Caretta caretta*	E
WA	Olive ridley sea turtle	*Lepidochelys olivacea*	E
CA	Southwestern pond turtle	*Clemmys marmorata pallida*	C1
AMPHIBIANS			
CA	California red-legged frog	*Rana aurora draytoni*	C1

Table 2 (continued). Listed and proposed threatened and endangered species which may occur in potential Pacific coastal barrier units.

State[a]	Common Name	Scientific Name	Status[b]
INVERTEBRATES			
OR,WA	Oregon silverspot butterfly	*Speyeria zerene hippolyta*	T
CA	Smith's blue butterfly	*Euphilotes enoptes smithi*	E
CA	Myrtles silverspot butterfly	*Speyeria zerene myrtleae*	E
CA	Behren's silver spot butterfly	*Speyeria zerene behrensii*	C1
WA	Newcomb's littorine snail	*Algamorda newcombiana*	C1
CA	Morro shoulderband snail	*Helminthoglypta walkeriana*	Proposed E
FISH			
CA	Tidewater goby	*Eucylogobius newberryi*	Proposed E
CA	Chinook salmon (Sacramento River winter run stock)	*Oncorhynchus tshawytscha*	T
OR,WA	Sockeye salmon (Snake River run stock)	*Oncorhynchus nerka*	E
OR,WA	Chinook salmon (Snake River Fall run stock)	*Oncorhynchus tshawytscha*	T
OR,WA	Chinook salmon (Snake River Spring run stock)	*Oncorhynchus tshawytscha*	T
MAMMALS			
OR	Columbian white-tailed deer	*Odocoileus virginianus leucurus*	E
CA	Point Arena mountain beaver	*Aplodontia rufa nigra*	E
OR	Northern sea lion	*Eumetopias jubatus*	T
CA	Southern sea otter	*Enhydra lutris nereis*	T
CA,OR,WA	Gray whale	*Eschrichtius robustus*	E
CA,OR	Northern elephant seal	*Mirounga angustirostris*	E
CA	Salt marsh harvest mouse	*Reithrodontomys raviventris*	T
HI	Hawaiian monk seal	*Monachus schauinslandi*	E
HI	Hawaiian hoary bat	*Lasiurus cinereus semotus*	E

Table 2 (continued). Listed and proposed threatened and endangered species which may occur in potential Pacific coastal barrier units.

State[a]	Common Name	Scientific Name	Status[b]
PLANTS			
OR	Western Lily	*Lilium occidentale*	C1
OR	Wolf's Evening-Primrose	*Oenothera wolfii*	C1
WA	Golden paintbrush	*Castilleja levisecta*	C1
WA	Sea cliff bluegrass	*Poa unilaterilis*	C1
CA	Salt marsh bird's beak	*Cordylanthus maritimus maritimus*	E
CA	Presidio manzanita	*Arctostaphylos hookeri* var. *ravenii*	E
CA	Howell's spineflower	*Chorizanthe howellii*	E
CA	Sonoma spineflower	*Chorizanthe valida*	E
CA	Santa Cruz cypress	*Cupressus abramsiana*	E
CA	Menzies' wallflower	*Erysimum menziesii*	E
CA	Pt. Reyes clover lupine	*Lupinus tidestromii* var. *layneae*	E
CA	Beach layia	*Layia carnosa*	E
CA	Swamp sandwort	*Arenaria paludicola*	Proposed E
CA	Marin dwarf-flax	*Hesperolinon congestum*	Proposed T
CA	Coastal dunes milk-vetch	*Astragalus tener titi*	C1
CA	Monterey spineflower	*Chorizanthe pungens* var. *pungens*	Proposed E
CA	Robust spineflower	*Chorizanthe robusta* var. *robusta*	Proposed E
CA	Gambel's watercress	*Rorippa gambellii*	Proposed E
CA	California sea-blite	*Suaeda californica*	Proposed E
CA	La Graciosa thistle	*Cirsium loncholepis*	C1
CA	Surf thistle	*Cirsium rhothophylum*	C1
CA	Nipomo Mesa lupine	*Lupinus nipomensis*	C1
CA	Awned bentgrass	*Agrostis aristiglumis*	C1
CA	Laurel hill manzanita	*Arctostaphylos uva-ursi* var. *franciscana*	C1
CA	Point Reyes paintbrush	*Castilleja leschkeana*	C1
CA	Baker's larkspur	*Delphinium bakeri*	C1

Table 2 (continued). Listed and proposed threatened and endangered species which may occur in potential Pacific coastal barrier units.

State[a]	Common Name	Scientific Name	Status[b]
CA	Yellow larkspur	*Delphinium luteum*	C1
CA	Santa Cruz tarweed	*Holocarpha macradenis*	C1
CA	Contra Coasta goldfields	*Lasthenia conjugens*	C1
CA	Coast lily	*Lilium maritimum*	C1
CA	Hickman's cinquefoil	*Potentilla hickmanii*	C1
CA	Seaside bird's beak	*Cordylanthus rigidus* ssp. *littoralis*	C1

[a] State: CA=California, HI=Hawaii, OR=Oregon, WA=Washington.
[b] Status: E=Endangered, T=Threatened, C1=Taxa for which the U.S. Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.

Certain salmon species are also at risk from a variety of cumulative and secondary effects of continued development. Native salmon stocks are threatened primarily by the cumulative effects of the following activities: (1) timber and agricultural management practices in coastal watersheds; (2) increased harvest pressure; and (3) construction of hydroelectric dams in the Columbia River watershed without adequate upstream and downstream passage facilities for the salmon. The cumulative effects of these activities have brought many runs of salmon to the brink of extinction.

Hawaiian Coastal Ecosystems

Coastal ecosystems in Hawaii, though similar to their continental counterparts, require special consideration because of their island nature. Because of the relatively small land area of the individual islands, Hawaiian coastal watersheds often extend to the highest inland ridges. Oceanic and marine influences also extend far inland, especially during extreme weather conditions. The islands are isolated from the continental land masses and support a predominantly endemic flora and fauna.

The Hawaiian Islands are under tremendous urban growth and development pressures. Most of the growth, and the associated cumulative and secondary impacts of development, occurs within the coastal zone due to the small size of the islands. Golf courses, resorts, hotels, and housing subdivisions are all taking a toll on coastal wetlands and adjacent uplands. There are four endangered waterbirds and two endangered sea turtles which depend on these habitats for survival. In addition to habitat loss, fragmentation, degradation, and increasing sedimentation, the introduction of nonnative predators such as the mongoose and feral cats further stresses native wildlife populations. The introduced California grass (*Brachiaria mutica*) and other exotic plants have outcompeted and replaced many of the more desirable native species in critical habitat areas (Karen Evans, U.S. Fish and Wildlife Service, pers. comm. 1993). Introduction of these and other exotic species has been correlated with reductions in native populations and subsequent imbalance in the ecosystem.

Marine Intertidal Reef and Beach Strand Ecosystems

Hawaii's coral reefs are important generators of sand for nearly all of Hawaii's beaches and they provide direct shoreline protection since they act as natural offshore breakwaters. The reefs also provide critical ecological functions. A symbiotic algae allows coral colonies to use solar energy for rapid construction of their calcium carbonate skeletons, the framework of the reefs. Coralline algae contributes to these structures by providing an additional source of calcium carbonate. Corals are most productive in shallow, warm, and clear water. Reefs are fragile ecosystems which are susceptible to a number of environmental changes. Freshwater runoff is often detrimental to coral reefs because of its cooler temperature, turbidity and decreased salinity. Sedimentation can directly smother corals, decrease light penetration, and reduce the amount of available

substrate to juvenile corals. Eutrophication, ultraviolet radiation, and direct contact from human hands or anchors may also damage coral reefs.

Besides corals, other reef organisms include sea urchins, clams, sea snails, sea cucumbers, and a variety of fish. In their larval stages, these organisms drift along the reef and both participate in and become part of the complex reef food web. Reef fish are both grazers and carnivores. While many reef organisms spend their entire lives near the reef, oceanic fish will periodically come in and feed among the reefs.

Sand deposits often extend offshore from coastal barriers to subtidal depths. Communities that typify these areas include cones (*Conus spp.*), mitres (*Terebra spp.*), and pen clams (*Pinna spp.*). Subtidal algae may become established on relatively stable sand deposits.

Shallow basalt platforms on the west side of the island of Hawaii have developed over time from periodic lava flows. These platforms are sparsely colonized by sturdy corals (especially *Pocillopora meandrina*) and algae. A limited assemblage of reef fish use these systems. In protected areas, well developed corals may become established on the lava. Lava flows periodically destroy coral communities and recovery requires decades.

Adult green sea turtles (*Chelonia mydas*) feed and rest in coastal waters around the Hawaiian islands. Other endangered sea turtles, such as the leatherback and the loggerhead, also occur in these waters. Several endangered whales (blue, finback, gray, humpback, right, sei, and sperm) use Hawaiian offshore habitats. The endangered Hawaiian monk seal (*Monachus schauinslandi*) uses offshore areas in its restricted range among the northwestern islands.

Marine Intertidal and Upland Beach Strand Ecosystems

The Marine Upland Maritime ecosystem in Hawaii occupies a relatively narrow zone between the high tide line and inland aquatic habitat. The maritime environment is characterized by salt spray, constant wind, low rainfall, intense sunlight, high evaporation, high temperatures, and shifting sands. Exposed beaches are colonized by decapod, amphipod, and isopod crustaceans, mollusks (*Terebra spp.*), and polychaete worms.

Richmond and Mueller-Dombois (1972) recognize thirteen Hawaiian coastal ecosystem classes based on dominant plant species and landforms. The distribution of the ecosystems is broadly related to rainfall and drought patterns. The zonation of maritime plants is largely influenced by exposure to wind and surf, and by soil, water, and salinity.

Bay mouth barriers, such as Lumahai Valley and Waimea Bay, may have seasonally shifting sands. Vegetation in these areas is restricted to stable sand berms or ridges behind the active beach. The vegetation helps to stabilize the shifting sand. Some bay barriers, such as Waimanu Bay and Waipio Bay, have a narrow band of low, older, vegetated dunes behind the beach. Dune vegetation generally consists of Hawaiian coastal strand plants such as *Scaevola, Messerschmidia*, and *Ipomea* (Moberly and Chamberlain 1964). Among the native coastal flora, a number of species are indigenous and relatively common in certain areas (Tabata 1980). These systems harbor two of the endangered plants in Hawaii and two plant species proposed for listing as endangered.

Well developed dunes are found behind the barrier beach at Kahuku on the northernmost shore of Oahu. Other barrier beaches, such as those on Maui and those fronting former fish ponds on the west coast of Hawaii, have narrow beaches with low backshore berms and coastal strand vegetation. Protected bay mouth coastal barrier units usually have wide, low-profile beach berm systems, often with introduced plants (Nolan and Cheney 1981). True Marine Upland Maritime forests do not occur in Hawaii, although some beaches do have stands of introduced Casuarina pines along the beach berms. The vegetation of strand and dune areas provides habitat for a number of small lizards, but little is known about the other terrestrial inhabitants of these areas. Various seabirds and shorebirds make use of the Marine Upland Dune and Beach Strand vegetation for roosting and nesting. Green sea turtles formerly nested on the Beach Strands throughout the archipelago. Now, there is major nesting only on the uninhabited northwestern Hawaiian Islands. A nest is very rarely reported from a beach in the inhabited main islands.

Estuarine Intertidal Ecosystems

In Hawaii, most of the aquatic habitats associated with coastal barriers are classified as estuaries (Cowardin et al. 1979). Most of these estuaries occur on Kauai and Oahu; very few are found on Hawaii. Using a broad definition of an estuary, Cox and Gordon (1970) identified about 50 estuaries for the State.

Coastal barrier estuarine habitats in Hawaii include shallow, brackish, and tidally influenced stream mouths and their periodically flooded marsh and grasslands. Estuarine habitats are typically associated with small ponds and pond/marsh complexes behind barrier beaches which form estuaries. Former fish ponds, which have open or partly obstructed or sporadic connection to the sea are also considered estuarine. Nearly all the aquatic habitats associated with coastal barriers in Hawaii include estuarine components which merge into freshwater ecosystems (Riverine, Lacustrine, or Palustrine). Estuarine ecosystems contain high concentrations of organic nutrients which contribute to their high productivity. This production contributes enormous energy to the detrital food web, substantially supporting local fish and wildlife.

The vegetation of estuaries in Hawaii is heavily influenced by exotic species such as the water hyacinth (*Eichornia crassipes*) (Elliot and Hall 1977). Pond edges and Emergent wetlands are often dominated by sedges and bullrushes (e.g., *Cladium spp.* and *Scirpus spp.*), indigenous grasses (e.g., *Bacopa spp.* and *Sesuvium spp.*), and introduced grasses such as *Paspalum spp.* and *Brachiaria mutica*. Mudflats have been covered by introduced pickleweed (*Batis maritima*). Estuarine riparian fringes often consist of indigenous hau trees (*Hibiscus tiliaceus*) but an introduced mangrove (*Rhizophora mangle*) is beginning to spread. Taro (*Colocasiaes culenta*) was introduced prehistorically and is currently cultivated in many coastal barrier wetlands.

While faunal diversity is relatively low compared to mainland systems, many of the species are endemic (Maragos 1975). Estuaries harbor native species of fish, prawns, and mollusks, and function as nurseries for a variety of inshore marine fish. The Hawaiian estuaries also play an important role in providing feeding grounds and nesting habitat for resident and migratory waterbirds. Wetlands are especially important for endemic waterbirds that are Federally listed as endangered: the Hawaiian stilt (*Himantopus himantopus knudseni*), Hawaiian coot (*Fulica americana alai*), Hawaiian gallinule (*Gallinula chloropus sandvicensis*), and the Hawaiian duck (*Anas wyvilliana*). Other species, such as the black-crowned night heron (*Nycticorax nycticorax hoactli*), also use these areas. The estuarine habitats not only supply endangered wildlife species with critical habitat needs, they also provide sufficient isolation from human disturbance and introduced predators such as cats, dogs, rats, and mongooses.

Riverine, Lacustrine, and Palustrine Ecosystems

A number of the wetlands associated with coastal barrier beaches are spring-fed, have no surface water connection to the ocean, and are freshwater systems. The flora and fauna of these wetlands and aquatic areas is similar to the inland portions of Hawaiian estuaries, which are also freshwater systems (Maragos 1975).

The majority of wetland loss in Hawaii has occurred within the coastal plains where most of the urban and agricultural development has been located (Hawaii Coastal Zone Management Program 1992). Approximately 31 percent of Hawaii's coastal wetlands have been lost since the 1780's. The impacts of encroaching development on habitat resources is of particular concern since most of Hawaii's wetlands are less than five acres in size which limits their protection under State and Federal water quality statutes. Additionally, many of the larger, and most biologically-important, wetlands are still not protected from permitted discharges.

Most of the freshwater habitat in Hawaii is found in streams. Three types of streams are found in Hawaii: (1) ephemeral; which carry water only immediately after a rain storm; (2) intermittent; which carry water part of the year but also dry up for part of the year; and (3) perennial; which flow all year long. Hawaiian streams are rocky, precipitous,

and rapidly flowing in nature. This environment supports a limited number of species. All native species of the stream macrofauna are diadromous, having had a marine larval stage for development. This is an artifact of the recent evolutionary development of these organisms from oceanic ancestors.

There are five freshwater fish species all of which are gobies. Some of these fish were important in the traditional native Hawaiian diet and culture (Titcomb 1972). At least four of these species are endemic: *Awaous stamineus, Eleotris sandwicencis, Sicyopterus stimpsoni*, and *Lentipes concolor. Stenogobius genivittatus* may have been introduced by early Pacific Island peoples. Other native freshwater macrofauna include two mollusks (*Neritina granosa* and *Melanoides spp.*) and two endemic crustaceans (*Atyoida bisulcata* and *Macrobrachium grandimanus*) (Parrish et al. 1978, Timbol and Maciolek 1978). In addition to native species, about 27 introduced species now thrive in Hawaii's freshwater stream system.

Marine Upland Ecosystem

The upland portions of coastal barriers in Hawaii generally contain disturbed forests dominated by introduced species. However, in remote areas and at higher elevations, native forest communities can be found along with their associated endangered species. The reduced state of these habitats explains the demise of many of Hawaii's forest birds. Other species such as the Oahu tree snails (*Achatinella spp.*) are Federally listed endangered species because of their habitat reduction.

Fish and Wildlife Resources of Individual Hawaiian Islands

The following discussion on coastal barriers and their associated fish and wildlife resources for individual Hawaiian Islands is based primarily on Holthus' (1988) review of Hawaiian coastal barriers. It should be noted that the definition of coastal barriers used by Holthus is broader than the definition used for the purposes of this study.

Niihau Island. The coastal barrier units of Niihau consist of barrier beach and dune systems which separate what are essentially coastal lagoons from the ocean (Cox and Gordon 1970). The dunes are well developed and vegetated on the Kaununui and Leahi barriers. Much of the coastal plain surrounding the lakes and lagoons is used for cattle grazing. The lagoons themselves are fringed with introduced pickleweed and contain mullet which dies off when the lagoons seasonally dry up (U.S. Fish and Wildlife Service n.d.). The lagoon wetlands provide habitat for the Hawaiian stilt population and are believed to provide seasonal habitat for many of the stilts from Kauai.

Kauai Island. The coastal barriers of Kauai consist primarily of bay barriers with estuarine wetlands fed by continuous or interrupted streams (AECOS, Inc. 1982, Manoa Mapworks 1983). The relatively undisturbed lower Wainiha and Lumahai Streams are

among the few that still have an abundance of freshwater gobies (Timbol and Environmental Impact Study Corp. 1977, Wilson Okamoto and Associates, Inc. 1981). One species, *Awaous stamineus*, migrates downstream to spawn, where it is an important fishery resource. Two native freshwater gobies are abundant, and three are less abundant, in the Hanalei River (Timbol and Environmental Impact Study Corp. 1977). Fishes inhabiting the estuarine streams of northeastern Kauai include flagtails (*Kuhliidae*), mullet (*Mugilidae*) and introduced tilapia (AECOS, Inc. 1982).

The estuaries at Wainiha and Lumahai Streams are considered primary waterbird habitat, providing nesting and feeding areas for all the endangered Hawaiian waterbirds (Ahuimanu Productions 1977). Nearby Hanalei Valley, is also a primary waterbird area. A National Wildlife Refuge has been established in the wetlands inland from these coastal barriers to secure habitat for the endangered Hawaiian waterbirds. The streams and estuaries of the coastal barriers along northeast Kauai also provide cover and feeding habitat for all the endangered native waterbirds (Ahuimanu Productions 1977).

Oahu Island. A variety of coastal barrier types are found on Oahu and they support various fish and wildlife resources. The lower estuarine reaches of Waimea Stream contain tilapia, mullet, and milkfish (*Chanos chanos*) (AECOS, Inc. 1979a, 1981). A wetland created by seasonal impoundment by the bay barrier provides marginal habitat for endangered waterbirds (Ahuimanu Productions 1977). The wetlands at Kahuku are identified as primary habitat for endangered waterbirds (U.S. Fish and Wildlife Service 1978). Portions of these wetlands have been set aside as a National Wildlife Refuge (Ahuimanu Productions 1977). In addition to being used by numerous migratory shorebirds, these wetlands are also used by the Laysan albatross (*Diomedea immutabilis*). The dunes along the shore at Kahuku contain some native Hawaiian strand vegetation which is not common along most of Oahu's highly altered shoreline. Endangered green sea turtles are thought to occasionally nest on the beach at Kahuka, probably the only site where this occurs.

The extensive estuary of Kahana ranked high in a survey conducted to select a National Estuarine Sanctuary because it is one of the least disturbed natural estuaries in Hawaii (Ahuimanu Productions 1977). However, it is of limited significance (and rated secondary) as waterbird habitat (U.S. Fish and Wildlife Service 1978). The estuary contains native prawn and native fishes (Maciolek 1972; Timbol 1972). Introduced mangroves are encroaching along the lower shores of Kahana estuary and around the Nuupia fish ponds (Ahuimanu Productions 1977, Elliot and Hall 1977). The interconnected ponds at Nuupia contain both native and exotic fishes characteristic of water where salinity is variable (AECOS, Inc. 1979a). The ponds provide nesting and feeding habitat for the Hawaiian stilt, black-crowned night heron, and Hawaiian duck (Ahuimanu Productions 1977), and have been rated high for Hawaiian waterbird habitat (U.S. Fish and Wildlife Service 1978). Migratory waterfowl and shorebirds also make use of Oahu's coastal barriers (Ahuimanu Productions 1977).

Molokai Island. Molokai's southern coast is characterized by fringing reefs and calm waters. Most of the wetlands on the island are associated with fishponds and mudflats. The ponds serve as rearing areas for mullet and milkfish. O'opu and tilapia are also common. A variety of invertebrates, including molluscs, worms, and crustaceans, utilize the ponds and provide prey for herons and other waterbirds. The barriers on Molokai Island support a variety of waterbirds including Hawaiian coots, Hawaiian stilts, Hawaiian gallinules, black-crowned night herons, and various ducks. Migratory shorebirds such as golden plover (*Pluvialis dominica*), ruddy turnstones (*Arenaria interpres*), wandering tattlers (*Heteroscelus incanus*) and sanderlings are also common. Most of the coastal fishpond vegetation is dominated by mangroves and extensive soil erosion has left a thick layer of mud along the coast (Ahuimanu Productions 1977, Elliot and Hall 1977).

Maui Island. Ponds and associated wetlands behind Maui's north-central coastal barrier beaches contain tilapia and mosquitofish. Numerous varieties of invertebrates (shrimp, snails, and aquatic insects) are found on the pond bottoms and on the aquatic vegetation. Bullfrogs occur along the pond fringes (AECOS, Inc. 1979b, 1979c). Kanaha Pond is primary nesting and feeding habitat for Hawaiian waterbirds. It is of critical value for the Hawaiian stilt and is also important for the Hawaiian coot and the black-crowned night-heron (Ahuimanu Productions 1977). Kanaha Pond is the most valuable single habitat for wintering waterbirds in Hawaii and is also used by some of the less common species of migratory shorebirds (Ahuimanu Productions 1977).

The shallow waters and mudflats of Kealia Pond provide valuable habitat for resident and migratory waterbirds. The pond has been designated as primary habitat for Hawaiian waterbirds, especially the endangered Hawaiian stilt and Hawaiian coot as well as the black-crowned night-heron (U.S. Fish and Wildlife Service 1978). The Hawaiian owl is also apparently a regular inhabitant (Ahuimanu Productions 1977). The pond contains milkfish, mullet, and prawns (*Macrobrachium grandimanus*), but is dominated by other introduced species, especially tilapia and the Malaysian prawn, the latter of which has spread from nearby aquaculture facilities (AECOS, Inc. 1979b, 1979c). During low-water periods, the fauna concentrate in the reduced pond providing important feeding opportunities for waterbirds.

Hawaii Island. Coastal barrier habitats on the island of Hawaii can be separated into two groups: (1) those associated with the drowned river valley and bay mouth on the east coast of Kohala peninsula, and (2) the aquatic habitats enclosed by beach barriers on the west side of the island, which were converted to fish ponds by the ancient island inhabitants. Pololu, Waimanu, and Waipio Valleys have aquatic fauna typical of streams and estuary ecosystems in Hawaii, including mullet, gobies, milkfish, and other species. Exotic mosquitofish and tilapia occur in the streams, ponds, and wetlands. Frogs occur around the pond edges. Freshwater snails, native shrimp and prawns, and introduced prawns are also found in the streams and ponds of this area. The wetlands of these three

coastal barriers have been identified as habitats of secondary importance for Hawaiian waterbirds. The endangered Hawaiian coot, Hawaiian duck, and the black-crowned night heron use these habitats for feeding and nesting (Ahuimanu Productions 1977).

The beach barrier/fish ponds on the west coast of Hawaii Island can be divided into those with surface connection to the sea and those without such connections. This western coastal region has no perennial streams and very little rainfall; the wetlands permit pockets of high productivity to persist in otherwise barren areas. Common fish in these habitats include tilapia and mosquitofish, as well as mullet, barracuda, flagtails, and a variety of other small fishes (Brock and Brock 1974, Maciolek and Brock 1974, Madden and Paulsen 1977).

Wainanalii Pond, with its open connection to marine waters, has varying degrees of salinity. Sea anemones (*Aiptasia*), rock oysters (*Isognomon costellatum*), mussels (*Brachidontes*), and hoof shells (*Hipponix*) are all common in this pond (Kay et al. 1977). The coastal barrier wetlands at Aimakapa and Opae Ula have been identified as primary waterbird habitat (U.S. Fish and Wildlife Service 1978). They are especially critical nesting and feeding locations for the endangered Hawaiian stilt and coot, and also provide feeding grounds for the black-crowned night heron. Both areas also provide major migratory waterfowl and shorebird habitat during winter months (Ahuimanu Productions 1977).

Cultural Resources Associated with Coastal Barriers

Prehistoric

Environmental changes in the late Pleistocene and early Holocene (ca. 12,000 to 8,000 Before Present (B.P.)) were characterized by climatic warming, rapid rise in sea level, extensive vegetation changes, desiccation of pluvial lakes, and faunal extinctions. The response and adaptation to these conditions by prehistoric peoples living on the Pacific coast is a current research effort by many scientists (Gearhart et al. 1990, Snethkamp et al. 1990).

At 10,000 B.P. the coastline may have been as much as 10 kilometers west of its present location. Therefore, a vast amount of archeological evidence for early human use of these areas is inundated and likely mobilized through sediment transport processes. Coastal barriers support depositional environments and may serve as storage areas or catch basins for cultural artifacts.

Early settlement patterns indicate migrations continued to cluster in areas of high resource yield, such as embayments, lagoons, and lower areas slightly inland, with access both to terrestrial and marine resources. These patterns suggest that coastal barriers and their associated aquatic areas and adjacent uplands are likely archeological sites by definition.

Historic

From a historical perspective (post European involvement), the Pacific coast has been characterized by the mixing of European, Russian, Asian, and Native American cultures. The published results of Captain Cook's 1778 voyage in the region alerted the world to the potential sea otter pelt trade. This served as the impetus for the rapid expansion of the fur trade companies, the first phase of the European colonization of the Pacific Northwest. As more people moved to the area, the demand for lumber increased. The first sawmill was established in 1827 and by the 1880's the modern maritime timber trade was beginning to form. Fishing and whaling industries were helping to sustain European settlements in the mid 1850's.

Up until the mid nineteenth century, the primary access to the coastal region was by sea. Navigation in the shallow embayments and river mouths often proved hazardous and many ships were smashed into coastal headlands during severe storms. Consequently, a rich history is available in the wreckage of these unfortunate voyages.

Contemporary

Coastal barrier geography and related resources continue to shape and influence present day coastal inhabitants. Many coastal Native Americans continue to strive to maintain a semblance of their former culture through subsistence hunting, fishing, and gathering. Tribal lands have the status of sovereignty within their respective jurisdictions and Federal laws have recognized treaty rights that influence fish and game harvests and rights which give deference to the buried remains of Native American ancestors.

Coastal ports have greatly influenced modern coastal communities. Both commercial and industrial ports provide for economic growth, domestic and international trade, and water transportation. Sport and commercial fishing have also greatly impacted modern coastal economies. The national and international tourist industry also supports coastal economies and the industry is the mainstay of large segments of the present coastal culture. Increasing demands to view whales, eagles, and sea lions, and the opportunity to walk along the coast away from the evidence of human intrusion, translate into huge influxes of dollars for the various coastal communities.

FEDERAL EXPENDITURES

Congress recognized that certain Federal Government actions and programs have subsidized and permitted development on coastal barriers resulting in the expenditure of millions of tax dollars each year. A basic tenant of the CBRA and the CBIA is to reduce wasteful Federal expenditure and financial assistance in coastal areas that are environmentally sensitive and subject to natural hazards. With certain exceptions, the

CBIA prohibits Federal agencies from providing new expenditures or financial assistance which would encourage development on units within the System, regardless of whether other Federal laws made such assistance available. Financial assistance is defined in Section 3(3) of the CBRA as "any form of loan, grant, guaranty, insurance, payment, rebate, subsidy, or any other form of direct or indirect Federal assistance" other than certain specified exceptions. Under the CBRA, prohibitions against providing Federal flood insurance coverage for properties within the System became effective October 1, 1983. Currently none of the State agencies in California, Hawaii, Oregon, or Washington utilize Federal flood insurance. However, Washington State is developing a State flood plan which, once approved by the Federal Emergency Management Agency, will make it eligible for Federal flood monies.

Miller and Stroup (1989) assessed potential Federal savings if the 88 potential coastal barrier units identified within California, Oregon, and Washington as of 1985 were included in the System. Potential cost savings to the Federal Government were determined for a low development case (50 percent development or urbanization of the fastland acreage in each unit) and a high development case (50 percent development of both the fastland and wetland acreage in each unit). Their savings estimates, which include the one-time capital costs for urban infrastructure and costs over a 20-year period for disaster relief, flood insurance subsidies, and shoreline protection, ranged from $603 million for a low development case to $708 million for a high development case. These potential savings represent Federal funds which might otherwise be spent for major capital costs of urban infrastructure (i.e., wastewater treatment, sewers, water supply, water treatment and distribution, roads, bridges, and causeways), disaster relief, flood insurance subsidies, and shoreline protection if the barriers were developed. Miller and Stroup used 1988 values for determining costs associated with urban infrastructure. Values for disaster relief, flood insurance subsidies, and shoreline protection were based on operating experience from 1979-1988, from which an average annual operating surplus/deficit value was determined, and the "savings" value was projected over a 20-year period. During this time period, an average of $88.5 million per year was spent for hurricane and coastal storm disasters, even though the decade was relatively quiescent (Miller and Stroup 1989). Since all the direct costs associated with development were not represented in their calculations, the savings estimates are considered conservative.

Pacific coastal barrier units currently eligible for inclusion in the System include 195 units comprising approximately 308.7 miles of shoreline and a total of 107,728 acres. The units are estimated to include 29,408 acres of fastland and 78,442 acres of associated aquatic habitats. Due to the increase in the number of units eligible for inclusion in the System since 1985, as well as the increased costs associated with development, the potential Federal savings from inclusion of Pacific coastal barriers in the System could be much higher than those estimated by Miller and Stroup (1989). These savings would be in addition to the $1.262 to $10.105 billion potentially saved from the previous addition

of Atlantic, Gulf, and Great Lakes coastal barriers to the System (Miller and Stroup 1989).

The amount of Federal expenditures in Pacific coastal areas is expected to increase due to mounting population and development pressures. The Pacific coastal population is expected to more than double during the period 1960-2010, adding more than six million persons to the current population base and bringing enormous development pressure to bear on the coast (National Oceanic and Atmospheric Administration 1990). Much of this population growth has already occurred. Increasing tourism will also exacerbate these pressures. In Hawaii alone, the number of tourists visiting the State has increased 44 percent since 1977 (Hawaii Coastal Zone Management Program 1992). Associated with increased development and tourism in coastal barrier areas is the potential for loss of human lives due to storm events and other natural hazards. The Federal Emergency Management Agency assesses the loss of human lives due to natural disasters on a county-wide basis. Therefore, we were unable to determine the loss of lives associated with natural hazards within the coastal zone. However, given the dynamic nature of coastal barriers and the natural hazards which impact these areas, the potential number of lives which might be saved from the devastation of natural hazards if coastal barrier development was not subsidized could be substantial. Examples of losses of lives and property include the following: 222 deaths and nearly $57 million in property damage from six tsunamis in Hawaii since 1946; three deaths and over $240 million in property damage from seven Hawaiian hurricanes since 1950; and $135 million in losses from 1982 to 1983 storms in California (California Coastal Commission 1992a, Hawaii Coastal Zone Management Program 1992). None of these damage estimates incorporate the loss of habitat, living resources, or recreational opportunities.

Over concern that not all Federal agencies were complying with the restrictions and other aspects of the CBRA, the Chairman and Ranking Minority Member, Senate Committee on Environment and Public Works, requested the General Accounting Office (GAO) to determine: (1) the extent of development in certain System units since the CBRA was enacted, (2) the degree to which new Federal financial assistance has been prohibited within the System, (3) the effectiveness of the processes requiring Federal agencies to annually certify that they are in compliance with the CBRA, and (4) the types and impact of Federal regulatory activities within the System (U.S. General Accounting Office 1992).

The GAO found that although the CBRA's prohibitions against new Federal financial expenditures and assistance within the System has slowed, delayed, or stopped development in some System units, significant development has occurred in some of the units. Significant new development occurred in nine of the 34 (26 percent) units reviewed by the GAO since the CBRA was enacted, and additional future development in these and other System units that are attractive or accessible is planned. The majority of this development occurred after October 1, 1983, when the CBRA prohibitions became

fully effective. The remoteness, inaccessibility, or lack of developable land in the other units will likely prevent them from being significantly developed in the future.

Although all agencies must abide by the CBRA prohibitions against providing financial assistance in System units, two of the 10 Federal agencies included in the GAO's review provided new financial assistance within System units. The Federal Emergency Management Agency (FEMA) underwrote national flood insurance for private property owners on System units for which the owners were ineligible. The GAO estimated that FEMA underwrote flood insurance coverage for nine percent of the homeowners in five units at a value of about $12.2 million. This value is an indication of the substantial cost savings the Federal government would receive by not providing financial assistance in hazardous coastal barrier areas. Additionally, the Department of the Air Force granted an easement on land within Eglin Air Force Base in Florida at no cost to a quasi-State agency that wished to construct a bridge from the mainland to a System unit. Based on the CBRA, the GAO determined that the granting of the easement for anything less than fair market value constituted financial assistance. Provision of Federal flood insurance policies and increased accessibility to System units is likely to encourage development in System units.

Development within hazardous coastal areas increases the potential costs to the Federal Government. Although the government's investment and liability in coastal barrier units is kept to a minimum by the CBRA's prohibitions against most new Federal expenditures and financial assistance within the System, the Federal government can still incur substantial costs if major destructive storms hit developed coastal barriers. For example, while the CBRA prohibits Federal loans and grants within System units for restoration of damage to privately owned structures that are not covered by Federal flood insurance, it does allow Federal emergency funds to be used for debris removal, and for temporary food and housing assistance for victims. These costs can be significant as the funding for disaster relief associated with Hurricane Hugo attests. The total funding expended in South Carolina alone for damage associated with Hurricane Hugo was approximately $765 million. Of this amount, the Federal government paid about $410 million for disaster relief while the remaining $355 million of flood insurance payments was funded by National Flood Insurance policyholders through premiums (U.S. Government Accounting Office 1992).

COASTAL MANAGEMENT PROGRAMS AND NATURAL RESOURCE PROTECTION ACTS

The Coastal Zone Management Act of 1972 (CZMA, P.L. 92-583) established a voluntary national program within the Department of Commerce to encourage coastal States to develop and implement coastal zone management plans. The plans are required to define boundaries of the coastal zone, to identify uses of the area to be regulated by

the State, the mechanism for controlling such uses, and to establish broad guidelines for priorities of uses within the coastal zone. Each of the Pacific coastal States with undeveloped coastal barriers have active Coastal Zone Management Agencies.

The CZMA was amended in 1990 to include a new Section 309, Coastal Zone Enhancement Grants Program (Section 309). This section identifies enhancement objectives for the issue areas of wetlands, coastal hazards, public access, marine debris, cumulative and secondary impacts, special area management planning, ocean resources, and government and energy-related facilities siting and activities. By preparing an Assessment and Strategy, each State with a Federally-approved coastal zone management program may apply for grants to develop program changes which support attainment of the national goals. The purpose of the Assessment is to determine whether coastal problems exist within each of the eight Section 309 enhancement areas and, where problems exist, to evaluate their nature, the extent to which they are already being addressed, and their relative importance. Priority needs are determined and a Strategy document is developed to address these needs. Individual State coastal zone management programs (CZMP), coastal protection acts, and the effectiveness of CZMP in protecting coastal areas are outlined below.

California

State coastal management efforts in California are shared by three agencies which oversee the development and conservation of the California coast: the California Coastal Commission (Commission), the San Francisco Bay Conservation and Development Commission (BCDC) and the California State Coastal Conservancy (Conservancy). The Commission has primary responsibility for regulating development along the ocean coast, BCDC has primary responsibility for regulating development in San Francisco Bay, and the non-regulatory Conservancy has primary responsibility to provide public access.

In 1972, California voters passed Proposition 20 which created the California Coastal Zone Conservation Commission and established policies to protect the resources of the California coastal zone. Four years later, the State legislature codified the coastal protection policies of Proposition 20 in the California Coastal Act of 1976 (Coastal Act). The Coastal Act, among other things, established the Commission as a permanent State agency with mandates to protect and enhance public access, recreational wetlands, visual resources, agriculture, commercial and industrial activities, and environmentally sensitive habitats within the coastal zone. In 1977, the Federal government approved the California Coastal Management Program (CCMP), allowing the Commission, BCDC, and the Conservancy to qualify for funding under the Coastal Zone Management Act of 1972.

The Commission's jurisdiction extends from the Oregon to the Mexico borders, excluding San Francisco Bay (which is under the jurisdiction of the BCDC), and extends inland as much as five miles from tidally influenced bodies of water. The Commission undertakes

its responsibilities through planning, permitting, and other non-regulatory mechanisms, and relies on cooperation between Federal, State, and local agencies. One mechanism for Federal cooperation is provided through Federal consistency review which allows the Commission and the BCDC to evaluate projects conducted or funded by the Federal government, as well as private sector projects which require Federal permits.

Along with Federal consistency review authority, the Commission's primary mechanism for implementing the CCMP is the coastal development permit program. Under this program, any development in the coastal zone may require a coastal development permit issued either directly by the Commission, or by a local government to which this authority has been delegated. This delegation of authority represents a unique State and local government partnership through which State-wide policies for conservation and use of coastal resources are reflected in local coastal planning and development decisions. Local governments, with assistance from the Commission, also develop Local Coastal Programs (LCP) which consist of a land use plan, zoning ordinances, zoning district maps, and other implementing actions, all of which should reflect the policies of the Coastal Act.

The Commission maintains permit jurisdiction over some lands, including the immediate shoreline (tidelands, submerged lands, and some public trust lands). Permit authority is not delegated to the local government in these areas. This authority, along with other on-going responsibilities, ensures the meeting of State-wide concerns and policies for the use and management of coastal resources.

The California State Coastal Conservancy was created in 1976 to develop and implement programs to protect, restore, and enhance resources in the coastal zone and San Francisco Bay, in keeping with the policies of the Coastal Act. The Conservancy has authority to acquire land, design and implement resource restoration and enhancement programs, and resolve land use conflicts. This enables it to complement the regulatory activities of its sister agencies. Accordingly, the Conservancy collaborates to implement public access and mitigation requirements arising from the two regulatory agencies' permit conditions.

Other State agencies hold lands within the coastal zone, including, but not limited to, the Department of Parks and Recreation, State Lands Commission, and Caltrans. These agencies all follow their own legislative mandates in the administration of their lands. As with other lands, development activities by State agencies on lands within the coastal zone require review through a coastal development permit.

The California Coastal Commission identified a number of coastal problems during the development of its Assessment for the Section 309 Program (California Coastal Commission 1992a). The Commission noted that most, if not all, of California's priority coastal zone management needs are related to the cumulative impacts of growth and development. Unprecedented population growth in recent decades has placed essentially

all of the State's coastal resources under increased environmental stress. The combined effect of numerous incremental development activities and decisions is a root cause of the depletion of coastal resources. The Assessment noted that the Commission's ability to assess and respond to this incremental loss of resources is inadequate and no viable mechanism currently exists by which the Commission could undertake a comprehensive approach to cumulative impacts management (California Coastal Commission 1992b).

Due to inconsistent and incremental coastal development regulatory practices, coastal wetland habitats are, and continue to be, degraded. Although the Coastal Act clearly mandates the preservation and enhancement of California's coastal zone wetlands, the problems associated with population growth, continuing development pressures, scientific uncertainty, insufficient funding and expertise, and political inconsistencies in protecting wetland systems at the State and National level, has made an integrated, comprehensive wetland management and enhancement program an elusive goal.

Three major findings arose from the assessment of coastal hazards: (1) CCMP policies and necessary data concerning "hazard avoidance" (i.e., directing development and redevelopment away from hazardous coastal areas) need to be more comprehensive; (2) significant alteration of the natural protective functions of the shoreline occurs because CCMP policies concerning shoreline protective devices and setback requirements are too general and inconsistent among LCP jurisdictions; and (3) current implementation of CCMP hazards policies both fail to discourage excessive grading and neglect other significant coastal hazards such as wildfires (California Coastal Commission 1992b).

A number of problems have been identified regarding the inability of the CCMP to direct development and redevelopment away from hazardous coastal areas. The Coastal Act allows the rebuilding of structures in the same location without a coastal development permit if the structure was destroyed by a disaster. Since many coastal hazards are location specific, allowing redevelopment in the same location, rather than on a more landward location, may be exposing the structure to continued hazards which results in continued rebuilding. An example of this is the repeated destruction and reconstruction of seawalls on properties managed by the Department of Parks and Recreation (DPR). Between 1978 and 1983, winter storms caused over $5 million in losses for debris removal and facilities replacement to park properties. In 1984, the DPR developed a Coastal Erosion Policy which was intended to avoid construction of new permanent facilities in areas subject to coastal erosion and to promote the use of expendable or movable facilities in areas subject to erosion. However, even when this policy was in place, the DPR rebuilt a timber seawall for the seventh time, with little design modification from the previously destroyed wall. Further problems arise due to the lack of standard criteria for delineating high hazard areas, the lack of policies regarding the development of accessways or structures in high hazard areas, and the lack of policies to deal with permitted structures which have used up their setback allowances or which continue to be occupied past their economic life. Allowance of shoreline protection for

existing structures will lead eventually to a complete armoring of the coast wherever development is located along the coastline. Shoreline armoring in turn leads to the eventual erosion of the coast and the destruction of protective functions of natural shoreline features. These problems become more serious when one considers that 86 percent of the California coast is experiencing irreversible erosion (California Coastal Commission 1992a).

Inconsistencies among Local Coastal Programs (LCP) has adversely affected the coastal zone. Different areas emphasize different portions of the Coastal Act and the standards of review vary among LCPs. Development which would never be considered in one LCP area, due to slope steepness, intensity of use, or change in regional character, for example, may be readily approved in another LCP area. Shoreline protection is also reviewed differently between LCP areas. Variations in allowable uses, intensity of development, and the economic life of the structure all influence the review the different LCP areas undertake for development and Coastal Act consistency.

Excessive grading has become a major concern on the California coast which the CCMP has also failed to discourage. During the past 10 years, the Commission has reviewed increasing numbers of projects proposed for areas with significant development constraints, such as steep terrain, fault zones, and landslides. The typical development approach to these hazards has been to reform the terrain to accommodate flatland development. In 1991, the Commission approved development projects for a shopping complex and a 55 lot subdivision which proposed a total of 7,219,000 cubic yards of grading (California Coastal Commission 1992a). This grading can lead to significant alteration of the natural landforms, increased erosion, runoff and nonpoint source pollution, destruction of small streams, and loss of natural vegetation and habitats. In addition to approval of grading projects, the growing number of grading violations is of concern. These activities generally involve little, if any, erosion control and do not take into consideration the environmental effects of the actions. The combination of approved grading projects and grading violations has resulted in enormous changes to coastal landforms and character, water quality, and habitat.

Hawaii

Hawaii has a number of laws which govern the management and protection of the coastal zone (Holthus 1988). Prior to the Federal Coastal Zone Management Act (CZMA), Hawaii passed the Shoreline Setback Law (Chapter 205-32, HRS) in 1970. This legislation delineated a restricted zone, generally 40 feet from the upper wash of waves in which construction or other related activities are prohibited except by a special approval procedure. The Shoreline Setback area is considered an area of particular concern because of its importance to the economy and environment of the State. Following passage of the Federal CZMA, Hawaii State legislation (Act 614, SLH 1973) was enacted authorizing the State Department of Planning and Economic Development to prepare the

State's Coastal Zone Management Program (CZMP) which was passed in 1977 (Act 188, SLH 1977). In the meantime, passage of the Hawaii Shoreline Protection Act of 1975 (Chapter 205A, HRS) established a Special Management Area (SMA) extending inland from the shoreline vegetation line for at least 100 yards. The Act established guidelines for the management and protection of resources in the SMAs.

The Hawaii CZMP encompasses the entire land area of each island with the exception of State forest preserves and Federal lands. The Act outlines specific objectives and policies as topics of particular concern, including: (1) provision of recreation opportunities, (2) protection and restoration of historic resources, (3) improvement of scenic and open space areas, (4) protection of coastal ecosystems, (5) provision for coastal-dependent economic uses, (6) reduction of coastal hazards, and (7) improvement of the review process involving development activities, including permit coordination and opportunities for public participation. These basic objectives and policies are reinforced by existing specific State and county statutes.

A variety of State and county agencies are involved in implementing and administering the objectives and policies of Hawaii's CZMP. The Department of Planning and Economic Development (DPED) is the lead agency implementing Hawaii's CZMP. Its responsibilities include handling fiscal and administrative matters, coordinating the organizational network, and reviewing State and county agency compliance with the program. The DPED is also responsible for determining instream flow requirements, but the Division of Land and Water Development, in the Department of Land and Natural Resources (DLNR), is actually setting standards for instream water quality. The Land Use Commission (LUC) is responsible for classifying all lands into the four land-use districts, administering requests for district boundary changes and reclassification, and approving special use permits in agricultural and rural districts.

The DLNR is the State's principal agency for managing State-owned lands and regulating uses in conservation district lands. It manages water development, commercial fishing, forestry, wildlife, fish and other aquatic resources, open space, and mineral resources. The DLNR also administers the Natural Area Reserve System (NARS, Chapter 195, HRS) and the Marine Life Conservation District Program (MLCD, Chapter 190, HRS), and prepares the State Comprehensive Outdoor Recreation Plan. The NARS was established to protect unique geological, volcanic, and other natural sites with distinctive marine, terrestrial, floral, and faunal features from degradation due to human activities. A NARS commission recommends areas for inclusion and proposes rules regarding their use, control, and protection for action by the Board of Land and Natural Resources. The MLCD Program was set up to preserve unique areas of Hawaii's marine environment. These districts are designated by DLNR and protected by regulations prohibiting certain activities and controlling allowable uses. The DLNR also designates Marine Fishery Conservation Areas in which there are gear, season, or location restrictions on certain kinds of fishing to allow stock replenishment and prevent conflicts in use.

The Department of Health (DOH) is the primary implementer of pollution controls, relating the CZMP through management of air and water quality, solid wastes, public health, and sewage treatment. The DOH also manages the National Pollution Discharge Elimination System permit program of the Clean Water Act of 1977, and thus regulates nearshore water quality.

The Office of Environmental Quality Control coordinates and directs State agencies in matters concerning environmental quality and coordinates the writing of State Environmental Impact Statements. The Department of Transportation regulates activities in the shore waters, including boating and recreation, and maintains, regulates, and issues licenses and permits for the construction of harbors and related facilities. The Department of Agriculture carries out programs to conserve, develop, and utilize the State's Agricultural resources, many aspects of which interact with CZMP objectives and policies.

In addition to the State agencies, the University of Hawaii provides research, technical assistance, and educational programs which interrelate with the State CZMP. These activities are conducted primarily through five components of the University: the Curriculum Research and Development Group in the College of Education, the Hawaii Institute of Marine Biology, the Environmental Center, the Water Resources Research Center, and the Sea Grant Program.

The Counties of Hawaii, Maui, Kauai, and the City and County of Honolulu, also have numerous responsibilities in the management of the Hawaii coastal zone. The county planning departments determine the SMA boundaries and directly administer land and water use controls through the issuance of development permits consistent with State CZMP objectives and policies. State-mandated county regulatory programs dealing with a variety of issues and important planning and zoning activities are also under county jurisdiction.

Hawaii's Assessment for the Coastal Enhancement Grants Program identified the preservation and restoration of the protective functions of natural shoreline features such as reefs, beaches, and dunes as a high priority (Hawaii Coastal Zone Management Program 1992). Development in coastal wetland areas has caused major concern in Hawaii in recent years. Some projects which have impacted wetlands have provided mitigation, while others have destroyed valuable resources. Wetland loss is of particular importance on the Hawaiian Islands since most wetlands are less than five acres in size which limits their protection under State and Federal water quality statutes. Additionally, many of the larger, and most biologically-important wetlands, are still not protected from permitted discharges. Hawaii has no State policies or regulations for the restoration of formerly existing wetlands. In cases where the extent of degradation has been severe, the economic costs of restoration would likely be prohibitive. Therefore, the State's current approach to wetland loss is to seek opportunities for preserving existing wetlands through

acquisition or by management as protected areas (Hawaii Coastal Zone Management Program 1992).

Other habitats are also at risk from degradation or destruction due to development without adequate safeguards for their protection. Coral reefs are indirectly protected through various State and county permitting programs but no specific reef management programs exist. Given the importance of reef ecosystems for fisheries, recreation, and hazard reduction, the Hawaii CZMP (1992) notes that specific management measures may be warranted. Even areas possessing sensitive marine resources and designated Marine Life Conservation Districts (e.g., Molokini Shoal on Maui and Hanauma Bay on Oahu) are suffering from the cumulative and secondary impacts of overuse. These areas have become popular tourist destinations which has led to resource and water quality degradation.

The Hawaii CZMP (1992) also identified the prevention and minimization of threats to life and property from episodic and chronic coastal hazards as a priority. The coastal hazards object of the Hawaii CZMP is to reduce hazard to life and property from tsunamis, storm waves, stream flooding, erosion, and subsidence. Several problems related to coastal hazards were identified. For example, other than the general requirements of the shoreline setback provisions and the National Flood Insurance Program, Hawaii lacks specific policies regarding rebuilding storm-damaged structures away from hazard areas. There is also no specific restriction on the use of public funds for projects which allow or encourage development in high hazard areas. Without these policies or restrictions, development will continue to occur in high hazard areas at the taxpayer's expense. The Assessment recommended that the State acquire some of the shallow shoreline lots which are threatened by erosion. By acquiring these parcels, development would be prevented in hazard areas, obviating the need for future construction of shore protection structures. This practice would preserve the protective function of beaches and dunes on the properties by retaining the natural beach processes. Additional benefits would occur if these purchased parcels were used as public parks or access areas.

Oregon

As part of Oregon's State-wide program for coordinated land use planning, the Oregon Coastal Management Program (OCMP) balances the needs for long-term growth, development, and protection of the State's coastal resources. The program is based primarily on the Oregon Land Use Planning Act (ORS 197) and relies on a partnership among the public, local governments, and State and Federal agencies to resolve general and often competing interests through land use plans and implementing measures. The OCMP is based on three separate but coordinated sets of planning and regulatory authorities: State-wide planning goals, State-approved comprehensive plans, and specified statutory authorities of various State agencies.

The State-wide planning goals set standards for the management of land and water uses, establish priorities for the use of various resources, and define informational needs and inventory requirements for sound planning. The goals express the State, regional, and national interests in land use. Four of the goals set specific standards for coastal resource planning for estuarine resources, coastal shorelands, beaches and dunes, and ocean resources. These goals require that the natural resources and values associated with these areas be protected, that development be planned to minimize the threat from natural hazards to life and property, and that appropriate areas and facilities be reserved for water-dependent uses and activities.

Compliance with the State-wide planning goals and coordination of the administration of land use planning activities are the principal responsibilities of the Department of Land Conservation and Development and the Land Conservation and Development Commission (LCDC). The primary vehicle for implementing the goals are comprehensive plans developed and administered by coastal cities and counties. Comprehensive plans must be fully coordinated with the needs and policies of State and Federal agencies, special districts, and the public. Once approved by LCDC, a plan serves at the State's standard for all land use decisions within the geographic area it covers.

Several State laws for management of coastal resources are also included in the OCMP. These laws include the Removal-Fill Law (ORS 541.605 et seq.) which regulates alterations to estuaries, lakes and other waterways, and the Oregon Beach Bill (ORS 390) which regulates uses and alterations along the ocean shore. The Oregon Beach Bill also established public ownership of the intertidal area and a public easement to the "dry land" area below the vegetation line. Geographic areas of particular concern also receive special State regulation. Several State agencies have authorities particularly related to coastal resource management including the Division of State Lands which has ownership and management responsibilities for submerged and submersible lands and the Parks Division of the Department of Transportation which manages the perpetual public easement to ocean shores and beaches established through the Beach Bill. Additional coastal resource management agencies include the Health Division and the Departments of Water Resources, State Forestry, Environmental Quality, Energy, Fish and Wildlife, and Agriculture.

The objective of the OCMP is to develop, implement, and continuously improve a management program that will preserve, conserve, develop, and restore the natural resources of the coastal zone. The program attempts to create and maintain a balance between conservation and development, and between conflicting private and public interests. This balance is intended to assure the greatest benefits to current and succeeding generations of Oregonians.

Although a variety of State laws exist to protect coastal areas, a study evaluating the implementation effectiveness of beachfront protection and related land use policies in

Oregon suggests that policies designed to mitigate hazards and protect the beaches are not working well (Good 1992). The study found that the demand for beachfront shoreline protection structures is driven more by land use decisions than by erosion hazards despite the establishment of the Beach Law in 1987. As a result, sensitive shoreline areas are suffering from inadequate protection. The study concluded that Oregon's ocean shore protection management regime needs an overhaul to ensure the long-term viability of the coastal zone.

In the Assessment for the Section 309 Program (Oregon Coastal Management Program 1992), the OCMP listed the improved protection of sensitive resources threatened by development pressure, particularly lands along the ocean shore, around lakes and estuaries, and along stream corridors, as a priority program enhancement. This need was identified due to the increasing development pressures in the coastal zone.

The Assessment noted that although development in the coastal zone is constrained by a variety of hazards, coastal property values have increased dramatically. The increasing value of real estate along the oceanfront, around estuaries and lakes, and on forested coastal terraces makes the development of areas previously considered too expensive or dangerous to develop more likely. Resources affected by this conversion include wetlands, beach cliffs, beach sand supply, a variety of plant and animal species, and coastal watershed water quality. As the least hazardous sites are developed, development is proposed for increasingly hazardous sites with attendant increased public and private costs and little regard for the unique values of coastal shorelands.

The Assessment report also noted that "the existing OCMP program only allows development in hazardous areas if the development can be shown to be adequately protected from the hazard. There are growing concerns that existing plans and ordinances do not adequately assure that appropriate safeguards are in fact in place. At the same time, the State has gathered new information which suggests that hazards to oceanfront development from flooding, erosion, and earthquakes may be greater than previously believed. As a consequence, the State needs to reconsider its policies for development, particularly in hazardous areas" (Oregon Coastal Management Program 1992). The report also notes that Oregon's land use management policies, as currently implemented, may have actually increased the proliferation of engineered shore protection structures which may lead to further coastal erosion.

Local governments have the authority to approve or deny proposed developments in their jurisdiction. However, Oregon's coastal communities tend to be small and are overwhelmed by the sheer numbers and scale of development proposals. Hazards associated with coastal development are often not adequately identified, assessed, or addressed due to a lack of review policies and standards. Local governments are also frustrated with the vagueness of policies, prohibitive costs for acquisition of the required technical expertise, and the lack of local enforcement or inadequacy of enforceable

ordinances. Additionally, local governments have no standards or procedures to ensure that hazard avoidance is the first option and structural solutions the last resort for new developments. As a result, individual developments are routinely approved with inappropriate protective structures. These limitations inhibit the ability of local governments to evaluate development proposals and assess their cumulative impacts (Oregon Coastal Management Program 1992).

Washington

The Department of Ecology (DOE) manages the State's coastal zone responsibilities primarily through the Shoreline Management Act of 1971 (SMA; RCW Chapter 90.58) (Shipman 1991). The SMA emphasizes the preservation of natural shoreline values and public uses of the shoreline. Although the law provides a number of mechanisms for managing activities on coastal barriers, these mechanisms are generally only guidelines. The ultimate responsibility for regulation and the issuing of permits in coastal areas is given to local jurisdictions. However, the DOE may appeal local government decisions it finds inconsistent with the local Shoreline Master Program to the Shoreline Hearings Board.

The State's public lands, including State-owned tidelands and shorelands, are managed by the Department of Natural Resources (DNR). These lands may be leased for port development, boat moorage, shellfish harvesting and other activities which are regulated by the DNR. The DNR is required to manage State-owned lands for the public benefit and must conform with the SMA in identifying appropriate uses. State-owned tidelands of the ocean coast from Cape Flattery to the Columbia River were placed under the jurisdiction of the Parks and Recreation Commission upon passage of the Seashore Conservation Act (RCW 43.51). The tidelands are reserved for public recreation and benefit and only activities consistent with public recreational use are permitted.

The State has enacted a number of laws and regulations pertaining to coastal areas: the Growth Management Act, the Seashore Conservation Act (RCW 43.51), the State Hydraulics Code (RCW 75.20), and the State Environmental Policy Act (RCW 43.21C, WAC 197-11). The comprehensive Growth Management Act (GMA) which was recently passed requires the identification and mapping of critical areas including wetlands, geologically hazardous areas, and flood zones. The GMA is similar to the SMA in that it establishes guidelines and provides oversight, but leaves the development of comprehensive coastal plans to the local communities.

Under the State Hydraulics Code, all activities which significantly impact the beds of State waters require a Hydraulics Approval Permit from the Department of Fisheries or the Department of Wildlife. Activities can only be restricted based on demonstrated harm to fish life. Specific criteria are set forth which set standards for bulkheads, marinas and breakwaters, and dredging. With respect to coastal barriers, the application

of activities is limited to tidelands and submerged lands, except to the degree they affect the locations of bulkheads for fastland development. The State Environmental Policy Act (SEPA) also helps guide coastal activities by requiring full disclosure and consideration of the adverse economic impacts of a project. However, SEPA has no regulatory authority and it is up to the discretion of local governments to use the advice of the DOE and other agencies. Possible mitigation strategies must also be considered under SEPA. SEPA can be applied to any non-exempt shoreline project, including subdivisions, construction activities, and shoreline modifications.

In addition to State regulations, local governments also regulate activity in the coastal zone. Each local jurisdiction must develop a Shoreline Master Program under the SMA to establish guidelines for shoreline uses and activities. Local jurisdictions also develop comprehensive plans which include zoning designations that are generally intended to limit development in certain areas or direct certain types of development toward more appropriate areas. Communities also establish criteria to meet building codes and health codes.

Several Tribes have reservations along the Washington coastline. While Federal laws apply in these areas, the State does not administer the responsibilities of these laws. State authority on fee lands within reservations is unclear. Federal actions on reservations may be subject to Federal consistency requirements with the State coastal zone management program.

In its Assessment report for the Section 309 Program, the State of Washington identified the adverse effects of growth upon the environment as one of its greatest challenges (Washington Department of Ecology 1992). Rapid growth in the coastal region has resulted in a wide range of secondary and cumulative impacts on coastal resources. These impacts include drainage increases, sedimentation, nonpoint source pollution, and habitat encroachment as well as the loss of wetland functions and values. Local SMPs could potentially be amended and improved to specifically address the cumulative impacts of growth on coastal shorelines and wetland resources.

In considering the needs to be addressed in managing coastal growth, the State noted that single-family residences are currently exempt under the SMA from the regular permit process for shoreline developments. This exemption has allowed the proliferation of hardened shoreline because such a large percentage of the shoreline is zoned for single-family residential use, particularly within the Puget Sound area. Institutional or nonstructural approaches to erosion, such as setbacks, have received little emphasis. The State is concerned that wide-spread shoreline armoring will reduce sediment input to shoreline systems. Reduced sediment supplies will lead to a transformation of sand beaches to cobble beaches, inducing aggravated shoreline erosion, beach erosion, and habitat degradation. The proliferation of hardened shoreline is likely to continue without better documentation of the consequences or better information about alternatives.

DESCRIPTION OF AREAS MAPPED

Based on the definition of coastal barriers and the established mapping criteria, the U.S. Fish and Wildlife Service has mapped all undeveloped coastal barriers bordering the Pacific Ocean. Public notification regarding the availability of draft maps of areas under consideration for inclusion in the System for each of the Pacific coast States was listed in the Federal Register in 1992 (Vol. 57, Nos. 79, 104, 130, and 158). Summaries of public comments received on the potential coastal barrier units, and subsequent changes to the units, are provided in Appendix A. Appendices B through E list the undeveloped coastal barrier units which have been identified and mapped for each of the four Pacific coastal States. Shoreline miles were determined to the nearest tenth of a mile and acreages were determined to the nearest acre. These appendices are provided to show the actual number of units which are currently classified as undeveloped coastal barriers and are eligible for inclusion in the System.

A total of 195 coastal barrier units have been mapped with a total area of 107,728 acres and 308.7 miles of shoreline (Figures 1, 2, 3, and 4). Of this acreage, approximately 29,408 acres consist of unprotected fastland and 78,442 acres consist of wetlands and other associated aquatic habitats. Fastland consists of the non-wetland area above the mean high tide line. Fastland makes up a relatively small proportion of the coastal barrier unit acreage accounting for 28 percent of the California acreage, 14 percent for Hawaii, 29 percent for Oregon, and 27 percent for Washington.

Coastal barrier ownership is illustrated in Table 3. This table represents ownership of units solely by Federal, State, local, or private interests as well as the number of units with mixed ownership. Mixed ownership is divided into units consisting of a mixture of public ownership (e.g., Federal and State lands) or a mixture of public and private lands. On units with mixed ownership, State records were used to estimate the overall percentage of public and private ownership. Private ownership accounts for 28 percent of the total California acreage, and 49 percent, 7 percent, and 16 percent of the Hawaii, Oregon, and Washington total acreage, respectively. The percentage of private ownership on Washington units is conservative, since the percentage of private ownership on four units with mixed ownership was unknown. Overall, private ownership comprises approximately 18 percent of the total acreage among all potential Pacific coastal barrier units.

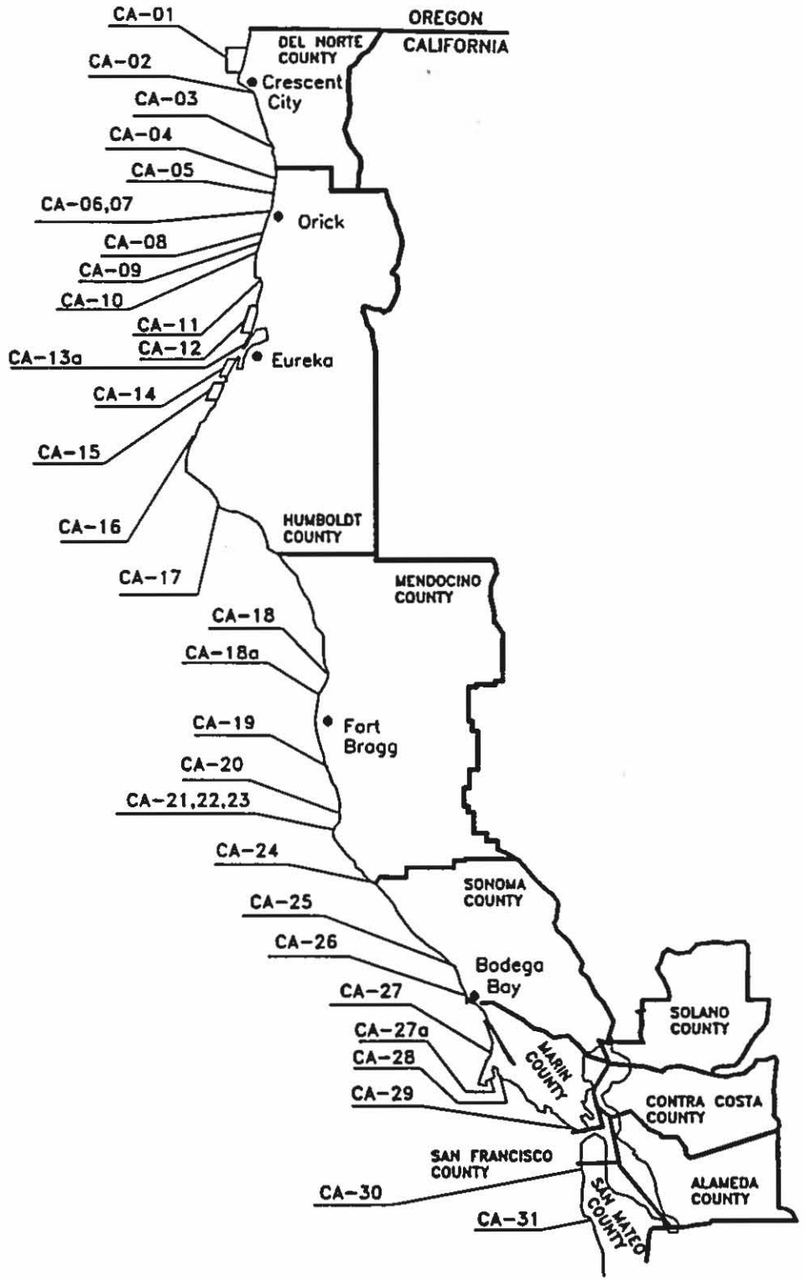
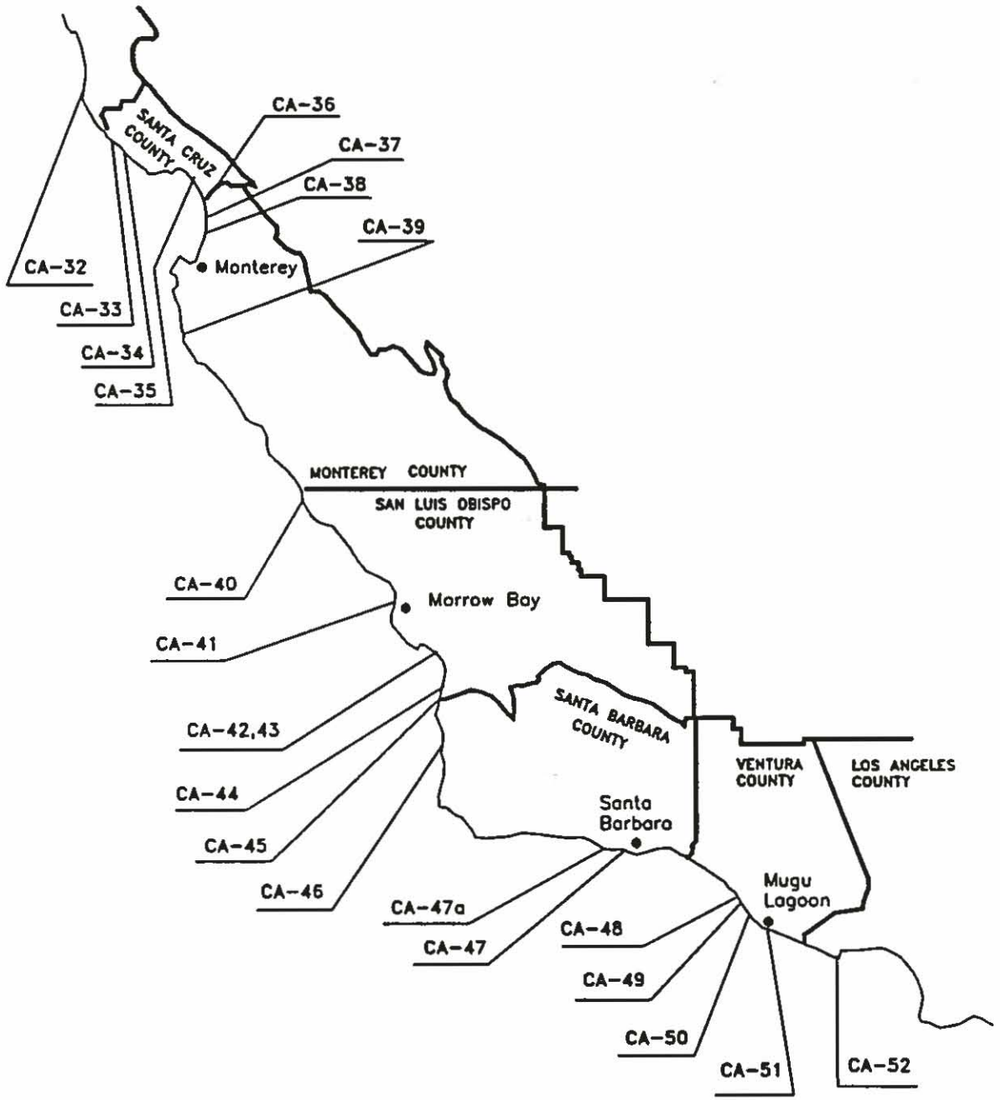


Figure 1. General locations of potential undeveloped coastal barriers in California. NOTE: No barriers are identified using #13 or 58.



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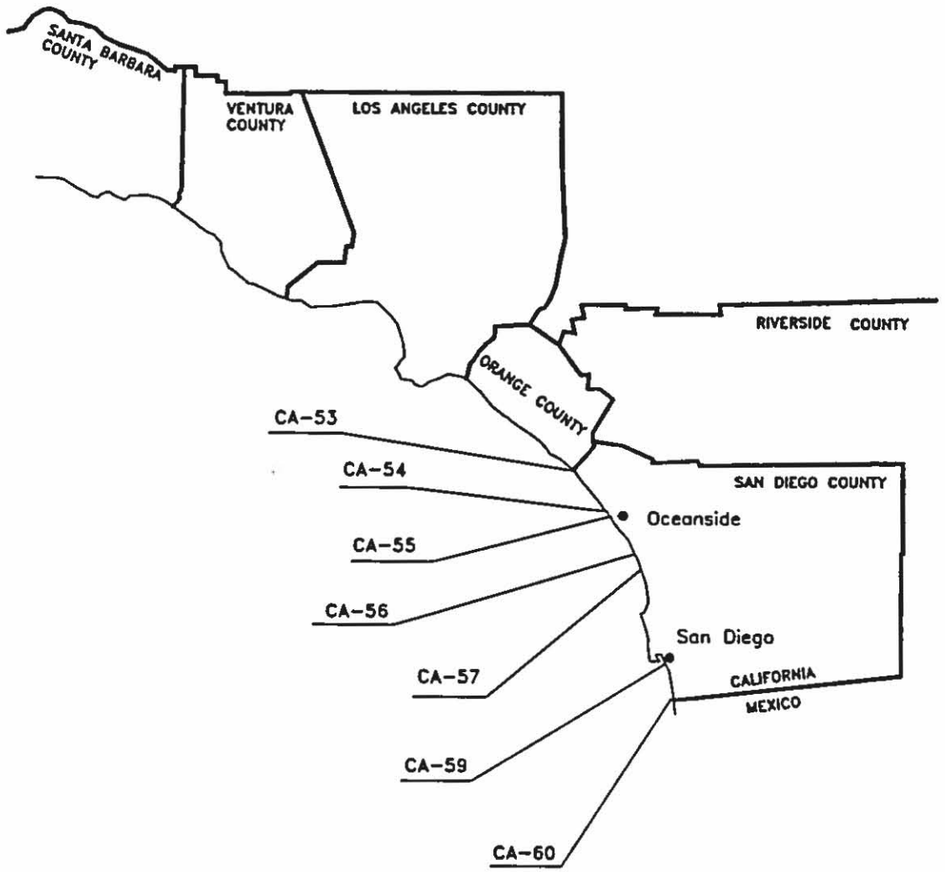

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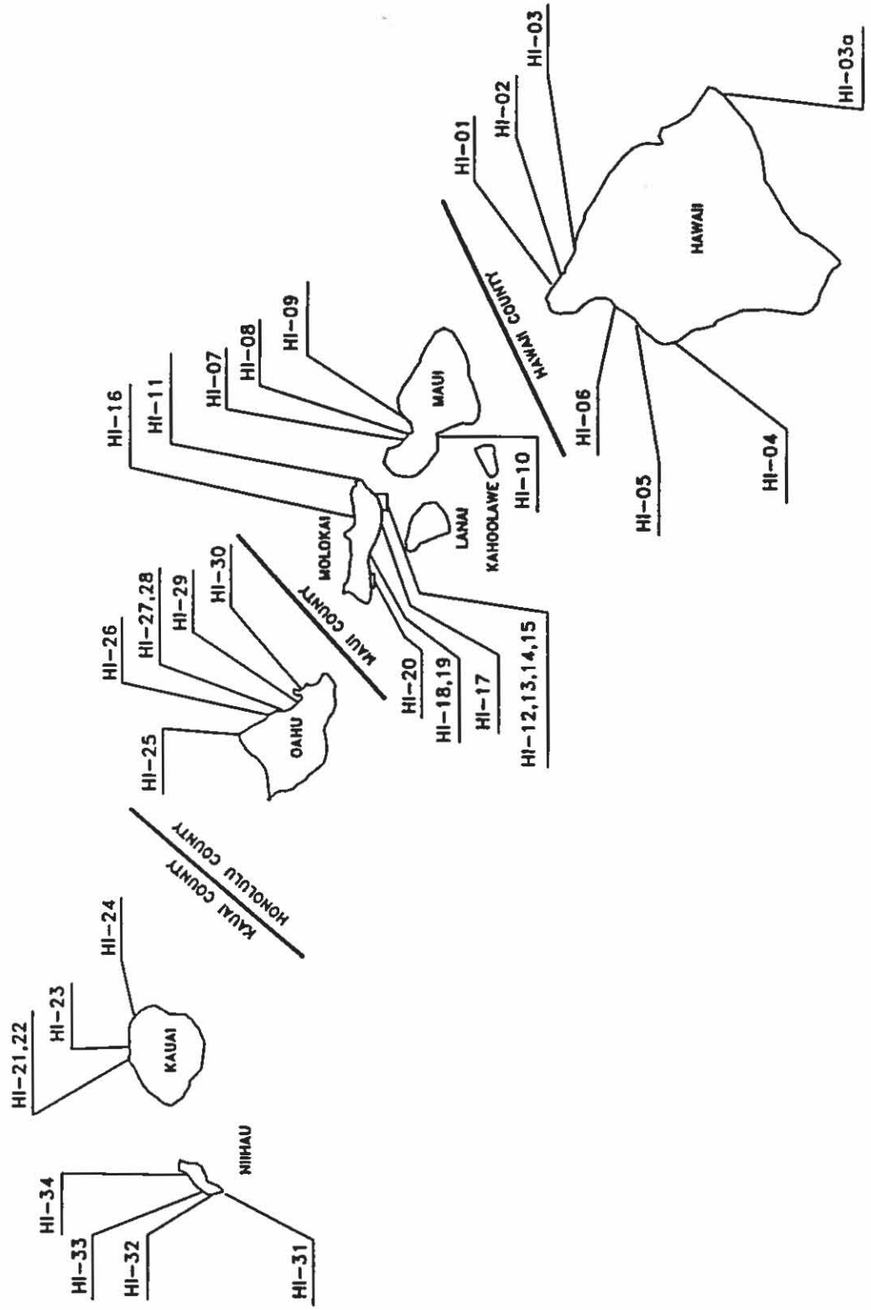

Figure 2. General locations of potential undeveloped coastal barriers in Hawaii.

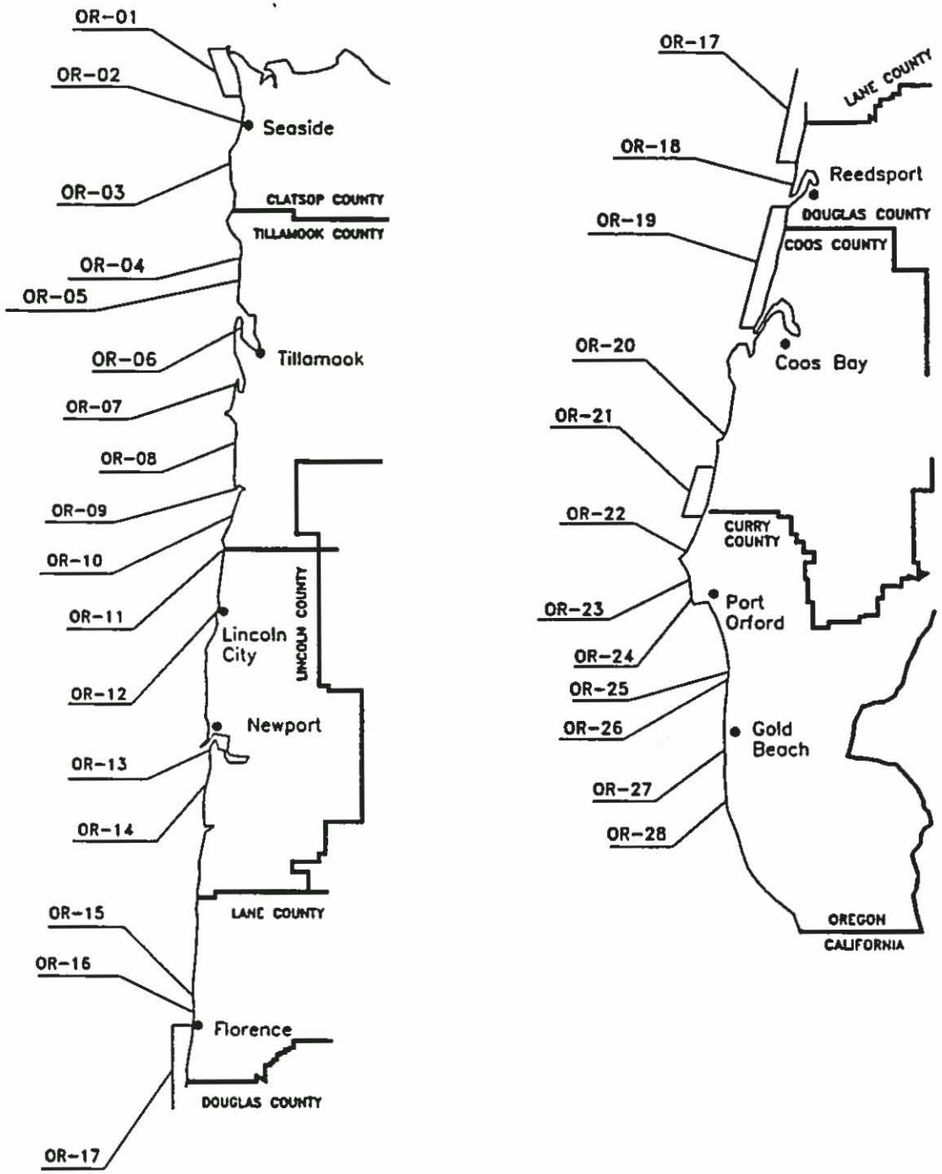

Figure 3. General locations of potential undeveloped coastal barriers in Oregon.

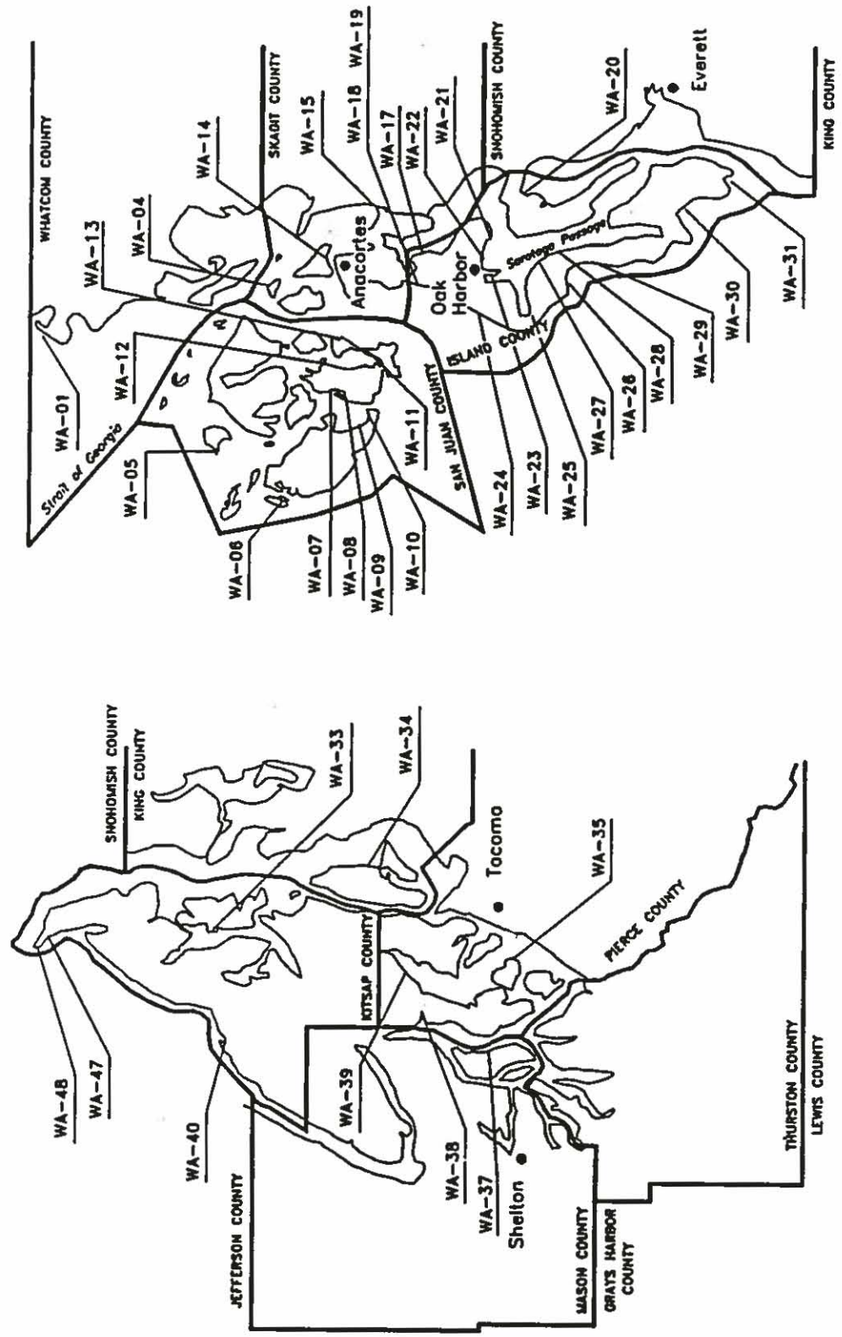

Figure 4. General locations of potential undeveloped coastal barriers in Washington. NOTE: No barriers are identified using #02, 03, 16, 32, 36, 45, 59, 64, 65, 66, 67, 68.

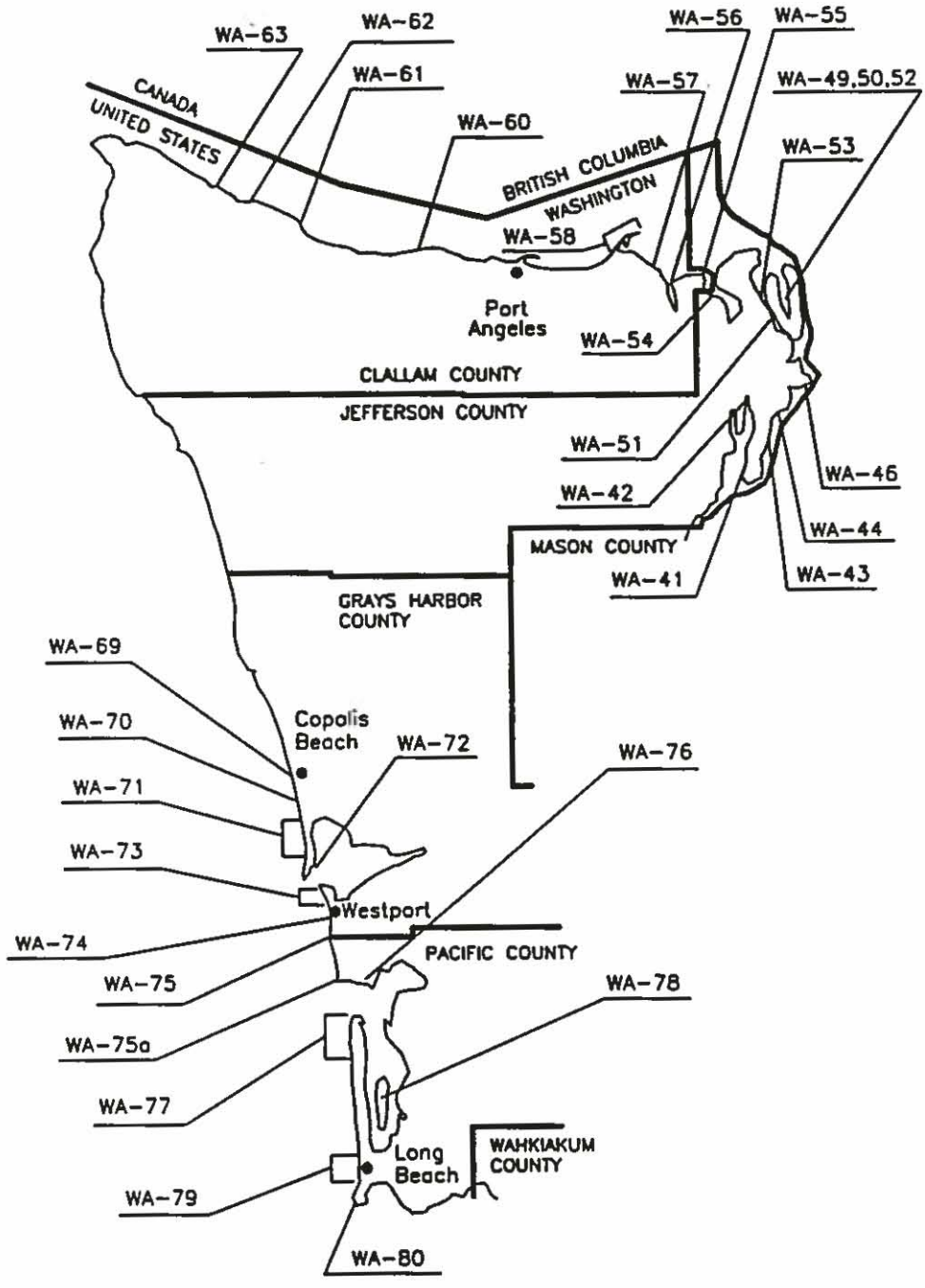

Figure 4. General locations of potential undeveloped coastal barriers in Washington. NOTE: No barriers are identified using #02, 03, 16, 32, 36, 45, 59, 64, 65, 66, 67, 68.

Table 3. Ownership of potential Pacific coastal barrier units.

	State (no. units/acreage)				
Ownership	California	Hawaii	Oregon	Washington	TOTAL
Federal	9 (6,551)	2 (458)	--- ---	10 (1,208)	21 (8,217)
State	17 (2,719)	1 (231)	7 (7,497)	10 (3,281)	35 (13,728)
Local	3 (216)	--- ---	--- ---	2 (293)	5 (509)
Private	7 (621)	16 (1,457)	3 (403)	35 (2,373)	61 (4,854)
Mixed (Public)	6 (3,131)	2 (196)	4 (13,549)	3 (5,955)	15 (22,831)
Mixed (Public/Private)	19 (23,231)	14 (2,952)	14 (24,578)	10 (6,069)	57 (56,830)
Unknown	1 (759)	--- ---	--- ---	--- ---	1 (759)
TOTAL UNITS:	62	35	28	70	195
TOTAL ACRES:	37,228	5,294	46,027	19,179	107,728

The U.S. Fish and Wildlife Service also identified and mapped units which occurred either partially or wholly on Tribal lands. However, these units have not been included in the above summary. Neither the CBRA nor the CBIA provide guidance regarding the inclusion of Tribal lands in the System. Recognizing the sovereignty of the Native American nations, the DOI intends to coordinate with each of the affected Tribes to discuss the implications of the CBIA and to determine their interest in including Tribal lands in the System.

Following public review of this study and the accompanying maps, the Secretary of the Interior will submit to the Committee on Merchant Marine and Fisheries of the House of Representatives and to the Committee on Environment and Public Works of the Senate, the study and maps identifying the boundaries of those undeveloped coastal barriers

considered appropriate for inclusion in the System together with the comments and recommendations of the appropriate Governors. Based on this information, Congress will decide which coastal barrier units will be included in the System. The DOI will also submit to Congress the recommendations of the Tribes either as part of the final study recommendations or at a later date following appropriate coordination.

PROPOSED RECOMMENDATIONS

Coastal barriers are unique landforms which provide protection for diverse aquatic habitats and natural resources and serve as the mainland's first line of defense against the impacts of severe coastal storms and erosion. Congress recognized the unique role coastal barriers play in providing these functions when it passed the Coastal Barrier Resources Act (CBRA) of 1982. The purpose of this Act was to minimize the loss of human life, wasteful expenditure of Federal revenues, and the damage to fish, wildlife, and other natural resources associated with development of coastal barriers. These objectives were accomplished by restricting future Federal expenditures and financial assistance which have the effect of encouraging development of coastal barriers, by establishing a Coastal Barrier Resources System, and by considering the means and measures by which the long-term conservation of the fish, wildlife, and other natural resources associated with coastal barriers may be achieved. Congress further endorsed the protection of coastal barriers, and signified that the System is providing valuable protection to coastal resources, with the passage of the Coastal Barrier Improvement Act (CBIA) of 1990. Although the CBRA only applied to barriers along the Atlantic and Gulf of Mexico Coasts, the CBIA allowed for the possible inclusion of Pacific coastal barriers in the System.

Although Pacific coastal barriers differ in form from their Atlantic and Gulf of Mexico counterparts, they are subject to similar development and population pressures and also provide important ecological functions. Pacific coastal barriers are also subject to a variety of coastal hazards unique to the Pacific. These hazards include volcanism, subduction zone earthquakes and tsunamis, El Nino Southern Oscillations, and storms of varying origin which impact the coastline along fronts of several hundred miles.

During recent decades, the Pacific coast has been subject to unprecedented human population growth and massive urban coastline development which has resulted in dramatic declines in its living resources and the large-scale loss and degradation of essential coastal and estuarine habitats. Development on coastal barriers can interfere with the natural movement of these sandy, unstable land masses resulting in erosion and loss of fish and wildlife habitat. Development can also destroy the barrier's ability to provide maximum protection to populated inland areas from natural coastal hazards such as tsunamis and severe storms. As a result of development on hazardous coastal barriers, the Federal government may ultimately pay millions of dollars to clear away storm debris and provide temporary food and shelter to residents displaced by the storms - expenditures not prohibited by the CBRA. Subsidization of development in these hazard prone areas may lead to additional loss of life during coastal storms, earthquakes, and other natural hazards.

Expansion of the existing System to include all the eligible Pacific coastal barriers could conservatively lead to direct savings to the Federal Government of between $603 million

to $708 million or more over a 20 year period. These potential savings represent Federal funds which might otherwise be spent under current Federal programs for the major capital costs of urban infrastructure, disaster relief, flood insurance subsidies, and shoreline protection associated with coastal barrier development (Miller and Stroup 1989). These costs only hint at the size of potential Federal subsidization if the coastal barriers were developed.

Although the CBRA has had an impact on discouraging development in some System units, development has and will continue to occur in some attractive, easily accessible units. A Government Accounting Office report on coastal barriers noted that development has occurred in some System units and development is likely to continue without stronger protective measures (U.S. Government Accounting Office 1992). While the availability of accessible coastal land is limited, populations of coastal areas are expected to increase by almost 60 percent nation-wide between the years 1960 and 2010 (National Oceanic and Atmospheric Administration 1990). This population increase will further spur market demand, providing an incentive for developers, owners, and investors to assume the risks associated with owning and building in these storm-prone areas. Stronger protective measures may be needed if further development is to be discouraged in hazardous areas.

Although many State and Federal regulations exist to prevent development in high hazard areas, State coastal zone management program assessments acknowledge that these regulations are not always followed and much of the decision-making is left to local jurisdictions. This results in a piecemeal approach to coastal protection leading to inadequate protection of coastal barriers from the impacts of development. Several Federal and State laws provide limited protection to coastal areas. However, none of the laws specifically provide coastal barrier protection. The State of California has noted that almost all development along the coastline will be exposed to erosion, bluff retreat, storm damage, wave run-up, tsunamis, earthquakes, landslides, or other hazards common to the California coast (California Coastal Commission 1992). This observation is particularly important given that the vast majority of the California coastline, as well as other Pacific coastlines, is eroding. A review of Oregon shoreline protection management suggests that sensitive shoreline areas are suffering from inadequate protection although beachfront protection and related land use policies are in place. Thus additional safeguards are needed to ensure the long-term viability of the coastal zone. Inclusion of Pacific coastal barriers in the System would encourage protection of these unique landforms and their associated aquatic habitats. States also suffer from budget cuts and inadequate resources to address many coastal problems further hampering their efforts to protect these unique and dynamic areas.

Public or private ownership of a coastal barrier unit should not determine its eligibility for inclusion into the System or the restrictions it will be subject to once included in the System. Several types of activities and lands are exempt from the restrictions of the

CBIA. Military activities essential for national security and Coast Guard operations are excepted from the requirements of the CBIA and most military and Coast Guard lands were not included in the System in the past. Otherwise protected areas were also exempted from all restrictions except for the prohibition on Federal flood insurance. After careful reevaluation, the Department of the Interior (DOI) has concluded that exempting public lands from all (or most) of the restrictions of the CBIA does not fulfill the purpose of the CBRA; namely to minimize loss of human life, reduce wasteful Federal expenditures, and protect fragile natural resources. Eligible coastal barriers on military or Coast Guard lands or in otherwise protected areas should become part of the System and subject to all the restrictions of the CBIA (National security activities and Coast Guard operations would still be excepted activities). Eliminating all, or most, of the restrictions on these lands does not adequately protect these landforms and associated aquatic habitats from degradation associated with development. Additionally, public ownership is not a guarantee of environmental protection and Federal monies could be used for wasteful and inappropriate purposes on these barriers if they are not included in the System. For example, military lands can be surplused and without the protection of the CBRA, there would be no disincentives or restrictions to development. Given that the majority of the coastal barriers identified on the Pacific coast are publicly owned, it is imperative that these areas be incorporated in the System in order to meet the purposes of the Act. Of the 107,728 acres eligible for inclusion in the System, only 4,854 acres (18 percent) are privately owned. This recommendation is a departure from the previous treatment of "otherwise protected areas" but the DOI believes it may be wise to reevaluate Atlantic, Great Lakes, and Gulf coast barriers to see if areas in public ownership should be added to the System.

Because of the important functions of Pacific coastal barriers and the current and future pressures placed on these landforms and their associated aquatic habitats, the DOI makes the following recommendation with regard to the inclusion of Pacific coastal barriers in the System.

> Recommendation: The DOI recommends that all undeveloped Pacific coastal barriers, regardless of ownership, be included in the System and subject to the specific exemptions in the CBIA. The DOI recommends that all potential units be incorporated into the System in order to meet the purposes of the CBIA; namely to minimize loss of human life, reduce wasteful Federal expenditure, and protect sensitive natural resources. The DOI also recommends that publicly owned units, which make up the majority of Pacific coastal barriers, also be included in the System and subject to all the restrictions on new Federal expenditures and financial assistance to ensure protection of these unique landforms and their associated aquatic habitats.

In addition to the above recommendation, the DOI also recommends that all requirements of the CBIA be extended to any new additions to the System. The DOI also notes that

neither the CBRA nor the CBIA provide guidance regarding the inclusion of Tribal lands in the System. Recognizing the sovereignty of the Native American nations, the DOI intends to coordinate with each of the affected Tribes to discuss the implications of the CBIA and to determine their interest in including Tribal lands in the System.

Pacific coastal barriers provide unique biological, cultural, and economic benefits to coastal States and the Nation. The barrier and its associated habitats are one ecological system, and the health and productivity of the entire system depends on the rational use of all the component parts. The inclusion of Pacific coastal barriers in the System would have a number of positive effects. Among these effects are decreased loss of human lives associated with development on hazardous coastal barriers and protection of fish and wildlife and other natural resources which are dependent on coastal barriers. Wasteful Federal expenditures in these dynamic coastal areas would also be reduced and State goals of wise coastal management would be promoted.

REFERENCES

AECOS, Inc. 1979a. Oahu coral reef inventory, Parts A and B. U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawaii. 552 pp.

AECOS, Inc. 1979b. Maui Island coral reef inventory, Parts A and B. U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawaii. 303 pp.

AECOS, Inc. 1979c. Maui coastal zone atlas, representing the Hawaii coral reef inventory, Island of Maui (MICRI), Part C. U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawaii. 84 maps.

AECOS, Inc. 1981. Oahu coastal zone atlas, representing the Hawaii coral reef inventory, Island of Oahu (OCRI), Part C. U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawaii. 93 maps.

AECOS, Inc. 1982. Kauai Island coastal resource inventory. U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawaii. 42 maps.

Ahuimanu Productions. 1977. An ornithological survey of Hawaiian wetlands, Vols. 1 and 2. U.S. Army Corps of Engineer, Pacific Ocean Division, Fort Shafter, Hawaii. 406 pp.

Brock, J. H. and R. E. Brock. 1974. The marine fauna of the coast of Northern Kona, Hawaii. University of Hawaii, Sea Grant Advisory Rep., UNIHI-SEAGRANT-AR-74-02.

California Coastal Commission. 1992a. Final assessment of the California coastal management program. 89 pp.

California Coastal Commission. 1992b. The California Coastal Commission's enhancement grants strategy. 50 pp.

Cooper, W. S. 1958. Coastal sand dunes of Oregon and Washington. Geol. Soc. Am. Mem. 72. 169 pp.

Cooper, W. S. 1967. Coastal dunes of California. Geol. Soc. Am. Mem. 104. 131 pp.

Cowardin, L. M., V. Carter, F. C. Golet, and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, FWS/OBS-79/31. 103 pp.

Cox, D. C. and L. C. Gordon. 1970. Estuarine pollution in the state of Hawaii. Vol. 1: Statewide study. University of Hawaii Water Resources Research Center. Tech. Rpt. 31.

Elliot, M. E. and E. M. Hall. 1977. Wetlands and wetland vegetation of Hawaii. U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawaii. 334 pp.

Federal Register. 1985. Availability of draft maps of areas under consideration for inclusion in the Coastal Barrier Resources System. Federal Register, March 4, 1985, 50(42):8,698-8,702.

Federal Register. 1992. Availability of draft maps of Oregon areas under consideration for inclusion in the Coastal Barrier Resources System. Federal Register, April 23, 1992, 57(79):14,846-14,848.

Federal Register. 1992. Availability of draft maps of Washington areas under consideration for inclusion in the Coastal Barrier Resources System. Federal Register, May 29, 1992, 57(104):22,821-22,823.

Federal Register. 1992. Availability of draft maps of California areas under consideration for inclusion in the Coastal Barrier Resources System. Federal Register, July 7, 1992, 57(130):29,883-29,885.

Federal Register. 1992. Availability of draft maps of Hawaii areas under consideration for inclusion in the Coastal Barrier Resources System. Federal Register, August 14, 1992, 57(158):36,668-36,671.

Gearhart II., R. L., J. C. Neville, and S. D. Hoyt. 1990. California, Oregon, and Washington Archaeological Resource Study, Vol. IV: History. U.S. Department of the Interior, Minerals Management Service, Pacific OCS Region, Camarillo, California. 119 pp.

Good, J. W. 1992. Ocean shore protection policy and practices in Oregon: an evaluation of implementation success. Ph.D. Thesis, Oregon State University, Corvallis, Oregon. 275 pp.

Hawaii Coastal Zone Management Program. 1992. Section 309 Coastal Zone Enhancement Grants, Assessment. Office of State Planning. 72 pp.

Hedgpeth, J. W. 1988. Coastal barriers of the Pacific coast: summary report. Appendix D *in* Report to Congress: Coastal Barrier Resources System. U.S. Department of the Interior, Washington, D.C. 42 pp.

Holthus, P. L. 1988. Coastal barriers of Hawaii and American Samoa: summary report. Appendix C *in* Report to Congress: Coastal Barrier Resources System. U.S. Department of the Interior, Washington, D.C. 51 pp.

Kay, E. A., S. L. Lau, E. D. Stroup, S. J. Dollar, and R. Young. 1977. Hydrologic and ecologic inventories of the coastal waters of West Hawaii. University of Hawaii Water Resources Research Center. Tech. Rpt. 105. 94 pp.

Komar, P. D. 1979. Physical processes and geologic hazards on the Oregon coast. Oregon Coastal Zone Management Association, Newport, OR. 72 pp.

Komar, P. D. 1983. The erosion of Siletz Spit, Oregon. *In* Handbook of Coastal processes and erosion. Boca Rotan, CRC Press.

Maciolek, J. A. 1972. Diadromous macrofauna and the Kahana Stream estuary ecosystem. Quality of Coastal Waters Project, University of Hawaii Water Resources Research Center. 22 pp.

Maciolek, J. A. and R. E. Brock. 1974. Aquatic survey of the Kona coast ponds, Hawaii Island. University of Hawaii Sea Grant Advisory Rep. UNIHI-SEAGRANT-AR-74-04. 73 pp.

Madden, W. D. and C. L. Paulsen. 1977. The potential for mullet and milkfish culture in Hawaiian fishponds. Hawaii Department of Planning and Economic Development. 54 pp.

Madin, I. 1991. Seismic hazards on the Oregon coast. Paper presented at *Coastal Natural Hazards: Science, Engineering, and Public Policy*, October 1-3, 1991. Newport, Oregon.

Manoa Mapworks. 1983. Kauai coastal resource atlas. U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawaii. 173 maps.

Maragos, J. E., ed. 1975. Hawaiian coastal water ecosystems: an element paper for the Hawaii coastal management study. Technical supplement 1: Technical considerations in developing a coastal zone management program for Hawaii. Hawaii Department of Planning and Economic Development. 51 pp.

Miller, H. C., and R. L. Stroup. 1989. Turning the tide on wasted tax dollars, potential Federal savings from additions to the Coastal Barrier Resources System. National Wildlife Federation and National Taxpayers Union, Washington, D.C. 24 pp.

Moberly, R., D. C. Cox, T. Chamberlain, F. W. McCoy, Jr., and J. F. Campbell. 1963. Hawaii's shoreline. Appendix 1: Coastal geology of Hawaii. University of Hawaii, Hawaii Inst. Geophys. HIG Rep. 41. 216 pp.

Moberly, R. and T. Chamberlain. 1964. Hawaiian beach systems. Final Report: revised and reissued, 1968. University of Hawaii, Hawaii Inst. Geophys. Rep. HIG-64-2. 95 pp.

National Oceanic and Atmospheric Administration. 1990. 50 years of population change along the Nation's coasts, 1960-2010. U.S. Department of Commerce. Washington, D.C. 41 pp.

Nolan, R. S. and D. P. Cheny. 1981. West Hawaii coral reef inventory. U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawaii. 491 pp.

Oregon Coastal Management Program. 1992. Coastal and ocean resources planning: an assessment or Oregon's coastal and ocean resource issues and management capability. Oregon coastal program section 309 assessment. 52 pp.

Parrish, J. D., J. A. Maciolek, A. S. Timbol, C. B. Hathaway, Jr., and S. E. Norton. 1978. Stream channel modification in Hawaii. Part D: Summary report. U.S. Fish and Wildlife Service. FWS/OBS-78/19. 18 pp.

Quinn, W. H., V. T. Neal, and S. E. Antunez de Mayolo. 1987. El Nino occurrences over the past four and a half centuries. J. Geophys. Res. 92(C13):14,449-14,461.

Richmond, T. A. and D. Mueller-Dombois. 1972. Coastline ecosystems on Oahu, Hawaii. Vegetatio 25(5-6):367-400.

Rozengurt, M. A. and I. Haydock. 1991. Effects of fresh water development and water pollution policies on the world's river-delta-estuary-coastal zone ecosystems. Coastal Wetlands, Coastal Zone 91, Amer. Soc. Civil Engineers, New York, New York.

Shih, S. M. 1992. Sea cliff erosion on the Oregon coast: from neotectonics to wave runup. Ph.D. Diss., College of Oceanography, Oregon Sate University, Corvallis, Oregon.

Shipman, H. 1991. Coastal barriers and accreted landforms in Washington State: an inventory and characterization. Shorelands and Coastal Zone Management Program, Washington Dept. Ecology, Olympia, Washington.

Snethkamp, P., G. Wessen, A. L. York, J. H. Cleland, S. D. Hoyt, and R. L. Gearhart, II. 1990. California, Oregon, and Washington Archaeological Resource Study, Vol. III: Prehistory. U.S. Department of the Interior, Minerals Management Service, Pacific OCS Region, Camarillo, California. 129 pp.

Stearns, H. T. 1978. Quaternary shorelines in the Hawaiian Islands. Bull. Bernice P. Bishop Mus. No. 237.

Tabata, R. S. 1980. The native coastal plants of Oahu, Hawaii. Newsl. Hawaiian Bot. Soc. 19:2-44.

Thomas, D. T. 1983. Changes in Columbia River Estuary habitat types over the past century. Columbia River Estuary Data Development Program, Columbia River Estuary Study Taskforce, Astoria, Oregon.

Timbol, A. S. 1972. Trophic ecology and macrofauna of Kahana estuary, Oahu. Ph.D. Dissertation. University of Hawaii, Honolulu. 228 pp.

Timbol, A. S. and Environmental Impact Study Corp. 1977. Aquatic survey of stream macrofauna for the hydroelectric power study of Hawaii. U.S. Army Corps of Engineers, Pacific Ocean Division, Fort Shafter, Hawaii.

Timbol, A. S. and J. A. Maciolek. 1978. Stream channel modification in Hawaii. Part A: State-wide inventory of streams. Habitat factors and associated biota. U.S. Fish and Wildlife Service. FWS/OBS-78/16. 157 pp.

Titcomb, M. 1972. Native use of fish in Hawaii. University of Hawaii Press, Honolulu, Hawaii. 175 pp.

U.S. Army Corps of Engineers, Pacific Ocean Division. 1971. Hawaii regional inventory of the national shoreline study. 110 pp.

U.S. Department of the Interior, Coastal Barriers Study Group. 1988. Report to Congress: Coastal Barrier Resources System. Executive Summary; Vols. 1-22; Appendixes A-D. Washington, D.C.

U.S. Fish and Wildlife Service. n.d. Notes on Niihau endangered species habitats. 2 pp.

U.S. Fish and Wildlife Service. 1978. Hawaiian waterbird recovery plan. Hawaiian Waterbird Recovery Team, Honolulu, Hawaii. 92 pp.

U.S. General Accounting Office. 1992. Coastal barriers: development occurring despite prohibitions against Federal assistance. GAO/RCED-92-115. 65 pp.

Washington Department of Ecology. 1992. Washington state coastal zone section 309 assessment and strategy: volume 2, strategy. Shorelands and Coastal Zone Management Program, WA Dept. of Ecology, Olympia, Washington. 37 pp.

Wiedemann, A.M. 1984. The ecology of the Pacific Northwest coastal sand dunes: a community profile. U.S. Fish and Wildlife Service. FWS/OBS-84/04. 130 pp.

Wilson Okamoto and Associates Inc. 1981. Environmental impact assessment, Lumahai aquaculture farm, Hanalei, Kauai, Hawaii.

APPENDICES

Introduction

In 1992, the U.S. Fish and Wildlife Service (Service) prepared and circulated for public review and comment, 1991 draft maps which delineated undeveloped coastal barrier units along the Pacific coast. Notice of the availability of draft maps was published in the Federal Register for Oregon on April 23, 1992, for Washington on May 29, 1992, for California on July 7, 1992, and for Hawaii on August 14, 1992. The draft maps were prepared based on the definition and criteria developed by the Service (Federal Register, Vol. 50, No. 42, March 4, 1985). The primary intent of the public review and comment period was to determine the technical correctness of the delineations of undeveloped coastal barriers.

The attached draft maps reflect all units which meet the technical criteria for undeveloped coastal barriers with the exception of those that occur on Tribal lands. Neither the CBRA nor the CBIA provide guidance regarding the inclusion of Tribal lands in the System. Recognizing the sovereignty of the Native American nations, the DOI intends to coordinate with each of the affected Tribes to discuss the implications of the CBIA and to determine their interest in including Tribal lands in the System.

A total of 195 coastal barriers meeting the criteria were mapped: 62 in California, 35 in Hawaii, 28 in Oregon, and 70 in Washington. In order to facilitate review of the draft coastal barrier maps relative to the draft circulated in 1992, the unit numbering system has remained the same. Deletion of units does not change numbers of the other units; additions are indicated by an "A" added to the preceding unit's number.

Appendix A is a summary of all comments received during the public comment period on the draft maps. A total of 91 organizations or individuals commented on the 1991 draft maps: 30 for California, 3 for Hawaii, 20 for Oregon, and 38 for Washington. Several comments addressed general concerns about the Coastal Barrier Resources System, while others addressed site specific concerns. Table 1 summarizes changes from the 1991 draft maps based on the public review. Table 2 summarizes the comments received regarding specific sites while Table 3 summarizes the general comments.

In addition to the summarized comments, numerous additions or expansions to potential units were recommended by the Coast Alliance, Washington, D.C., in all four States. These proposed additions and expansions generally included undeveloped shoreline features; steep headlands; off-shore, high, steep islands; wetlands lacking a fronting barrier; or units less than one quarter mile in length. These types of shoreline features do not meet the Service's published delineation criteria.

Appendices B through E provide lists of the potential Coastal Barrier Resources System units for the States of California, Hawaii, Oregon, and Washington.

Appendix A. Summary of Comments

Table A-1 (California). Modifications made to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

County	Unit Number	Unit Name	Action
Del Norte	CA-01-91	Smith River/Lake Earl	no change
Del Norte	CA-02-91	Whaler Island	slight line work alignment
Del Norte	CA-03-91	Klamath River	no change
Humboldt	CA-04-91	Fern Canyon	no change
Humboldt	CA-05-91	Gold Bluffs	no change
Humboldt	CA-06-91	Redwood Creek	expanded north edge; exclusion added
Humboldt	CA-07-91	Freshwater Lagoon	no change
Humboldt	CA-08-91	Stone Lagoon	no change
Humboldt	CA-09-91	Dry Lagoon	no change
Humboldt	CA-10-91	Big Lagoon	no change
Humboldt	CA-11-91	Little River	no change
Humboldt	CA-12-91	Clam Beach/Mad River	combined with CA-13 into single unit
Humboldt	CA-13-91	Samoa Peninsula	combined with CA-12 into single unit
Humboldt	CA-13A	North Spit	new unit
Humboldt	CA-14-91	South Spit	north end reduced
Humboldt	CA-15-91	Eel River	slight expansion up Eel River
Humboldt	CA-16-91	Mattole Beach	no change
Mendocino	CA-17-91	Usal Creek	no change
Mendocino	CA-18-91	Ten Mile Creek	changed to two smaller units
Mendocino	CA-18A	Inglenook	new unit from south end of CA-18
Mendocino	CA-19-91	Navarro River	no change
Mendocino	CA-20-91	Alder Creek	no change
Mendocino	CA-21-91	Manchester Beach S.P. (north)	no change

Table A-1 (California, continued). Modifications made to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

County	Unit Number	Unit Name	Action
Mendocino	CA-22-91	Manchester Beach S.P. (center)	no change
Mendocino	CA-23-91	Manchester Beach S.P. (south)	no change
Mendocino/ Sonoma	CA-24-91	Gualala River	no change
Sonoma	CA-25-91	Russian River	no change
Sonoma	CA-26-91	Salmon Crk Beach	no change
Marin	CA-27-91	Abbotts Lagoon	north end reduced
Marin	CA-27A	Drakes Beach	new unit
Marin	CA-28-91	Drakes Estero	no change
Marin	CA-29-91	Rodeo Cove	no change
San Mateo	CA-30-91	Laguna Salada	no change
San Mateo	CA-31-91	Elmar Beach	no change
San Mateo	CA-32-91	Pescadero Creek	no change
Santa Cruz	CA-33-91	Waddell Creek	no change
Santa Cruz	CA-34-91	Scott Creek	no change
Santa Cruz	CA-35-91	Sunset State Beach	no change
Santa Cruz/Monterey	CA-36-91	Zmudowski Beach S.P.	no change
Monterey	CA-37-91	Moss Landing	no change
Monterey	CA-38-91	Salinas River	no change
Monterey	CA-39-91	Little River	no change
Monterey	CA-40-91	La Cruz Rock	no change
San Luis Obispo	CA-41-91	Morro Bay S.P.	no change
San Luis Obispo	CA-42-91	Pismo State Beach (north)	exclusion added
San Luis Obispo	CA-43-91	Pismo State Beach (south)	no change

Table A-1 (California, continued). Modifications made to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

County	Unit Number	Unit Name	Action
San Luis Obispo	CA-44-91	Oso Flaco Lake	no change
San Luis Obispo/Santa Barbara	CA-45-91	Santa Maria River	no change
Santa Barbara	CA-46-91	Santa Ynez River	no change
Santa Barbara	CA-47-91	Goleta Beach C.P.	no change
Santa Barbara	CA-47A	Coal Oil Point	new unit
Ventura	CA-48-91	Santa Clara River	no change
Ventura	CA-49-91	Mcgrath Lake	no change
Ventura	CA-50-91	Ormond Beach	no change
Ventura	CA-51-91	Mugu Lagoon	no change
Los Angeles	CA-52-91	Malibu Point	no change
San Diego	CA-53-91	San Mateo Point	no change
San Diego	CA-54-91	Las Flores Creek	no change
San Diego	CA-55-91	Santa Margarita river	no change
San Diego	CA-56-91	Agua Hedionda	no change
San Diego	CA-57-91	Batiquitos Lagoon	no change
San Diego	CA-58-91	Torrey Pines State Reserve	unit deleted
San Diego	CA-59-91	Silver Strand	expanded to the south; exclusion added
San Diego	CA-60-91	Tijuana Slough	no change

Table A-1 (Hawaii). Modifications made to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

Island	Unit Number	Unit Name	Action
Hawaii	HI-01-91	Pololu Valley	no change
Hawaii	HI-02-91	Waimanu Bay	no change
Hawaii	HI-03-91	Waipio Bay	no change
Hawaii	HI-03A	Waiopae Ponds	new unit
Hawaii	HI-04-91	Honokohau Bay	no change
Hawaii	HI-05-91	Kiholo Bay	no change
Hawaii	HI-06-91	Makaiwa	no change
Maui	HI-07-91	Waihee	no change
Maui	HI-08-91	Paukukaio	no change
Maui	HI-09-91	Kanana Pond	no change
Maui	HI-10-91	Kealia Pond	no change
Molokai	HI-11-91	Piplo Fishpond	no change
Molokai	HI-12-91	Kaawanui Fishpond	no change
Molokai	HI-13-91	Paialoa Fishpond	no change
Molokai	HI-14-91	Lepelepe	no change
Molokai	HI-15-91	Pahoa	no change
Molokai	HI-16-91	Pelekunu Bay	no change
Molokai	HI-17-91	Alii Fishpond	no change
Molokai	HI-18-91	Kamiloloa	no change
Molokai	HI-19-91	Kaunakakai	no change
Molokai	HI-20-91	Kahanui	no change
Kauai	HI-21-91	Wainiha Bay	no change
Kauai	HI-22-91	Lumahai Beach	no change
Kauai	HI-23-91	Puu Poa Point Area	no change
Kauai	HI-24-91	Kilauea Bay	no change
Oahu	HI-25-91	Kii NWR	no change
Oahu	HI-26-91	Kahana Bay	no change
Oahu	HI-27-91	Molii Pond	no change
Oahu	HI-28-91	Waiahole Beach	no change
Oahu	HI-29-91	Heeia	no change
Oahu	HI-30-91	Nuupia Pond	no change
Niihau	HI-31-91	Leahi Point	no change

Table A-1 (Hawaii, continued). Modifications made to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

Island	Unit Number	Unit Name	Action
Niihau	HI-32-91	Nonopapa	no change
Niihau	HI-33-91	Kiekie	no change
Niihau	HI-34-91	Kaununui	no change

Table A-1 (Oregon). Modifications made to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

County	Unit Number	Unit Name	Action
Clatsop	OR-01-91	Columbia R./Clatsop Spit	north end reduced to exclude south jetty
Clatsop	OR-02-91	Necanicum River	slight line work alignment
Clatsop	OR-03-91	Chapman Beach/Ecola Creek	no change
Tillamook	OR-04-91	Nehalem Spit & Bay	slight line work alignment
Tillamook	OR-05-91	Manhattan Beach	no change
Tillamook	OR-06-91	Bayocean Peninsula/ Tillamook Bay	slight expansion along south edge
Tillamook	OR-07-91	Netarts Spit & Bay	slight expansion along south edge
Tillamook	OR-08-91	Sand Lake Estuary	no change
Tillamook	OR-09-91	Nestucca Spit & Bay	no change
Tillamook	OR-10-91	Kiwanda Beach	no change
Tillamook/ Lincoln	OR-11-91	Salmon River Estuary	reduced north edge, expanded up the Salmon River
Lincoln	OR-12-91	Salishan Spit/Siletz Bay	expanded to the south in Siletz Bay
Lincoln	OR-13-91	South Beach	no change
Lincoln	OR-14-91	Ona Beach/Beaver Creek	no change
Lane	OR-15-91	Baker Beach	no change
Lane	OR-16-91	Heceta Beach	no change
Lane/ Douglas	OR-17-91	Oregon Dunes	no change
Douglas	OR-18-91	North Spit/Umpqua R.	no change
Coos	OR-19-91	North Spit & Coos Bay/Oregon Dunes	extended north edge, line work alignment in Coos Bay
Coos	OR-20-91	Bullards Beach/Coquille River	added wetland area near Bandon
Coos/Curry	OR-21-91	New River	added wetland area north of Floras Creek
Curry	OR-22-91	Sixes River	no change

Table A-1 (Oregon, continued). Modifications made to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

County	Unit Number	Unit Name	Action
Curry	OR-23-91	Elk River	no change
Curry	OR-24-91	Garrison Lake	slight line work alignment
Curry	OR-25-91	Euchre Creek	no change
Curry	OR-26-91	Greggs Creek	no change
Curry	OR-27-91	Hunter Creek	no change
Curry	OR-28-91	Pistol River	no change

Table A-1 (Washington). Modifications to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

County	Unit Number	Unit Name	Action
Whatcom	WA-01-91	Semiahmoo Spit/Drayton Harbor	no change
Whatcom	WA-02-91	Portage Bay	unit deleted, Indian reservation
Whatcom	WA-03-91	Portage Island	unit deleted, Indian reservation
Skagit	WA-04-91	Sinclair Island	no change
San Juan	WA-05-91	Waldron Island	no change
San Juan	WA-06-91	Henry Island/Nelson Bay	small exclusion added
San Juan	WA-07-91	Fisherman Bay North	no change
San Juan	WA-08-91	Fisherman Bay South	no change
San Juan	WA-09-91	Low Point	no change
San Juan	WA-10-91	San Juan Island South	no change
San Juan	WA-11-91	Mud Bay/Shoal Bight	no change
San Juan	WA-12-91	Spencer Spit	no change
San Juan	WA-13-91	Decatur Head	no change
Skagit	WA-14-91	Guemes Island	no change
Skagit	WA-15-91	Padilla Bay	no change
Skagit	WA-15A	Ship Harbor	new unit
Skagit	WA-16-91	Turners Bay	unit deleted, Indian reservation
Island	WA-17-91	Ben Ure Spit	south edge expanded
Island	WA-18-91	Cranberry Lake	no change
Island	WA-19-91	South of Cranberry Lake	small exclusion added
Island	WA-20-91	Arrowhead Beach	no change
Island	WA-21-91	Polnell Point	south edge reduced
Island	WA-22-91	Crescent Harbor Area	no change
Island	WA-23-91	Oak Harbor Area	no change
Island	WA-24-91	Whidbey Island NW	no change
Island	WA-25-91	Whidbey Island SW	no change
Island	WA-26-91	Crockett Lake	no change

Table A-1 (Washington, continued). Modifications to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

County	Unit Number	Unit Name	Action
Island	WA-27-91	Race Lagoon	no change
Island	WA-28-91	Whidbey Island East	no change
Island	WA-29-91	Lake Hancock	no change
Island	WA-30-91	Useless Bay Area	no change
Island	WA-31-91	Cultus Bay	no change
Kitsap	WA-32-91	Port Madison Area	unit deleted, Indian reservation
Kitsap	WA-33-91	Battle Point	no change
King	WA-34-91	Point Heyer	no change
Pierce	WA-35-91	McNeil Island	no change
Mason	WA-36-91	Squaxin Island	unit deleted, Indian reservation
Mason	WA-37-91	Buffingtonis Lagoon	no change
Pierce	WA-38-91	Vaughn Bay	no change
Pierce	WA-39-91	Henderson Bay Area	no change
Kitsap	WA-40-91	Stavis Bay	no change
Jefferson	WA-41-91	Zelatched Point	no change
Jefferson	WA-42-91	Tarboo Bay	no change
Jefferson	WA-43-91	Toandos Peninsula East	no change
Jefferson	WA-44-91	Thorndyke Bay	slight line work alignment
Kitsap	WA-45-91	Point Julio	unit deleted, Indian reservation
Jefferson	WA-46-91	Bywater Bay	no change
Kitsap	WA-47-91	Fowlweather Bluff East	no change
Kitsap	WA-48-91	Fowlweather Bluff	no change
Jefferson	WA-49-91	Oak Bay East	no change
Jefferson	WA-50-91	Oak Bay	no change
Jefferson	WA-51-91	Oak Bay West	no change
Jefferson	WA-52-91	Kilisut Harbor	no change
Jefferson	WA-53-91	Kala Point	no change
Jefferson	WA-54-91	Port Discovery Area	west edge reduced

Table A-1 (Washington, continued). Modifications to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

County	Unit Number	Unit Name	Action
Clallam	WA-55-91	Thompson Spit	no change
Clallam	WA-56-91	Sequim Bay	no change
Clallam	WA-57-91	Kilakala Point	southwest edge expanded
Clallam	WA-58-91	Dungeness Spit	no change
Clallam	WA-59-91	Mouth Elwha River	unit deleted, Indian reservation
Clallam	WA-60-91	Crescent Bay	small exclusion added
Clallam	WA-61-91	Pysht River	small exclusion added
Clallam	WA-62-91	Clallam Bay	no change
Clallam	WA-63-91	Mouth Hoko River	no change
Clallam	WA-64-91	Mouth Waatch River	unit deleted, Indian reservation
Clallam	WA-65-91	Sooes River	unit deleted, Indian reservation
Clallam	WA-66-91	Quillayute River	unit deleted, Indian reservation
Jefferson	WA-67-91	Queets River	unit deleted, Indian reservation
Grays Harbor	WA-68-91	Raft River	unit deleted, Indian reservation
Grays Harbor	WA-69-91	Copalis River	small exclusions added
Grays Harbor	WA-70-91	Conner Creek	north edge reduced
Grays Harbor	WA-71-91	Ocean Shores	slight line work alignment along east edge
Grays Harbor	WA-72-91	Ocean Shores South	no change
Grays Harbor	WA-73-91	Westport	no change
Grays Harbor	WA-74-91	Grayland North	no change
Pacific	WA-75-91	Grayland Beach	no change
Pacific	WA-75A	Grayland South	new unit
Pacific	WA-76-91	Empire Spit	unit reduced, Indian reservation

Table A-1 (Washington, continued). Modifications to potential coastal barrier units based on the 1992 public review and comment period on draft maps.

County	Unit Number	Unit Name	Action
Pacific	WA-77-91	North Beach Peninsula	no change
Pacific	WA-78-91	Jensen Point	slight line work alignment along north edge
Pacific	WA-79-91	Long Beach/Seaview	south edge expanded
Pacific	WA-80-91	Cape Disappointment	no change

Table A-2. Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
CALIFORNIA		
CA-01-91	Coast Alliance Washington, D.C.	Include Pyramid Point, Prince Island, Hunter Rock, and undeveloped mainland areas to east and north excluding developed areas
	Pacific Shores Property Owners Association Long Beach, CA.	Exclude Pacific Shores subdivision and properties, dune is stabilized with beach grass, unit includes 27 miles of roads, group dedicated to conservation
	Pacific Shores Subdivision California Water District	Opposes designation of unit, not threatened by hazards
	County of Del Norte Crescent City, CA	Map is out of date, may include developed areas, will further complicate difficult situation, as currently mapped opposed to inclusion
	Mel Bley Los Angeles, CA	Inclusion would have significant socio-economic impacts, request EIS
	Margaret George Arcata, CA	Favors including unit in system
	The Friends of Del Norte County Gasquet, CA	Supports addition to the system
	Reservation Ranch Smith River, CA	Could be considered a Federal "taking", eliminate all private lands in Del Norte Co. from the System
	Alan D. Barron Crescent City, CA	Supports the designation
	Rosemary Bauman Crescent City, CA	Should be included in the System
	North Group, Redwood Chapter, Sierra Club Arcata, CA	Support listed areas in Del Norte County, of special importance Lakes Earl and Tolawa
	Chuck Seward Crescent City, CA	Unit should be included as well as other units in Del Norte County
CA-02-91	Coast Alliance	Include Whaler Island, extend landward boundary to follow Bluff Road to include Cushing Creek
	County of Del Norte	Not in conformance with criteria, unnecessary restrictions on Hwy. 101, as currently mapped opposed to inclusion

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
CA-03-91	Coast Alliance	extend southern boundary and include secondary barrier area at Klamath and Waukell Flat
	County of Del Norte	Subject map is out of date, potentially affects already developed lands, as currently mapped opposed to inclusion
CA-04-91	Coast Alliance	Extend north and south along undeveloped shoreline to include Ossagon, Butler, Boat, and Squashan Creeks and Fern Canyon
	Redwood Empire Division, League of California Cities Fortuna, CA	Object to including 13 units in Humboldt County (CA-04 to 16), will hinder Hwy. 101 funding, unnecessary proliferation of different levels of regulations
	City of Fortuna Fortuna, CA	Rejects inclusion of 13 Humboldt County sites (CA-04 to 16), existing regulations are adequate, concerned about limits to Federal funding
	County of Humboldt Eureka, CA	Opposed to inclusion of any units in Humboldt County (CA-04 to 16), current State and local regulations are adequate, in many cases barriers are most stable areas
	Mel Bley	Unclear why area was delineated
CA-05-91	Coast Alliance	include undeveloped sections of shoreline and creek outlets
CA-06/07-91	Coast Alliance	combine units 06, 07, and 08 excluding developed areas
	Mel Bley	Hwy. 101 is a man-made structure, units should be considered developed and excluded from the system, demand an EIS
	Redwood Chapter, Sierra Club	Combine units 06 and 07, information center building located in unit
CA-08-91	Coast Alliance	Combine with units 06 and 07 excluding developed areas
CA-09-91	Coast Alliance	Combine units 08, 09, and 10 excluding developed areas
	City of Fortuna	Lack of Federal funding may limit needed expansion to Hwy 101

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
CA-10-91	Coast Alliance	Extend unit 10 to Hwy. 101 and include all of Big Lagoon County Park
CA-11-91	Coast Alliance	Include undeveloped shoreline to the north, Little River Rock, and Tepona Point, and to the south Little River State Beach and Clam Beach County Park landward to Hwy. 101
	Redwood Chapter, Sierra Club	Wetlands are present east of Hwy. 101, include area from Pilot Point to south end of Clam Beach
CA-12-91	Coast Alliance	Combine with unit 13, extend unit 12 boundary to Hwy. 101
	Redwood Chapter, Sierra Club	Combine units 12 and 13
CA-13-91	Coast Alliance	Combine with unit 12, include wetlands around Mad River Slough, include undeveloped shoreline seaward of Somoa
	Manila Community Services District Arcata, CA	Opposition to specific parcels with plans for passive recreation and community waste water system which may use Federal funds, specific units meet criteria and are consistent with local plans
CA-14-91	Coast Alliance	Combine with unit 15
	Mel Bley	Exclude sea wall on South Jetty, include wetlands to Hookton, Beatrice, and Hwy. 101
	Redwood Chapter, Sierra Club	Concur with mapped delineation 11
CA-15-91	Coast Alliance	Extend to 10' contour, include Sevenmile Slough, Crab Park, extend up Eel River, include Centerville Beach
CA-16-91	Coast Alliance	Extend boundaries to include undeveloped shoreline, offshore rocks, and stream mouths
CA-17-91	Coast Alliance	Extend boundaries to include undeveloped shoreline, include offshore rocks as separate units or within unit 17
CA-18-91	Coast Alliance	Extend landward to 40' contour, extend to include undeveloped shoreline and offshore rocks
CA-19-91	Coast Alliance	Include undeveloped but developable areas, south end should include creek mouths

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
CA-20-91	Coast Alliance	Extend north and south to include undeveloped but developable areas
CA-21/22/23-91	Coast Alliance	Combine the units, excluding developed areas, include Point Arena to the south
CA-24-91	Coast Alliance	Include Gualala Point County Park and Robinson Reef
CA-25-91	Coast Alliance	Extend south to include Halfmoon Rock, Goat Rock, Blind Beach, points off Peaked Hill and rest of Sonoma Coast State Beach
CA-26-91	Coast Alliance	Combine with unit 25, include South Salmon Creek Beach
CA-27-91	Coast Alliance	Extend south boundary along Point Reyes Beach, exclude developed areas
CA-28-91	Coast Alliance	Extend western boundary for undeveloped areas, including Drakes Beach
CA-29-91	Coast Alliance	Include Tennessee Point, Bird Island, and Point Bonita
CA-30-91	Coast Alliance	Include Beach State Park and Mori Point
CA-31-91	Coast Alliance	Extend to undeveloped but developable areas along San Mateo State Beaches
CA-32-91	Coast Alliance	Include entire area of San Mateo Coast State Beaches
CA-33-91	Coast Alliance	Extend north and south to follow coast road, include mouth of Arroyo Las Trancas, Greyhound and Pelican Rocks
CA-34-91	Coast Alliance	Extend north to include undeveloped but developable shoreline, to south include El Jarro Point and mouth of Molino Creek
CA-35-91	Coast Alliance	Include entire area of Maresa State Beach
CA-36-91	Coast Alliance	Include Sunset State Beach, landward to associated habitats of McClusky Slough
CA-37-91	Coast Alliance	Combine with unit 38, landward boundary should follow Salinas River

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
	Monterey County Salinas CA	Relocate boundary to west side of Salinas River, FEMA funds being used to rebuild marine laboratories
CA-38-91	Coast Alliance	Include more of Salinas River and seaward land areas
CA-39-91	Coast Alliance	Extend to coast road, include Point Sur and sea otter game range, include undeveloped areas to the north
CA-40-91	Coast Alliance	Include Point Sierra Nevada, Breaker Point, Harlech Castle Rock, Point Piedras Blancas, and Piedras Blancas
CA-41-91	Coast Alliance	Include mouth of Morro Bay, Morro Rock, Morro Bay S.P., extend to wetlands of Los Osos Creek, extend south to include undeveloped but developable areas
	Dept. of Planning and Building, San Luis Obispo County San Luis Obispo, CA	Meets the criteria, Morro Rock should be included
	Land Conservancy of San Luis Obispo Co. San Luis Obispo, CA	Favors inclusion of unit, add Morro Rock
	Rick Algert, Harbor Director City of Morro Bay Morro Bay, CA	Encourage efforts, should not conflict with local planning, dredged disposal sites must not be made infeasible
CA-42-91	Coast Alliance	Include more of Meadow Creek, extend south to join unit 43
CA-43-91	Coast Alliance	Join with unit 42, include Pismo State Beach, join with unit 44
CA-44-91	Coast Alliance	Include wetlands associated with Oso Flaco and Little Oso Flaco Lakes, extend south to include undeveloped but developable areas
CA-45-91	Coast Alliance	Extend to include undeveloped but developable areas and landward along Santa Maria River
CA-46-91	Coast Alliance	Extend to include undeveloped but developable areas

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
CA-47-91	Coast Alliance	Include all Goleta Beach County Park and wetlands of Goleta Slough
	National Park Service Ventura, CA	Add units on offshore islands, include Gaviota S.P., Devereaux Slough, and Carpinteria salt marsh
CA-48/49-91	Coast Alliance	Combine these units, include McGrath Lake and undeveloped areas along Mandalay Beach
CA-50-91	Coast Alliance	Extend to include undeveloped but developable areas, extend south to include wetlands not mapped
	Ormond Beach Observers Ventura, CA	Include within the system, plus Mugu Lagoon and Santa Clara River mouth
CA-51-91	Coast Alliance	Extend west to Arnold Road and east to include Point Mugu
CA-52-91	Coast Alliance	O.K.
CA-53-91	Coast Alliance	Edge should follow road consistently, include lake to southeast
CA-54-91	Coast Alliance	Extend to include valley and river openings to coast
CA-55-91	Coast Alliance	Extend to include undeveloped but developable areas
CA-56-91	Coast Alliance	Include Agua Hedionda and Carlsbad State Beach
CA-57-91	Coast Alliance	Include Batiquitos Lagoon and several "otherwise protected areas"
CA-58-91	Coast Alliance	Include Torrey Pines State Reserve and wetland areas of Soledad Valley
CA-59-91	Coast Alliance	Include Silver Strand State Beach excluding developed areas
CA-60-91	Coast Alliance	Include wetlands associated with Oneonta Slough and Tijuana River
HAWAII		
HI-01-91	Coast Alliance (note: all of the following comments were from the Coast Alliance)	Include all wetlands and the flood-prone Pololu Stream Valley, include all undeveloped coastline
HI-02-91		Include all the flood-prone Waimanu Stream Valley, include all undeveloped coastline, combine units 01 and 02

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
HI-03-91		Include all the flood-prone Waipio Stream Valley, include all undeveloped coastline on map/quad
HI-04-91		Not included in maps received
HI-05-91		Include all undeveloped coastline on map/quad, extend inland boundary
HI-06-91		Include Manoku Hopeaia Fishponds, Kumalae Point, and all undeveloped coastline on map/quad
HI-07-91		Include all undeveloped coastline on map/quad, combine units 07 and 08
HI-08-91		Include Nehe Point
HI-09-91		Include Hobron Point and coral reef
HI-10-91		Extend inland to include all gulches, include all undeveloped coastline
HI-11-91		Include all undeveloped coastline on the map/quad
HI-12,13,14,15 and 17-91		Combine to form one continuous unit, include all coral reefs and mangroves
HI-16-91		Include all undeveloped coastline on either side of unit and nearshore islands
HI-18/19-91		Units O.K.
HI-20-91		Include all undeveloped coastline on the map/quad
HI-21-91		Combine units 21 and 22, extend western boundary to include coral reefs
HI-22-91		Include flood-prone areas of Lumahai River Valley and Waipa Stream and undeveloped coastline to Waioli Beach Park
HI-23-91		Include Hanalei Beach Park and undeveloped parts of Puu Poa Point and coastline east of unit
HI-24-91		Include all undeveloped coastline on the map/quad and nearshore islands
HI-25-91		Include all undeveloped coastline on the map/quad and nearshore islands
HI-26-91		Include flood-prone areas of Kahana Stream valley, extend west to development, include coral reefs

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
HI-27-91		Include Kualoa Regional Park, Mokolii Island, Kaawaa Stream valley, and more of Kane'ohe Bay
HI-28-91		Extend east to include undeveloped coastline, include Kahaluu Pond and Laenani Beach Park
HI-29-91		At a minimum include Heeia State Park and Kane'ohe Beach Park, include Heeia Pond
HI-30-91		Extend to west to include Pukaulua Point
HI-31,32, and 33-91		Include entire coastline on map/quad
HI-34-91		Include entire coastline on map/quad
OREGON		
OR-01-91	Oregon Natural Resources Council (ONRC), Portland, OR	Include undeveloped areas 1 mile inland or to Hwy. 101
	Columbia River Estuary Study Taskforce (CREST), Astoria, OR	Does not meet criteria, stabilized jetty
	Corps of Engineers (COE), Portland District	Reduce to exclude jetty, could impact navigation channel project
OR-02-91	ONRC	Appears O.K.
OR-03-91	ONRC	Include Chapman Beach and more of Cannon Beach, extend 1 mile inland along undeveloped shoreline
OR-04-91	ONRC	Include Nehalem Bay S.P., Dean Point, and undeveloped coastline
	COE, Portland District	Should be covered by exception for jetty maintenance
	Port of Nehalem Nehalem, OR	Opposed to inclusion, possible shallow-draft navigation channel, State regulations are adequate
OR-05-91	ONRC	Appears O.K.
OR-06-91	ONRC	Include Kilchis Point, undeveloped areas to north, Miami R. east of Hwy. 101, south to Bay City, Cape Meares, and extend southeast portion
	COE, Portland District	Some Corps owned lands, sand/rock constructed dike may not meet criteria, several identified dredged material disposal sites

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
OR-07-91	ONRC	Include undeveloped shoreline northwest of Happy Camp and eastern boundary 1 mile inland
OR-08-91	ONRC	Include undeveloped part of Whalen Is., Siuslaw N.F. 1 mile inland, and expand northwest portion
OR-09-91	ONRC	Include flood prone area to southeast, Porter Point, and Nestucca Spit S.P.
OR-10-91	ONRC	Extend north to Neskowin
	Neskowin North, Inc. Neskowin, OR	Exclude site, stabilized sand dunes, no large water resources associated with site
OR-11-91	ONRC	Add beach area near Camp Westwind, extend east boundary, and north boundary to south Neskowin and Suislaw N.F. 1 mile inland
OR-12-91	ONRC	Add Josephine Young Memorial Park and Siletz Bay and associated wetlands
	Beth Gerl Lincoln City, OR	North end is a coastal barrier
OR-13-91	ONRC	Add South Beach S.P. and undeveloped shore of Yaquina Bay, King Slough, and Yaquina River extending 1 mile inland
	COE, Portland District	Should be covered by exception for maintenance of jetties
	City of Newport Newport, OR	General comments about Urban Growth Boundary, city limits, and State/local regulations
	A.D. Dority, III Lake Oswego, OR	Remove unit, wetlands are not adjacent, inclusion in conflict with City's Comprehensive Master Zoning Plan, local regulations are adequate
OR-14-91	ONRC	Include Ona Beach S.P. and Beaver Cr. marshlands and flood prone areas
OR-15-91	ONRC	Include undeveloped coast from Ten Mile Cr. through Baker Beach extending 1 mile inland, include more of Heceta Beach and Nott, Mussel, and Alder Lakes
OR-16-91	ONRC	Combine units 15, 16, and 17, and add North Jetty Lake
OR-17-91	ONRC	Extend 1 mile inland in Suislaw N.F.

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
	COE, Portland District	Potential bank protection project within unit
OR-18-91	ONRC	Include Steamboat Island, Salmon Harbor, and undeveloped parts along north edge
	COE, Portland District	Proposed habitat creation on north spit, in-bay disposal area, and bank protection could be impacted
OR-19-91	ONRC	Extend to Umpqua River/south jetty and east boundary 1 mile inland from coastline, include Henderson Marsh, and remainder of Fossil Point
	COE, Portland District	Proposed creation of habitat on north spit could be impacted, Corps owns land in unit
	F. Willis Smith and C. Wylie Smith Coos Bay, OR	North Spit should not be included, exclude Sitka Dock
	Bureau of Land Management (BLM) North Bend, OR	Exclude BLM administered lands, current jurisdictions are adequate, management consistent with the Act
OR-20-91	ONRC	Extend 1 mi. inland to meet Coquille River, add small area near Bandon
	COE, Portland District	Corps owns land in unit, maintenance of jetties should be exception
OR-21-91	ONRC	Extend east boundary 1 mile inland, include Bandon S.P. and Bradley Lake, combine 21, 22, & 23 as a single unit
	BLM	Exclude BLM administered lands, current jurisdictions are adequate, management consistent with the Act
	Kalmiopsis Audubon Society of Curry Co., Port Orford, OR	Include all dune area on east side of New River north of Floras Lake and small creek south of the lake
OR-22-91	ONRC	Combine with units 21 and 23, include Sixes River and Cape Blanco S.P., extend 1 mile inland
OR-23-91	ONRC	Combine with units 21 and 22, extend 1 mile inland
OR-24-91	ONRC	Include more of Garrison Beach State Wayside and beach south of Garrison Lake to the bluffs

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
	Kalmiopsis Audubon Society	Expand southern end beaches to the bluffs and include Hubbard Creek
OR-25-91	ONRC	Include more beach to north and south and Arizona Beach
	Kalmiopsis Audubon Society	Include entire beach between units 25 and 26, add Arizona Beach
OR-26-91	ONRC	Include more beach to the north and headlands to the south
OR-27-91	ONRC	To the north include more beach and undeveloped land inland and extend south edge along beach
OR-28-91	ONRC	Extend to north including Cape Sebastian S.P. to Buena Vista Ocean Wayside, include Pistol River S.P.
WASHINGTON		
WA-01-91	Washington Department of Ecology (WDOE)	Site appears to meet criteria
	Coast Alliance	Extend northern and southern boundaries
	Foster, Pepper & Shefelman Seattle, WA	Site is considered developed, not subject to hazards, do not include in the System
	Lummi Indian Business Council Bellingham, WA	Usual and accustomed area of shellfish harvest, oppose if harvest activities not exempted
WA-02-91	WDOE	Site appears to meet criteria
	Coast Alliance	Combine 03 and 03 into a single unit
	Lummi Indian Business Council Bellingham, WA	Oppose inclusion into System, on reservation land
WA-04-91	WDOE	Point with marsh
	Coast Alliance	Extend boundary to 20' contour
WA-05-91	WDOE	Exclude any existing structures at western end
	Coast Alliance	Include undeveloped areas of Henry Island or add new unit, extend northern and southern boundaries
WA-06-91	WDOE	Exclude development on high ground
	Coast Alliance	Include undeveloped areas of Henry Island or add new unit, extend northern and southern boundaries

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
WA-07-91	WDOE	Site appears to meet criteria
	Coast Alliance	Combine 07 and 08 to include islands
WA-08-91	WDOE	Site appears to meet criteria
WA-09-91	WDOE	Small tombolo and wetland area
	Coast Alliance	O.K.
WA-10-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend to include mouth and undeveloped shoreline area of Fish Creek
WA-11-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend northern and southern boundaries
WA-12-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend eastern boundary to include Frost Island and west farther inland
WA-13-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend boundaries to north and east
WA-14-91	WDOE	Revise if necessary to exclude structure at western end
	Coast Alliance	Extend eastern and western boundaries to include undeveloped shoreline, include Kelly Point
WA-15-91	WDOE	Site is not a natural feature but appears to meet the criteria
	Coast Alliance	Extend boundaries to include mouths of Telegraph Slough and Indian Slough
	Corps of Engineers Seattle District	Inclusion could preclude Federal flood control project under study by the Corps and Skagit County
WA-16-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend into Similk Bay to include shoreline to northwest and southwest
	Swinomish Tribal Community LaConner, WA	General support of state purposes, cannot endorse proposals which would infringe upon sovereignty
WA-17-91	WDOE	Site appears to meet criteria

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
	Coast Alliance	Extend southern boundary to include shoreline areas along Skagit Bay
WA-18-91	WDOE	Site appears to meet criteria
	Coast Alliance	Combine 18 and 19 into a single unit to include undeveloped shoreline of west beach
WA-19-91	WDOE	Revise to exclude existing homes, if any
	Maxine Keesling Woodinville, WA	Object to inclusion, family cabin on unit, land does not border Pacific Ocean
	Island County Planning and Community Development Coupeville, WA	Contains an existing structure, unit may be developable if applicable regulations can be met
WA-20-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include undeveloped shoreline areas of Camano Island into West Pass
WA-21-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend landward to 40' contour and undeveloped shoreline accordingly
WA-22-91	WDOE	Do not include sewage lagoons and/or exclude sewage facility
	Coast Alliance	Extend landward to 20' contour and southwestern boundary toward Eerkes Spring
WA-23-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend northern boundary to include small lake, extend south at 20' contour toward Maylor Point
WA-24-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend along northerly shore to include Rocky Point
WA-25-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include undeveloped shoreline to the northeast and southeast of unit
WA-26-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include area east of Keystone Ferry Landing

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
WA-27-91	WDOE	Site appears to meet criteria
	Coast Alliance	Combine 17 and 28 as single unit or added unity for undeveloped shoreline of Saratoga Passage
WA-28-91	WDOE	Site appears to meet criteria
	Island County Planning and Community Development	Contains one structure of unknown use
WA-29-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend northern and southern boundaries to include undeveloped shorelines
WA-30-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend southeastern boundary along undeveloped shoreline as far as possible
WA-31-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include all of Cultus Bay
WA-32-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include undeveloped shoreline toward Point Jefferson
WA-33-91	WDOE	Site appears to meet criteria
	Coast Alliance	O.K.
WA-34-91	WDOE	Site appears to meet criteria
	Coast Alliance	O.K.
WA-35-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend boundaries along shore toward Still Harbor and Hyde Point
WA-36-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend boundaries or add units for undeveloped shoreline of Squaxin Island
	Squaxin Island Tribe Shelton, WA	Opposed without first discussing with the Tribe
WA-37-91	WDOE	Site appears to meet criteria

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
	Coast Alliance	Include shoreline and spit at Buffington's Lagoon and McMicken Island
	Walter Scott, Jr. Belfair, WA	Do not include site, would place a lien on property
WA-38-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include undeveloped spit off Windy Bluff and undeveloped shoreline mouth of Vaughn Bay
WA-39-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend to Cramer Road and undeveloped area southwest of Minter
WA-40-91	WDOE	Site appears to meet criteria
	Coast Alliance	O.K.
WA-41-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include entire gravel beach north to Tabook Point and south to Tskutsko Point
WA-42-91	WDOE	Site appears to meet criteria
	Coast Alliance	O.K. but could include mudflat abutting shore
WA-43-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include grave beach to south and north to combine with unit 44
WA-44-91	WDOE	Site appears to meet criteria
	Coast Alliance	Make sure it includes all wetlands, include grave beach and combine with unit 43, extend to South Point
WA-45-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include all of Point Julia and gravel beaches
	Corps of Engineers Seattle District	Conflicts with existing Federal Port Gamble navigation channel project
	Port Gamble S'Klallam Tribe Kingston, WA	Recognize Tribal sovereignty, proposed units must be submitted to Tribal Council
WA-46-91	WDOE	Site appears to meet criteria

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
	Coast Alliance	Include remainder of undeveloped beach, White Rock, Hood Head, and Coon Bay
WA-47-91	WDOE	Site appears to meet criteria
	Coast Alliance	Combine 47 and 48 as a single unit
WA-48-91	WDOE	Site appears to meet criteria
	Coast Alliance	Could extend around north tip of Foulweather Bluff and bluff to south
WA-49-91	WDOE	Site appears to meet criteria
	Coast Alliance	Could extend to join 50
WA-50-91	WDOE	Site appears to meet criteria
	Coast Alliance	Could extend to join 49
	Corps of Engineers Seattle District	May conflict with existing Federal Oak Harbor navigation travel project
WA-51-91	WDOE	Site appears to meet criteria
	Coast Alliance	Combine with 50, include gravel beach to south, sandy beach west of Portage Canal
WA-52-91	WDOE	Site appears to meet criteria
	Coast Alliance	O.K.
WA-53-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend south to mouth of Chimacum Creek, include all of Kuhn Spit
WA-54-91	WDOE	Exclude county road and parts west
	Coast Alliance	O.K. would like gravel beaches included
WA-55-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include grave beach to west and to east ending at Diamond Point
WA-56-91	WDOE	Exclude possible development on or adjacent to Travis Spit
	Coast Alliance	Extend north to area exposed at low tide, combine with 57, extend south to Pitship Point
WA-57-91	WDOE	Site appears to meet criteria

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
	Coast Alliance	Include all wetlands associated with Grays Marsh and Creek, include area exposed at low tide at Kulakala Point and to southeast, combine with 56
WA-58-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include wetlands and aquatic habitat east of Dungeness, extend south to include beach
	Corps of Engineers Seattle District	Could conflict with Federal Dungeness River flood control levee project
WA-59-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend east to barrier at Angeles Point, ideally desire to extend to include undeveloped shoreline to Port Angeles and west through section 31
	Corps of Engineers Seattle District	Could conflict with Federal Elwha River flood control levee project
	Lower Elwha Tribal Council Port Angeles, WA	Expect some revision along reservation shoreline, work toward compromise
WA-60-91	WDOE	Revise to exclude structures
	Coast Alliance	Include remainder of beach to east, undeveloped beaches along Crescent and Agate Bays
WA-61-91	WDOE	Recheck landward for possible structures
	Coast Alliance	Include tidal flat to south, all of Reed Creek, and sandy beach abutting Straight of Juan De Fuca
WA-62-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend along shore to include Slip Point and westerly to include Middle Point
WA-63-91	WDOE	Check for structures at west end
	Coast Alliance	Extend to west to include sandy beach and east to Kydaka Point, Eagle Point, and sandy beach north of Sekiu Airport
WA-64-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include all wetlands south of Waatch River, include more of rivermouth, extend south to combine with 65
WA-65-91	WDOE	Site appears to meet criteria

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
	Coast Alliance	Combine with 64, entire shoreline abutting Olympic N.P. should be included
WA-66-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include wetlands seaward of picnic area and remainder of beach south of spit
	Corps of Engineers Seattle District	Would conflict with existing Federal navigation protection project
WA-67-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend north to include sand spit, additional sandy area to east, remainder of sand beach to south
WA-68-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend inland to road/path, include Hogsback and Little Hogsback
Wa-69-91	WDOE	Site appears to meet criteria, check for structures
	Coast Alliance	Include Copalis Head to north, make southern edge flush with road
WA-70-91	WDOE	Confirm accuracy of northern boundary
	Coast Alliance	Include undeveloped shoreline to north and connect with 69, extend to the south
	Edwina Menath Sea View Estates, Inc. Seattle, WA	Reduce to eliminate high ground
	Inga Homan Hoquiam, WA	Opposed to inclusion, owns the land
WA-71-91	WDOE	Confirm that all structures have been excluded
	Coast Alliance	Extend south to North Jetty/Brown Point
	Michael L. Pence City Manager Ocean Shores, WA	Questions about impact to proposed boardwalk
	Corps of Engineers Seattle District	Could impair maintenance of existing Federal Grays Harbor North Jetty navigation project
WA-72-91	WDOE	Site appear to meet criteria but delineation should exclude navigation channel

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
	Coast Alliance	Extend to west to includ Oyhut Wildlife Recreation Area and sand dunes
	Michael L. Pence City Manager Ocean Shores, WA	Question about Federal funding for dredging and existing and/or expanded ferry service
WA-73-91	WDOE	Confirm all structures have been excluded, recheck delineation of associated aquatic habitat
	Coast Alliance	Extend to the north to South Jetty, inland boundary should include all undeveloped sand dunes, extend south to road
	Corps of Engineers Seattle District	Could impair maintenance of existing Federal Grays Harbor South Jetty navigation project and South Jetty protection measures
	Port of Grays Harbor Aberdeen, WA	North end excessive, eliminate northern 2,400 feet or reduce to only include primary dune system
	Westport Shipyard, Inc. Westport, WA	No historical record of extensive storm damage to warrant inclusion
	Richard E. Roller Westport, WA	Remove from consideration, current State and local regulation adequate
WA-74-91	WDOE	Site appears to meet criteria, area to north may also
	Coast Alliance	O.K.
	Westport Shipyard, Inc. Westport, WA	No historical record of extensive storm damage to warrant inclusion
WA-75-91	WDOE	Confirm south boundary and exclude structures
	Coast Alliance	Extend northern boundary, extend inland boundary to Hwy. 105, extend southern boundary full length of beach to include all undeveloped beach and sand dunes
	Westport Shipyard, Inc. Westport, WA	No historical record of extensive storm damage to warrant inclusion
WA-76-91	WDOE	Site appears to meet criteria
	Coast Alliance	Extend to west of Cape Shoalwater, make inland line more even, unclear how determined
	Corps of Engineers Seattle District	Could preclude use of existing dredged material disposal site

Table A-2 (continued). Summary of site specific comments on the 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

Unit Number	Organization/Name	Comment
WA-77-91	WDOE	Site appears to meet criteria
	Coast Alliance	Eastern boundary include Leadbetter Point State Park, sand dunes, and associated wetlands, would like to include Willapa Bay
	George O. Gregg Snohomish, WA	State and local regulations adequate, do not include this unit
	Orlien N. Becker Snohomish, WA	Governed by State and county, Federal rules not necessary, delete portion which affects Long Beach Peninsula
WA-78-91	WDOE	Site appears to meet criteria
	Coast Alliance	Include all of Long Island
WA-79-91	WDOE	Confirm all structures excluded, extend south to Beard's Hallow, confirm northern boundary and wetlands
	Coast Alliance	Combine with 80 as a single unit
	City of Long Beach Long Beach, WA	State Shoreline Management Act adequate, no history of loss of life or property, do not include in System
WA-80-91	WDOE	Site appears to meet criteria
	Coast Alliance	Combine with 79 as a single unit

Table A-3. Summary of general comments on 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

State	Organization/Name	Comment
California	California Department of Boating and Waterways Sacramento, CA	Inclusion is an unnecessary procedure for protection
	California Department of Transportation Sacramento, CA	Delineation should be outside of existing highway right of way, may constrain future transportation options
	San Diego Association of Governments San Diego, CA	Keep options for federal funding; county level protection adequate
	Coast Alliance Washington, D.C.	Include California in System; expand to include additional undeveloped coastlines subject to hazards
	Association of Monterey Bay Area Governments Marina, CA	Request to be added to mailing list
Hawaii	Coast Alliance Washington, D.C.	Include Hawaii in System; expand to include additional undeveloped coastlines and coral reefs
Oregon	George & Rhonda Osterag Salem, OR	Include in System
	Columbia River Estuary Study Taskforce Astoria, OR	Concerned about need for and the implications of the program
	Port of Siuslaw Florence, OR	Unneeded restrictions
	City of Florence Florence, OR	Do not include Oregon coast; State and local regulations are adequate
	1000 Friends of Oregon Portland, OR	Support inclusion; expand to include entire undeveloped coastal ecosystem
	Board of Commissioners Tillamook, OR	Reject inclusion of Oregon coastal areas
	Coast Alliance Washington, D.C.	Include Oregon in System; expand to include additional undeveloped coastlines subject to hazards
	E. Zahn Port Ludlow, WA	Include Washington and Oregon in the System

Table A-3 (continued). Summary of general comments on 1991 draft coastal barrier maps for California, Hawaii, Oregon, and Washington.

State	Organization/Name	Comment
Washington	Senator Sid Snyder Long Beach, WA	Opposition; unnecessary and unwanted
	Milton R. Towne Westport, WA	Support inclusion in System
	Gene & Delores Karthauser Colbert's Sturgeon Farms Long Beach, WA	Support inclusion in System
	Kurt & Linda Reiber	Include Washington coast in System
	Bonnie B. Robbins Seattle, WA	Include fragile coastal areas
	Mrs. G. B. Cote Anacortes, WA	Include WA and OR in System
	Columbia River Estuary Study Taskforce Astoria, OR	Concerned about need for and the implications of the program
	Pacific County Commissioners South Bend, WA	Do not include WA nor Pacific County; unnecessary layer of regulation
	Marjorie Blodgett Washougal, WA	Include Washington in System
	Donna Abell Marysville, WA	Include Washington in System
	Sylvan W. Law Olympia, WA	Include Pacific Coast in System
	John L. Greenbaum West Lafayette, IN	Favor inclusion in System
	Bureau of Indian Affairs Portland, OR	Recognize Indian treaty rights; consult directly with tribes
	E. Zahn Port Ludlow, WA	Include WA and OR coastlines
	Coast Alliance Washington, D.C.	Include Washington in System, expand to include additional undeveloped coastlines subject to hazards
	Lummi Indian Business Council Bellingham, WA	Concerned about the process; Service to work directly with Tribal governments

Appendix B. Potential California Coastal Barrier Resources System Units.

County	Unit Number[a]	Unit Name	Shoreline (miles)	Fastland[b] (acres)	Wetland[c] (acres)	Total Area (acres)
Del Norte	CA-01	Smith River/Lake Earl	11.3	2,130	4,750	6,880
Del Norte	CA-02	Whaler Island	2.7	95	152	236[d]
Del Norte	CA-03	Klamath River	1.2	70	831	901
Humboldt	CA-04	Fern Canyon	4.1	367	84	451
Humboldt	CA-05	Gold Bluffs	1.0	43	31	74
Humboldt	CA-06	Redwood Creek	0.6	52	124	174[e]
Humboldt	CA-07	Freshwater Lagoon	0.9	61	243	304
Humboldt	CA-08	Stone Lagoon	0.9	66	619	685
Humboldt	CA-09	Dry Lagoon	0.4	21	66	87
Humboldt	CA-10	Big Lagoon	3.6	239	1,417	1,656
Humboldt	CA-11	Little River	0.6	49	34	83
Humboldt	CA-12	Clam Beach/Mad River	12.6	1,022	366	1,388
Humboldt	CA-13A	North Spit	3.4	645	153	759[f]
Humboldt	CA-14	South Spit	4.5	647	4,477	5,124
Humboldt	CA-15	Eel River	9.1	781	2,783	3,564
Humboldt	CA-16	Mattole Beach	1.1	46	177	223
Mendocino	CA-17	Usal Creek	0.3	6	12	18
Mendocino	CA-18	Ten Mile River	0.3	19	15	34
Mendocino	CA-18A	Inglenook	1.6	215	73	288
Mendocino	CA-19	Navarro River	1.1	13	46	59
Mendocino	CA-20	Alder Creek	0.5	8	8	16
Mendocino	CA-21	Manchester Beach S.P. (north)	0.4	29	8	37
Mendocino	CA-22	Manchester Beach S.P. (center)	0.7	81	103	184
Mendocino	CA-23	Manchester Beach S.P. (south)	0.8	128	108	236

Appendix B (continued). Potential California Coastal Barrier Resources System Units.

County	Unit Number	Unit Name	Shoreline (miles)	Fastland (acres)	Wetland (acres)	Total Area (acres)
Mendocino/ Sonoma	CA-24	Gualala River	0.5	23	59	82
Sonoma	CA-25	Russian River	0.6	24	144	168
Sonoma	CA-26	Salmon Crk Beach	0.3	14	31	45
Marin	CA-27	Abbotts Lagoon	1.0	152	228	380
Marin	CA-27A	Drakes Beach	0.3	17	35	52
Marin	CA-28	Drakes Estero	3.8	382	2,399	2,781
Marin	CA-29	Rodeo Cove	0.3	10	40	50
San Mateo	CA-30	Laguna Salada	0.4	31	21	52
San Mateo	CA-31	Elmar Beach	0.4	18	5	23
San Mateo	CA-32	Pescadero Creek	0.5	21	280	301
Santa Cruz	CA-33	Waddell Creek	0.4	9	8	17
Santa Cruz	CA-34	Scott Creek	0.5	21	6	27
Santa Cruz	CA-35	Sunset State Beach	0.4	15	13	28
Santa Cruz/Monterey	CA-36	Zmudowski Beach S.P.	3.3	248	206	454
Monterey	CA-37	Moss Landing	1.2	78	46	124
Monterey	CA-38	Salinas River	1.6	120	268	388
Monterey	CA-39	Little River	0.3	14	35	49
Monterey	CA-40	La Cruz Rock	0.3	11	31	42
San Luis Obispo	CA-41	Morro Bay S.P.	3.4	613	2,275	2,888
San Luis Obispo	CA-42	Pismo State Beach (north)	1.1	155	82	237
San Luis Obispo	CA-43	Pismo State Beach (south)	0.5	67	15	82
San Luis Obispo	CA-44	Oso Flaco Lake	0.6	150	155	305
San Luis Obispo/Santa Barbara	CA-45	Santa Maria River	1.0	77	281	358

Appendix B (continued). Potential California Coastal Barrier Resources System Units.

County	Unit Number	Unit Name	Shoreline (miles)	Fastland (acres)	Wetland (acres)	Total Area (acres)
Santa Barbara	CA-46	Santa Ynez River	0.7	35	214	249
Santa Barbara	CA-47	Goleta Beach C.P.	0.7	12	21	33
Santa Barbara	CA-47A	Coal Oil Point	0.3	8	77	85
Ventura	CA-48	Santa Clara River	0.6	18	113	131
Ventura	CA-49	Mcgrath Lake	0.6	31	27	58
Ventura	CA-50	Ormond Beach	1.2	56	83	139
Ventura	CA-51	Mugu Lagoon	5.9	462	1,403	1,865
Los Angeles	CA-52	Malibu Point	0.4	12	27	39
San Diego	CA-53	San Mateo Point	0.8	36	75	111
San Diego	CA-54	Las Flores Creek	0.5	19	19	38
San Diego	CA-55	Santa Margarita river	1.2	80	285	365
San Diego	CA-56	Agua Hedionda	0.5	28	42	70
San Diego	CA-57	Batiquitos Lagoon	0.4	23	25	48
San Diego	CA-59	Silver Strand	1.2	172	737	909
San Diego	CA-60	Tijuana Slough	2.1	125	569	694
TOTAL SHORELINE AND ACREAGE:			103.5	10,220	27,060	37,228

[a] The following units have been deleted based on the 1992 public review and comment period: CA-13 and CA-58.
[b] Fastland = a rough estimate of the area that is above the mean high tide line and/or non-wetlands. Fastland is a very general representation of potentially developable land.
[c] Wetland = a rough estimate of associated aquatic habitats, including adjacent wetlands, marshes, estuaries, and inlets.
[d] 11 acres excluded from unit.
[e] 2 acres excluded from unit.
[f] 39 acres excluded from unit.

Appendix C. Potential Hawaii Coastal Barrier Resources System Units.

Island	Unit Number	Unit Name	Shoreline (miles)	Fastland[a] (acres)	Wetland[b] (acres)	Total Area (acres)
Hawaii	HI-01	Pololu Valley	0.4	24	54	78
Hawaii	HI-02	Waimanu Bay	0.4	14	154	168
Hawaii	HI-03	Waipio Bay	0.8	57	156	213
Hawaii	HI-03A	Waiopae Ponds	0.3	19	26	45
Hawaii	HI-04	Honokohau Bay	0.3	7	24	31
Hawaii	HI-05	Kiholo Bay	0.6	12	23	33[c]
Hawaii	HI-06	Makaiwa	0.5	8	13	21
Maui	HI-07	Waihee	0.5	15	41	56
Maui	HI-08	Paukukaio	0.4	7	15	22
Maui	HI-09	Kanana Pond	0.7	31	224	231[d]
Maui	HI-10	Kealia Pond	2.4	100	588	688
Molokai	HI-11	Piplo Fishpond	0.4	2	32	34
Molokai	HI-12	Kaawanui Fishpond	0.6	18	67	85
Molokai	HI-13	Paialoa Fishpond	0.4	6	31	37
Molokai	HI-14	Lepelepe	1.3	[e]	118	118
Molokai	HI-15	Pahoa	0.6	[e]	27	27
Molokai	HI-16	Pelekunu Bay	0.3	21	25	46
Molokai	HI-17	Alii Fishpond	0.5	[e]	29	29
Molokai	HI-18	Kamiloloa	0.6	[e]	39	39
Molokai	HI-19	Kaunakakai	0.8	[e]	56	56
Molokai	HI-20	Kahanui	6.6	[e]	1,277	1,277
Kauai	HI-21	Wainiha Bay	0.3	16	12	28[f]
Kauai	HI-22	Lumahai Beach	0.3	12	111	123
Kauai	HI-23	Puu Poa Point Area	0.3	4	19	23
Kauai	HI-24	Kilauea Bay	0.3	13	58	71
Oahu	HI-25	Kii NWR	0.5	22	206	228
Oahu	HI-26	Kahana Bay	0.4	14	152	164[g]
Oahu	HI-27	Molii Pond	0.9	27	145	170[h]

Appendix C (continued). Potential Hawaii Coastal Barrier Resources System Units.

Island	Unit Number	Unit Name	Shoreline (miles)	Fastland (acres)	Wetland (acres)	Total Area (acres)
Oahu	HI-28	Waiahole Beach	1.1	7	25	32
Oahu	HI-29	Heeia	0.4	[e]	247	247
Oahu	HI-30	Nuupia Pond	1.1	67	360	427
Niihau	HI-31	Leahi Point	0.3	12	22	34
Niihau	HI-32	Nonopapa	0.7	111	148	259
Niihau	HI-33	Kiekie	0.6	38	39	77
Niihau	HI-34	Kaununui	0.5	49	38	87
TOTAL SHORELINE AND ACREAGE:			28.7	733	4,601	5,294

[a] Fastland = a rough estimate of the area that is above the mean high tide line and/or non-wetlands. Fastland is a very general representation of potentially developable land.
[b] Wetland = a rough estimate of associated aquatic habitats, including adjacent wetlands, marshes, estuaries, and inlets.
[c] 12 acres excluded from unit.
[d] 24 acres excluded from unit.
[e] Fastland acreage too small to delineate.
[f] 0.4 acres excluded from unit.
[g] 2 acres excluded from unit.
[h] 2 acres excluded from unit.

Appendix D. Potential Oregon Coastal Barrier Resources System Units.

County	Unit Number	Unit Name	Shoreline (miles)	Fastland[a] (acres)	Wetland[b] (acres)	Total Area (acres)
Clatsop	OR-01-91	Columbia R./Clatsop Spit	8.8	820	1,852	2,672
Clatsop	OR-02-91	Necanicum River	0.8	87	196	283
Clatsop	OR-03-91	Chapman Beach/Ecola Creek	0.3	16	15	31
Tillamook	OR-04-91	Nehalem Spit & Bay	2.5	430	2,208	2,638
Tillamook	OR-05-91	Manhattan Beach	0.5	20	5	25
Tillamook	OR-06-91	Bayocean Peninsula/ Tillamook Bay	4.4	821	8,634	9,455
Tillamook	OR-07-91	Netarts Spit & Bay	5.1	478	2,596	3,074
Tillamook	OR-08-91	Sand Lake Estuary	2.1	253	1,138	1,391
Tillamook	OR-09-91	Nestucca Spit & Bay	2.5	343	776	1,119
Tillamook	OR-10-91	Kiwanda Beach	1.3	117	80	197
Tillamook/ Lincoln	OR-11-91	Salmon River Estuary	0.6	92	197	289
Lincoln	OR-12-91	Salishan Spit/Siletz Bay	0.6	47	359	406
Lincoln	OR-13-91	South Beach	1.5	151	107	258
Lincoln	OR-14-91	Ona Beach/Beaver Creek	0.5	22	28	50
Lane	OR-15-91	Baker Beach	3.4	533	457	990
Lane	OR-16-91	Heceta Beach	0.7	94	67	161
Lane/ Douglas	OR-17-91	Oregon Dunes	18.6	1,917	1,934	3,851
Douglas	OR-18-91	North Spit/Umpqua R.	5.5	1,972	3,443	5,415
Coos	OR-19-91	North Spit & Coos Bay/Oregon Dunes	20.7	2,881	5,691	8,572
Coos	OR-20-91	Bullards Beach/Coquille River	4.5	711	988	1,699
Coos/Curry	OR-21-91	New River	13.2	1,124	1,306	2,430
Curry	OR-22-91	Sixes River	0.6	48	143	191
Curry	OR-23-91	Elk River	2.0	103	143	246
Curry	OR-24-91	Garrison Lake	0.8	62	131	193

Appendix D (continued). Potential Oregon Coastal Barrier Resources System Units.

County	Unit Number	Unit Name	Shoreline (miles)	Fastland (acres)	Wetland (acres)	Total Area (acres)
Curry	OR-25-91	Euchre Creek	0.7	44	61	105
Curry	OR-26-91	Greggs Creek	0.4	13	15	28
Curry	OR-27-91	Hunter Creek	0.3	13	39	52
Curry	OR-28-91	Pistol River	1.7	166	40	206
TOTAL SHORELINE AND ACREAGE:			104.6	13,378	32,649	46,027

[a] Fastland = a rough estimate of the area that is above the mean high tide line and/or non-wetlands. Fastland is a very general representation of potentially developable land.
[b] Wetland = a rough estimate of associated aquatic habitats, including adjacent wetlands, marshes, estuaries, and inlets.

Appendix E. Potential Washington Coastal Barrier Resources System Units.

County	Unit Number[a]	Unit Name	Shoreline (miles)	Fastland[b] (acres)	Wetland[c] (acres)	Total Area (acres)
Whatcom	WA-01	Semiahmoo Spit/Drayton Harbor	0.8	26	561	587
Skagit	WA-04	Sinclair Island	0.3	4	9	13
San Juan	WA-05	Waldron Island	0.3	8	11	19
San Juan	WA-06	Henry Island/Nelson Bay	0.9	27	106	133
San Juan	WA-07	Fisherman Bay North	0.4	15	65	80
San Juan	WA-08	Fisherman Bay South	0.7	15	235	250
San Juan	WA-09	Low Point	0.3	2	4	6
San Juan	WA-10	San Juan Island South	0.3	4	3	7
San Juan	WA-11	Mud Bay/Shoal Bight	0.8	7	79	86
San Juan	WA-12	Spencer Spit	0.7	8	12	20
San Juan	WA-13	Decatur Head	0.3	8	138	146
Skagit	WA-14	Guemes Island	0.5	16	14	30
Skagit	WA-15	Padilla Bay	0.7	8	36	44
Skagit	WA-15A	Ship Harbor	0.4	11	23	34
Island	WA-17	Ben Ure Spit	0.4	7	96	103
Island	WA-18	Cranberry Lake	0.5	36	162	198
Island	WA-19	South of Cranberry Lake	0.5	24	28	52
Island	WA-20	Arrowhead Beach	0.3	7	6	13
Island	WA-21	Polnell Point	1.1	12	4	16
Island	WA-22	Crescent Harbor Area	1.1	56	220	276
Island	WA-23	Oak Harbor Area	0.7	21	48	69
Island	WA-24	Whidbey Island NW	1.1	23	50	73
Island	WA-25	Whidbey Island SW	0.8	29	26	55
Island	WA-26	Crockett Lake	1.2	88	569	657
Island	WA-27	Race Lagoon	0.9	16	38	54
Island	WA-28	Whidbey Island East	0.5	8	13	21
Island	WA-29	Lake Hancock	0.7	15	193	208
Island	WA-30	Useless Bay Area	0.5	9	23	32

Appendix E (continued). Potential Washington Coastal Barrier Resources System Units.

County	Unit Number	Unit Name	Shoreline (miles)	Fastland (acres)	Wetland (acres)	Total Area (acres)
Island	WA-31	Cultus Bay	0.4	11	89	100
Kitsap	WA-33	Battle Point	0.5	5	6	11
King	WA-34	Point Heyer	0.4	5	7	12
Pierce	WA-35	McNeil Island	0.6	3	4	7
Mason	WA-37	Buffingtonis Lagoon	0.3	3	4	7
Pierce	WA-38	Vaughn Bay	0.4	5	163	168
Pierce	WA-39	Henderson Bay Area	0.5	7	62	69
Kitsap	WA-40	Stavis Bay	0.3	5	45	50
Jefferson	WA-41	Zelatched Point	0.4	2	4	6
Jefferson	WA-42	Tarboo Bay	1.3	33	291	324
Jefferson	WA-43	Toandos Peninsula East	0.3	2	5	7
Jefferson	WA-44	Thorndyke Bay	0.4	9	91	100
Jefferson	WA-46	Bywater Bay	0.7	7	150	157
Kitsap	WA-47	Fowlweather Bluff East	0.3	4	21	25
Kitsap	WA-48	Fowlweather Bluff	0.6	10	27	37
Jefferson	WA-49	Oak Bay East	0.4	11	9	20
Jefferson	WA-50	Oak Bay	0.6	10	27	37
Jefferson	WA-51	Oak Bay West	0.4	11	32	43
Jefferson	WA-52	Kilisut Harbor	0.9	25	542	567
Jefferson	WA-53	Kala Point	0.6	23	8	31
Jefferson	WA-54	Port Discovery Area	0.3	5	9	14
Clallam	WA-55	Thompson Spit	0.3	3	7	10
Clallam	WA-56	Sequim Bay	1.9	70	959	1,029
Clallam	WA-57	Kilakala Point	0.8	33	229	262
Clallam	WA-58	Dungeness Spit	5.2	261	2,960	3,221
Clallam	WA-60	Crescent Bay	0.5	26	77	103
Clallam	WA-61	Pysht River	1.1	15	298	313
Clallam	WA-62	Clallam Bay	0.9	21	15	36

Appendix E (continued). Potential Washington Coastal Barrier Resources System Units.

County	Unit Number	Unit Name	Shoreline (miles)	Fastland (acres)	Wetland (acres)	Total Area (acres)
Clallam	WA-63	Mouth Hoko River	0.4	9	12	21
Grays Harbor	WA-69	Copalis River	1.9	211	121	332
Grays Harbor	WA-70	Conner Creek	1.3	149	17	158[d]
Grays Harbor	WA-71	Ocean Shores	6.5	442	147	
Grays Harbor	WA-72	Ocean Shores South	1.9	185	247	432
Grays Harbor	WA-73	Westport	2.2	366	131	475[e]
Grays Harbor	WA-74	Grayland North	0.6	27	19	46
Pacific	WA-75	Grayland Beach	1.0	93	34	127
Pacific	WA-75A	Grayland South	0.4	21	34	55
Pacific	WA-76	Empire Spit	3.4	264	626	890
Pacific	WA-77	North Beach Peninsula	6.3	1,473	3,380	4,853
Pacific	WA-78	Jensen Point	1.0	9	192	201
Pacific	WA-79	Long Beach/Seaview	4.5	535	191	726
Pacific	WA-80	Cape Disappointment	1.5	158	68	226
TOTAL SHORELINE AND ACREAGE:			71.9	5,077	14,132	19,179

[a] The following units have been deleted based on the 1992 public review and comment period: WA-02, WA-03, WA-16, WA-32, WA-36, WA-45, WA-59, WA-64, WA-65, WA-66, WA-67, WA-68.

[b] Fastland = a rough estimate of the area that is above the mean high tide line and/or non-wetlands. Fastland is a very general representation of potentially developable land.

[c] Wetland = a rough estimate of associated aquatic habitats, including adjacent wetlands, marshes, estuaries, and inlets.

[d] 8 acres excluded from unit.

[e] 22 acres excluded from unit.