Pacific Northwest estuaries range from large (Washington's Grays Harbor, 58,000 acres) to small (Oregon's Twomile Creek, 20 acres); from rural (Big Creek estuary in Lincoln County, Oregon) to urban (Puget Sound in Washington, supporting a population of 3.9 million); and from pristine to seriously degraded. They are used as stopovers by migratory birds, as spawning and nursery habitat for salmon, and—for people—as places of reflection, recreation, and commerce.

Estuary management consists largely of understanding issues and stakeholders, regulating use, and monitoring development. However, it also involves knowing the ecological system and its cycles, characteristics, tendencies, and trends. Indeed, lack of information might be the single thing that most hinders effective management. In this book, the Pacific Northwest Coastal Ecosystems Regional Study provides the basic information about estuaries in the region, including acreage, major population centers, natural features, and freshwater sources. The book also discusses federal and state agencies and other groups involved in estuary management, and it examines the perennial issues that arise when human development competes with natural habitat.

The book covers 4 estuaries in Washington, 22 in Oregon, and 1 in northern California.

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Estuary Management in the Pacific Northwest

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Pacific Northwest Coastal Ecosystems Regional Study

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An Overview of Programs and Activities in Washington, Oregon, and Northern California

Pacific Northwest Coastal Ecosystems Regional Study

Oregon Sea Grant
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OREGON STATE UNIVERSITY

The Pacific Northwest Coastal Ecosystems Regional Study
The Pacific Northwest Coastal Ecosystems Regional Study (PNCERS) is an interdisciplinary, multiyear study aimed at helping coastal managers and policymakers understand how estuarine and nearshore ecosystems of the Pacific Northwest coast are affected by natural variability in environmental conditions and by human activities. PNCERS is a partnership of the Oregon Coastal Management Program, Washington Sea Grant, and the National Marine Fisheries Service, in cooperation with Oregon Sea Grant, and is funded by the National Oceanic and Atmospheric Administration Coastal Ocean Program.

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Contents

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Abbreviations

BCDC	Bay Conservation and Development Commission (California))
CCC	California Coastal Commission
CCMP	comprehensive conservation and management plan
Coast Guard	U.S. Coast Guard
the Corps	U.S. Army Corps of Engineers
CREST	Columbia River Estuary Study Taskforce
DEQ	Oregon Department of Environmental Quality
DLCD	Department of Land Conservation and Development
EPA	Environmental Protection Agency
GHEMP	Grays Harbor Estuary Management Program (Washington)
MLMA	Marine Life Management Act
NERRS	National Estuarine Research Reserve System
NOAA	National Oceanic and Atmospheric Administration
ODFW	Oregon Department of Fish and Wildlife
PNCERS	Pacific Northwest Coastal Ecosystems Regional Study
SEPA	State Environmental Policy Act (Washington)

1 Introduction

This report has been prepared in support of the Pacific Northwest Coastal Ecosystems Regional Study (PNCERS) to provide a summary and compendium of the management of estuaries in the Pacific Northwest of the United States that lie between Puget Sound, Washington, and Cape Mendocino, California. Federal, state, and local government management programs and any significant special programs (for example, National Estuarine Research Reserves and National Estuary Programs) are summarized, and the management of each major estuary is referenced.

Information is referenced either by agency source or specific document from a variety of sources, including governmental and tribal Web sites, from which we have quoted liberally. Agency contacts and document references are given in the References.

Organization

In general, the discussion in each section proceeds from north to south: Washington, the co-managed Columbia River, Oregon, and Humboldt Bay in northern California.

The historical progress of estuary management in the region is captured in a time line of moments or events in each state. Part two describes the estuaries in the PNCERS study area, including estuary type, size, and general physical, biological, and cultural characteristics. Part three lists the many federal, tribal, and state agencies involved in estuary management and briefly describes legal authorities and programs. Part four details management programs and planning approaches for each of the three states and for the estuaries of principal interest to PNCERS. Finally, part five explores estuarine management issues that

are common to the region and describes how management programs in the three states respond.

Scope

This report reviews 4 estuaries in Washington, 22 in Oregon, and 1 in northern California. The overview of state and local management strategies and programs is descriptive and does not analyze effectiveness or make value judgments. It is intended to help estuary resource managers and practitioners—those who are involved in a variety of estuary-related activities, such as restoration and education—learn more about the variety of strategies and programs being pursued to protect, manage, and restore estuaries in the Pacific Northwest.

Treatment of the Lower Columbia River Estuary and the Puget Sound Estuary

The lower Columbia River estuary and Puget Sound are large systems and are both extremely important economically, ecologically, and politically. By nature of their size and significance, they are also entities unto themselves, with a multiplicity of management programs and activities. Neither the Columbia River nor Puget Sound is included in the PNCERS physical, biological, or social science research, and as a result, neither is described in as much detail as other estuaries. This report includes basic resource and management information about these estuaries. An appendix contains a list of additional reading.

The PNCERS Perspective

The Pacific Northwest Coastal Ecosystems Regional Study attempts to create a link between the body of scientific information and understanding of coastal ecosystems and the management of estuarine and coastal resources. Unique physical, biological, economic, cultural, and political conditions provide the framework for considering this region's estuaries. These conditions were summarized in a 1996 PNCERS publication entitled *Change in Pacific Northwest Coastal Ecosystems.*

> Pacific Northwest coastal ecosystems are part of a dynamic natural system that is widely variable across spatial and temporal scales. Numerous atmospheric, oceanic, hydrologic, and ecological processes intersect in the region at the eastern edge of the Pacific Ocean Basin, where the eastward-flowing Subarctic Current encounters the North American continent and bifurcates to form two distinct components, the northern-flowing Alaska Current and the southward-flowing California Current. The California Current system, an eastern boundary current, is a complex transitional zone between water masses in the larger Pacific Ocean Basin and freshwater discharged from coastal watersheds. The Pacific Northwest Coastal Ecosystems Regional Study (PNCERS)

area, generally between Vancouver Island and Cape Mendocino, is a zoogeographic transition between the Aleutian biological province to the north and California to the south.

Habitat conditions and ecosystem relationships are many and complex throughout the region. The interaction of highly variable atmospheric, oceanic, and biological processes results in continually shifting water-column habitat nearshore and over the continental shelf. Differences in shoreline geomorphology create a variety of habitat conditions. Rocky shores and associated reefs occur along Washington's Olympic Peninsula, southern Oregon, and northern California coasts. Numerous small estuaries south of the large Columbia River estuary contrast with two large coastal estuaries in Washington to the north and Humboldt Bay to the south, near Cape Mendocino.

Policy and management related to coastal resources have not always given adequate consideration to the ecosystem context of the resources, the variability of natural systems, or the cumulative effects of resource use and human perturbations over time. Today, increasing demands for coastal resources and the compromised nature of coastal ecosystems require that management and use of resources be far more responsive to the limits and conditions of the ecosystem than ever before. In turn, developing and carrying out management programs that are more ecosystem sensitive will require a better understanding of coastal ecosystem function and variability, the effects of management practices on the ecosystem, and the economic and social consequences of natural ecosystem variability and degradation by human activities.

Definitions of *Estuary*

The definitions of an estuary are many and reflect the high degree of variability among estuaries in the real world. These definitions share features but can be specific, broad, technical, or biological. It appears that one person's estuary is another person's tidal wetland. Below are some scientific, legal, and functional definitions of estuary.

estuary, n. 1. that part of the mouth or lower course of a river in which the river's current meets the sea's tide. 2. an arm or inlet of the sea at the lower end of a river (*Random House Unabridged Dictionary,* p. 664)

estuary, an enclosed body of water where a river interacts with the ocean, generally characterized by a range of salinity from oceanic values (33 ppt) to freshwater; estuaries are unique and essential habitats for early life-history stages of many species (PNCERS, 1998)

estuary, includes estuarine water, tidelands, tidal marshes and submerged lands. Estuaries extend upstream to the head of tidewater, except for the Columbia River estuary, which by definition extends into the western edge of Puget Island (*Oregon Statewide Planning Goal for Estuaries*—Goal 16, Estuarine Resources).

estuary, a semi-enclosed body of water, connected to the ocean, where salt water is measurably diluted with fresh water from the land. . . . It is a zone of transition between the marine-dominated systems of ocean and the upland river systems, a zone where the mix of the two yields one of the most biologically productive zones on Earth. . . . Estuaries are not a single habitat, but rather a complex and interrelated web of habitats defined and distinguished by the interplay of geology, river-flows, tides, and other factors. (*Oregon Estuary Planbook,* 1987)

estuary, a semi-enclosed, glacial fjord where saltwater from the ocean is mixed with fresh water draining from the surrounding watershed. (Puget Sound Water Quality Action Team)

estuary, a part of a river or stream or other body of water that has an unimpaired connection with the open sea and where the sea water is measurably diluted with fresh water derived from land drainage. The term also includes near coastal waters and wetlands of the Great Lakes that are similar in form and function to estuaries. (Estuaries and Clean Waters Act of 2000)

estuary, a partially enclosed body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the salty sea water. Estuaries and the lands surrounding them are places of transition from land to sea, and from fresh to salt water. Although influenced by the tides, estuaries are protected from the full force of ocean waves, winds, and storms by the reefs, barrier islands, or fingers of land, mud, or sand that define an estuary's seaward boundary. (EPA Office of Water)

estuary, a coastal waterbody where ocean water is diluted by out-flowing fresh water (Puget Sound Water Quality Action Team, *Puget Sound Water Quality Management Plan,* 2000 Draft)

estuary, body of water partly surrounded by land where fresh water from rivers and streams runs into and mixes with salt water from the ocean. Estuary is another name for bay, sound, inlet, harbor, lagoon. (Restore America's Estuaries Coalition)

estuaries in Oregon are, in reality, complex systems made up of parts of four major subsystems: riverine, slough, bay and marine subsystems. These parts blend from one another with no clear demarcation, but each has some distinct characteristics:

> The riverine subsystem dominates where the river flows from the mountains into the estuary. This wide single channel meanders through marshlands, many of which have been diked for pasture.
>
> A slough subsystem occurs where small tributary streams with very little flow make their way toward the main channel. Salt marshes fringe these drainage ways.

> The bay is dominated by broad tidal flats of mud and sand. This area will be covered by water at high tide.
>
> At the mouth of the estuary, the surging flood tide brings the marine environment into the estuary. (*Oregon Estuary Planbook,* 1987)

estuaries and coastal lagoons, waters at the mouths of streams which serve as mixing zones for fresh and ocean water during a major portion of the year. Mouths of streams which are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant mixing of fresh and saltwater occurs in the open coastal waters. (California State Water Resources Control Board)

Management Time Line

The time line on the following pages charts nearly 150 years of management initiatives for Washington, Oregon, California, and the federal government. It includes major events—for example, the 1976 approval of the Washington State Coastal Management Plan—and significant pieces of legislation that affect estuary management today.

Time Line of Management Initiatives

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1851				State of California enacts first law specifically dealing with fish and game matters—specifically, the right to take oysters and the protection of property rights of persons planting oysters.
1855	Treaties between the U.S. government and several Northwest Indian tribes are signed relegating the tribes to reservations. Rights to fish and hunt in traditional tribal places are reserved.			
1870				Board of Fish Commissioners, forerunner to the California Fish and Game Commission, is established—the first wildlife conservation agency in the U.S.
1871	U.S. Commission of Fish and Fisheries is established.			
1889		Washington statehood—all submerged lands title given to state.		
1890		Bush Act is passed by Washington State legislature governing oyster tidelands. Any person purchasing tidelands unfit for oyster cultivation could cancel the deed.		
1899	Rivers and Harbors Act			
1913			Oswald West Act (declares all wet sand and beaches to be public highways)	

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1918	Migratory Bird Treaty Act			
1934	1934 Indian Reorganization Act			
1948	Federal Water Pollution Control Act			
1949		Hydraulic Code passed—requires that any person, organization, or government agency wishing to conduct any construction activity in or near state waters must do so under the terms of a permit issued by the Washington State Department of Fish and Wildlife.		
1953	Submerged Lands Act			
1956	Fish and Wildlife Coordination Act—authorizes the development and distribution of information and the development of policies and procedures related to fish and wildlife. Is implemented by the Department of Interior.			
1961	Passage of the first Anadromous Fish Conservation Act authorizing a cooperative grant program with the states			

Time Line of Management Initiatives, cont.

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1965	Pollution Control in Navigable Waters Act Water Resources Planning Act	Marine Recreation Lands Act		California Legislature passes the McAteer-Petris Act (creating a temporary agency called the Bay Conservation and Development Commission, BCDC).
1966	National Wildlife Refuge System Administration Act			
1967		Washington Clean Air Act Seashore Conservation Act is enacted; explicitly dedicates Washington state beaches to public recreation.	Oregon Beach Bill (provides for public use, recreation, and enjoyment of the ocean shore in perpetuity)	
1969	National Environmental Policy Act (requiring environmental assessments)		ORS 215 (requires all lands of the state to be subject to local government comprehensive plans and zoning ordinances)	McAteer-Petris Act is amended to make the BCDC permanent and to make the SF Bay plan state law.
1970	Water Quality Improvement Act National Estuary Study National Estuarine Pollution Study	Washington State Department of Ecology is established.	Citizen's initiative creating Scenic Waterways legislation March 3 gubernatorial order establishing a moratorium on all state agency activity associated with estuarine filling	
1971		Shoreline Management Act establishes a management scheme and ethic for local comprehensive planning and land use control for all shorelines in the state. State Environmental Policy Act (SEPA) Water Resources Act	Passage of bill organizing citizens and local officials to form Oregon Coastal Conservation and Development Council (ORS 191)	

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1972	Coastal Zone Management Act, including the authorization of the National Estuarine Research Reserve Program Marine Mammal Protection Act Federal Water Pollution Control Act (Clean Water Act)—establishes Section 404 permit program regulating the discharge of dredge and fill material (administered by the Corps with EPA oversight)			Proposition 20, the Coastal Conservation Initiative, a citizens' initiative, is approved as a temporary measure in November and made permanent by the California Coastal Act of 1976. Public access, privatization, and low-quality development along the shoreline are primary issues.
1973	Endangered Species Act—provides for the designation and protection of wildlife, fish, and plant species in danger of extinction Ramsar Convention adopted (enforced in 1975).		Passage of the Oregon Land Use Act, Chapter 197 (Establishes Land Conservation and Development Commission [LCDC] and the basic policies of Oregon's Land Use Program)	
1974	The nation's first estuarine sanctuary is established in South Slough Estuary, Coos Bay	The Council on Environmental Policy is created and is directed to write the procedures and guidelines that eventually become the SEPA Guidelines (1976).	The nation's first estuarine sanctuary is established in South Slough Estuary, Coos Bay	Suisun Marsh Preservation Act is passed for San Francisco Bay (requires the development of a marsh protection plan)

Time Line of Management Initiatives, cont.

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1974, cont.		U.S. District Court Judge George Boldt rules that the tribes had reserved the right to half of the harvestable salmon and steelhead in western Washington *(US* v. *Washington*). As a result of the Boldt decision, tribes become responsible for establishing fishing seasons, setting harvest limits, and enforcing tribal fishing regulations.		
1975		State Water Pollution Control Act Washington Tanker Safety Act—in anticipation of the opening of the Trans Alaska Pipeline, the Act is an attempt to regulate tanker safety by requiring state pilots in "coastwise trade," tug escorts for tankers, double hull construction, use of VTS within Puget Sound, and exclusion of tankers greater than 125,000 DWT from Puget Sound.	The Department of Land Conservation and Development is designated Oregon's coastal zone management agency. LCDC adopts first 14 of Oregon's statewide planning goals.	California Coastal Commission adopts the California Coastal Plan (a decentralized, local coastal planning process with state oversight and consistency review)

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1976	Fishery Conservation and Management Act Federal Land Policy and Management Act of 1976, which requires the Bureau of Land Management to manage in a way that accommodates many uses of the land, such as fishing, camping, hiking, boating, grazing, timber harvesting, and mining.	SEPA Guidelines come into effect NOAA approves the Washington State Coastal Management Program Grays Harbor Estuary Management Plan Task Force forms with Coastal Zone Management Act grant for the purpose of developing an integrated estuary plan.	LCDC adopts statewide planning requirements that promote estuary planning at the local level (with active state and federal agency participation)—Goals 16–19: Estuarine Resources, Coastal Shorelands, Beaches and Dunes, Ocean Resources. The planning framework was used to prepare plans for 17 of Oregon's major estuaries and adjacent shorelands. Plans feature an estuary classification system, integrated planning approaches, mitigation and mitigation banking, and outcome effectiveness accounting.	The California Coastal Act (CPRC 3000 *et seq.*) is enacted to provide long-term protection of California's 1,100-mile coastline. The act adopts recommendations contained in the California Coastal Plan called for in Proposition 20. Land Parks Act Porter-Cologne Water Quality Act establishes State Water Resources Control Board and each regional water quality control board as the principal state agencies for having primary responsibility in coordinating and controlling water quality in California.
1977			Formal approval of Oregon's Coastal Management Program by Federal Office of Coastal Zone Management. Amendments to ORS 197 and re-appeal of ORS 191 underscore the state's commitment to CZM and land-use planning	California's Coastal Management Program is approved and the California Coastal Commission, along with San Francisco's BDCD, is delegated the authority to carry out the state's program.

Time Line of Management Initiatives, cont.

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1978				U.S. Secretary of Commerce approves California's coastal zone management plans. BCDC is named the lead agency for San Francisco Bay, and the California Coastal Commission (CCC) is named the lead agency for the rest of the coast.
1979			Oregon legislature establishes the Land Use Board of Appeals, refines and codifies estuary mitigation require-ments.	
1981		Legislature creates the Commission on Environmental Policy to evaluate and suggest possible amendments to SEPA Guidelines with the goals of reducing paperwork, duplication, and delay and of improving the quality of envi-ronmental decision making.	Oregon legislature establishes "Post-Acknowledgement" procedures for amendment and periodic review of acknowledged comprehensive plans.	CCC adopts "Statewide Interpretive Guidelines for Wetlands and Other Wet Environmentally Sensitive Habitat Areas" (used to identify wetlands, interpret Coastal Act wetland policies, assist in permit applications, describe mitigation measures and buffers, and outline restoration procedures).
1982		Aquatic Lands Act enacted to provide for management of state-owned public trust resources in a manner con-sistent with the public trust doctrine.		
1983			Oregon legislature refines post-acknowledgment procedures and makes the Land Use Board of Appeals a permanent quasi-judicial body.	

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1984		SEPA Rules come into effect (the work of the Commission on Environmental Policy), replacing the SEPA Guidelines.	LCDC amends statewide planning goals, including Goal 2 (Land Use Planning), Goal 8 (Recreation Needs), and Goals 16–19 (Coastal Resources Goals).	California Parks and Recreational Facilities Act Fish and Wildlife Enhancement Act
1985	Coastal Zone Management Act Amendments change the name of the National Estuarine Research Reserve Program to the National Estuarine Research Reserve System (NERRS) to highlight the research dimension, add a coordinated research and monitoring program, and encourage education programs that will serve the entire system.	Puget Sound Water Quality Authority created to oversee implementation of Puget Sound Basin/Puget Sound management plan.		
1986		Grays Harbor Estuary Management Plan (GHEMP) adopted by GHEMP Task Force.		
1987	Congress authorizes the National Estuary Program.	PSWQ Management Plan is developed (updated 1991, 1994, 1996, 2000).	State Ocean Resources Management Act	
1988	National Estuaries Day is established to celebrate the importance of America's estuaries and to promote awareness and education about these coastal bays, sounds, and lagoons.	Puget Sound is designated an Estuary of National Significance by EPA and given priority for cleanup and protection.		Wildlife, Coastal and Park Land Conservation Act (Proposition 20)
1989	North American Wetlands Conservation Act			

Time Line of Management Initiatives, cont.

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1990	Coastal Zone Act Reauthorization Amendments create the Coastal Nonpoint Pollution Control Program (CZARA section 6217). Oil Pollution Act—enhances the response to oil spills and requires natural resource damage assessments Endangered Species Act reauthorization Nonindigenous Aquatic Nuisance Prevention and Control Act—creates a federal program to prevent and control the spread of aquatic nuisance species	Growth Management Act Coordinated Tribal Water Quality Program is developed by 26 of Washington's federally recognized tribes.		The Lempert-Keene-Seastrand Oil Spill Prevention and Response Act of 1990 establishes California's Oil Spill Prevention and Response program. The Marine Resources Protection Act originates with the passage of Proposition 132 in November 1990.
1991		EPA approves the Puget Sound Management Plan as the federal Comprehensive Conservation and Management Plan for the basin. Oil Spill Prevention and Response Act creates a new state agency, the Office of Marine Safety, with broad regulatory powers.		

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1992	Washington governor and British Columbia premier create the Environmental Cooperation Council.	Environmental Cooperation Act (Puget Sound and Georgia Basin agreement between Washington State and British Columbia) Grays Harbor Estuary Management Plan (GHEMP) approved by the Office of Ocean and Coastal Resource Management. Revised/amended GHEMP completed by task force but not adopted.	Oregon Governor Barbara Roberts nominates Tillamook Bay to the National Estuary Program.	
1993	NOAA adds a NERRS program office following the recommendations of a review panel. Environmental Cooperation Council forms the Puget Sound/Georgia Basin International Task force to address protection of inland marine waters.			
1994		Judge Rafeedie rules that all public and private tidelands within the case area are subject to treaty harvest, except for shellfish contained in artificially created beds. The ruling is unanimously upheld in a 1998 appeal.		

Time Line of Management Initiatives, cont.

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1995		The first amendments to the SEPA Rules, integrating SEPA with the Model Toxics Control Act and the planning process under the Growth Management Act		Completion of the Regional Cumulative Assessment Program—an in-depth analysis of the Monterey Bay region
1996	National Invasive Species Act creates federal interagency Aquatic Nuisance Species Task Force	Puget Sound Water Quality Act authorization expires. The state legislature enacts the Puget Sound Water Quality Protection Act and establishes the Puget Sound Water Quality Action Team and Puget Sound Council.		California 6217 Coastal Nonpoint Pollution Control Program is submitted to the Office of Ocean and Coastal Resource Management. The CCC implements a jurisdictionwide, computerized, permit tracing and outcomes database.
1997		The second set of SEPA amendments becomes effective. Among other things, the amendments create the Local Project Review Act, the Permit Assistance Center, and the Land Use Study Commission. The Shoreline Management Act and the Growth Management Act are amended as well.		
1998	Estuary Habitat Restoration Partnership Act is passed by the Senate.		Dairy Nutrient Management Act	

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
1999	Seven salmon species are listed under the Endangered Species Act. The listing of Puget Sound's wild chinook is the first ESA listing in the United States to affect a major urban area. Clinton signs Executive Order 13112, requiring federal agencies to collaborate in developing a national invasive species management plan. National Estuarine Research Reserves total 22 (in 19 states and Puerto Rico). Executive Order 13112 establishes Federal Invasive Species Council and calls for the development of Invasive Species Management Plan.	Aquatic Nuisance Species Management Plan developed		Marine Life Management Act (MLMA)- applies to fish and shellfish taken by commercial and recreational fishers and to all marine wildlife. MLMA shifts the burden of proof toward demonstrating that fisheries and other activities are sustainable. Through the MLMA, the California legislature delegates greater management authority to the Fish and Game Commission and the Department of Fish and Game. MLMA takes an ecosystem approach to resource management. Ballast Water Management for Control of Non-Indigenous Species Act (Assembly Bill 703)
2000	Estuary Restoration Act 2000 passes Senate and House; signed by President Clinton. Goals of the act are to establish the Estuary Habitat Restoration Council of federal agencies, develop national restoration strategy, and authorize $275 million of federal matching funds over five years (max. 65% federal share project).	Amended regulations for preparation of local Shoreline Master Programs are adopted. Substitute House Bill 2466 requires ships to comply with U.S. Coast Guard ballast water management program by July 2002.		

Time Line of Management Initiatives, cont.

DATE	FEDERAL	WASHINGTON	OREGON	CALIFORNIA
2001		Oyster growers in Grays Harbor and Willapa sign a pact with the Departments of Ecology, Agriculture, and Fish and Wildlife to "phase out" the use of the pesticide carbaryl.	Oregon Aquatic Nuisance Species Management Plan, under review	

2 Estuaries

Although estuary management consists largely of understanding issues and stakeholders, regulating use, and monitoring development, it also involves knowing the ecological system and its cycles, characteristics, tendencies, and trends. Managers participating in past PNCERS workshops have indicated that the lack of information—particularly baseline data about ecological conditions or functions—might be the single thing that most hinders effective management.

The information presented in the following pages provides the basic information about the estuaries in the region, including acreage, major population centers, natural features, and freshwater sources. Pacific Northwest estuaries range from large (Washington's Grays Harbor, 58,000 acres) to small (Oregon's Twomile Creek, 20 acres); from rural (Big Creek estuary in Lincoln County, Oregon) to urban (Puget Sound in Washington, supporting a population of 3.9 million); and from pristine to highly degraded. They are used as stopovers by migratory birds, as spawning and nursery habitat for salmon, and—for people—as places of reflection, recreation, and commerce.

Several estuaries in the study area are recognized by such federal programs as the National Estuary Program and the National Estuarine Research Reserve System. Congress developed the National Estuary Program under Section 320 of the 1987 Clean Water Act. The National Estuary Program's primary goal is "to protect estuaries of national significance that are threatened by degradation caused by human activity." The Coastal Zone Management Act (1972) created the National Estuarine Research Reserve System. Administered by the National Oceanic and Atmospheric Administration (NOAA), it is a system of

estuarine research laboratories designed to promote informed resource management. This report covers three National Estuary Program estuaries: Puget Sound (Washington), the lower Columbia River (Oregon and Washington), and Tillamook Bay (Oregon); and two National Estuarine Research Reserve System estuaries: Padilla Bay (Washington) and South Slough (Oregon).

Most of the PNCERS research projects take place in five main estuaries: Grays Harbor and Willapa Bay in Washington; and Tillamook Bay, Yaquina Bay, and Coos Bay in Oregon. For a complete list of PNCERS research activities and detailed descriptions of research initiatives, see the PNCERS annual report (available on-line at www.pncers.org).

Washington

(Grays Harbor, Willapa Bay, Puget Sound, Padilla Bay)

Overview of Washington Estuaries

There are approximately 221,900 acres of estuarine (tidal) wetlands in Washington State, about 25 percent of its overall estuarine area and about 24 percent of the state's wetland total of 938,000 acres. The shallow coastal estuaries (Grays Harbor, Willapa Bay) and their shorelines are characterized by small cities and towns, mostly at the river mouths, still-extensive farmlands, dairy lands, and shellfish aquaculture. Most shorelines are in private ownership, with the exception of Willapa Bay, where portions lie within the Willapa National Wildlife Refuge.

Sources: Shorelands and Environmental Assistance Program 2000; Good, et al 1998

Grays Harbor

Grays Harbor (58,000 acres) is located in Grays Harbor County, Washington. The city of Aberdeen (population 16,750) is situated at the convergence of the Wishkah and Chehalis Rivers, at the east end of the estuary, and the city of Westport (population 2,050) is located near the mouth on the south peninsula.

The Grays Harbor estuary is one of the four major staging areas for shorebirds in North America, a critical refueling point for shorebirds migrating to and from their northern breeding grounds.

Grays Harbor, Washington

Freshwater sources: Humptulips (North Bay tributary), Johns River, Elk River (South Bay tributary), east and west forks of the Hoquiam River (Hoquiam), Wishkah River (Aberdeen), and the Chehalis River (Cosmopolis, Aberdeen)

Willapa Bay

Located in southwest Washington, Willapa Bay is the largest of the estuaries under study in the PNCERS program. It covers roughly 59,000 acres at high tide and has 129 miles of shoreline. Approximately half of Willapa Bay as measured at high tide becomes exposed at low tide, thus creating around 40,000 acres of intertidal area.

In the bay there is a twice-daily tidal change that exposes large sand or mudflats adjacent to emergent salt marshes. The mudflats are typically devoid of emergent vegetation but support eelgrass and benthic invertebrates, which are essential food for higher-order organisms. Today a large portion of the intertidal mudflats has been invaded and drastically altered by the introduced cordgrass, *Spartina alterniflora.*

A center of the aquaculture industry, Willapa Bay is the nation's largest commercial producer of oysters. Nearly 10,000 acres of privately owned or leased tidelands is used for commercial cultivation. Oyster beds on the tideflats provide habitat for crabs, eelgrass, algae, and many marine invertebrates.

Almost two-thirds of the land in the watershed is commercial forestlands. Farms and irrigated lands make up another 7 percent, including 1,400 acres of bogs that produce most of the state's harvest of cranberries.

The cities of South Bend and Raymond are located at the east end of the estuary, on the Willapa River. The towns of Long Beach, Ocean Park, Nahcotta, and Oysterville are located on the Long Beach Peninsula; the town of Tokeland is located at the north end of the estuary. In all, about 19,000 year-round residents call Willapa Bay home.

Freshwater sources: North River, Palix River, Nasele River, Willapa River, Bears River, Cedar River

Sources: Wolf, 1993; Chambers of Commerce for Oysterville, Tokeland, Nahcotta, Ocean Park, and Long Beach, Washington

Padilla Bay (National Estuarine Research Reserve)

Padilla Bay is part of a large river delta located in the Puget Sound/Georgia Basin region—a fjord estuary carved out by glaciers that retreated 10,000 to 20,000 years ago. Padilla Bay is just one small bay in the large Puget Sound/Georgia Basin estuary and is at the saltwater edge of the large delta of the Skagit River. It is about eight miles long and three miles across. Padilla Bay is the only Natural Estuarine Research Reserve in Washington State. Designated in 1980, the reserve's

11,000-plus acres are managed by the Washington State Department of Ecology.

The bay is filled with sediment from the Skagit River, and as a consequence its bottom is shallow, flat, and muddy. It is so shallow that almost the whole bay is intertidal. This means that it is flooded at high tide, but when the tide goes out the whole bay empties out, exposing miles and miles of mudflats. This condition allows unusually large eelgrass meadows to grow. There are nearly 8,000 acres of eelgrass in Padilla Bay—one of the largest concentrations of eelgrass on the Pacific coast.

Most of Padilla Bay's small watershed (23,000 acres) is low, flat delta that is now farmland. In the late 1800s the marshes of the Skagit River delta were diked and drained. The Skagit River is now confined to a channel that empties into Skagit Bay, leaving Padilla Bay "orphaned" from the river that formed its mudflats. Today, Padilla Bay's freshwater comes from a number of agricultural sloughs. The Swinomish Channel connects Padilla Bay to Skagit Bay.

The salt marsh habitat associated with Padilla Bay was almost entirely diked and drained for farmland before 1900. The fringe of salt marshes that remains commonly has salt grass (*Distichlis spicata*), saltbush (*Atriplex patula*), pickleweed (*Salicornia virginica*), and seaside arrow-grass (*Triglochin maritimum*), among others. The nonnative cordgrass *Spartina alterniflora* is present in Padilla Bay, but control efforts have been initiated.

On the western fringe of the sanctuary, intensive industry is highly evident. March Point harbors two large oil refineries, Shell and Texaco, that refine crude oil into gasoline, stove oil, diesel, and other products. Near the highway at the southern end of the bay are fertilizer, seed, and feed-processing facilities that service the large agricultural valley.

Source: Padilla Bay National Estuarine Research Reserve, Washington Department of Ecology

Puget Sound (National Estuary Program)

The Puget Sound Basin covers more than 16,000 square miles, of which 80 percent is land and 20 percent is water. One-third of Puget Sound's shorelines, 767 miles, have been altered or reinforced with bulkheads. Twenty-five percent of the intertidal zone—areas that are regularly covered by tides—has been modified. Two-thirds of Washington State's 5.9 million residents live around the sound.

Puget Sound is both a deep estuary and a fjord carved by glaciers. The bottom of Puget Sound is a series of underwater valleys and ridges, called *basins* and *sills,* with an average depth of 450 feet. The maximum depth (930 feet) occurs just north of Seattle. A relatively shallow sill at Admiralty Inlet separates the waters of the Strait of Juan de Fuca from the waters of Puget Sound proper.

The difference between high and low tide is nearly 12 feet at Seattle, significantly more than at other estuaries. This results in a large amount of water moving in and out of the estuary with the tide. When the tide rises, water is forced into the southern basin.

Most marine water flows from the ocean to the sound through the Strait of Juan de Fuca. Lighter freshwater from land enters the estuary and flows over the salty seawater. As this happens, friction and turbulence mix seawater with fresh water, creating a brackish layer at the surface. This surface layer, ranging from 30 to 190 feet deep in different parts of the sound, flows seaward while denser marine waters is drawn into the deeper layers of the estuary.

The two-layer circulation system is disturbed by shallow sills, a series of underwater ridges that rise toward the surface of the water and force water to recirculate from the surface to the depths of the basin. Water flow is also complicated by the islands, narrow passages, and changes in water depth that characterize Puget Sound. The estuarine circulation patterns affect the millions of tons of sediment and other material transported to or resuspended in the sound. However, unlike the waters that eventually move seaward, most particles are permanently trapped in the basin. In the main basin, only a fraction of the particles initially present in the surface water are carried past Admiralty Inlet.

The Puget Sound ecosystem boasts a diverse collection of habitats. The local marine environment alone supports more than 220 species of fish, 26 species of marine mammals, 100 species of seabirds, shore birds and waterfowl, and numerous invertebrate and plant species.

Because of the limited involvement of PNCERS researchers in Puget Sound, this paper gives the estuary significantly abbreviated treatment. Additional information can be found through the resources listed below.

Sources: Puget Sound Water Quality Action Team, Washington Department of Ecology, Washington State Department of Natural Resources

Washington Estuaries—Character and Description

Grays Harbor	Location	On the Washington coast, bound by Point Brown to the north and Point Chehalis to the south. Six rivers flow into the estuary, the most significant of which is the Chehalis.
	Area (mean higher high water)	235 square kilometers 22,137 ha 58,000 acres (approximate)
	Watershed/drainage area	6,304 square kilometers
	Estuary description	Over 60% of the estuary is intertidal and exposed by semidiurnal tides that range up to 4 meters.
	Salinity	Varies by season and location: Summer: 5% at head of estuary, 30% toward the entrance. Winter: 0.5% at head of estuary, 33% toward the entrance
	Water temperature	Varies by season and location: Summer: 19°C (inner harbor), 15°C (central section) Winter: 2°C (inner harbor), 8°C (central section)
	Other comments	Storms accompanied by gale and occasionally hurricane force winds hit the Washington coast during the fall and winter, affecting sediment transport and water properties.
Willapa Bay	Location	On the southwest Washington coast, between Grays Harbor (north) and the Columbia River (south) and protected from the Pacific Ocean by the Long Beach Peninsula. Nine rivers and several sloughs empty into Willapa Bay. The bay has a north-south orientation.
	Area (mean higher high water)	260 square kilometers 31,970 ha 59,000 acres (approximate)
	Watershed/drainage area	1,865 square kilometers
	Estuary description	Much of the estuary is shallow—less than 15% of the estuary is deeper than 7 meters—and over half of the estuary's surface area is exposed at low tide. Broad, expansive tideflats are drained by intertidal creeks that connect to deeper subtidal channels.
	Salinity	Varies by season and location: 7–30% (Salinity is lower toward river mouth and from October through March when river discharge rates are highest.)
	Water temperature	Varies by season and location 3–21°C (higher temperatures toward the shallow headwaters and in the summer months)

Washington Estuaries—Character and Description, cont.

	Other comments	Sediments consist of mixed sand and mud with sandy sediments prevalent near the mouth and central region of the estuary. Sand-mud composites are prevalent across the entrance toward the east and in the midsection, and mud is prevalent in the southern portion of the estuary. Storms accompanied by gale and occasionally hurricane force winds hit the Washington coast during the fall and winter, affecting sediment transport and water properties.
Padilla Bay	Location	Padilla Bay is one of many small bays in the Puget Sound/Georgia Basin estuary. It is at the saltwater edge of the large delta of the Skagit River. It is connected to Skagit Bay to the south by the Swinomish Channel.
	Area	The Padilla Bay National Estuarine Research Reserve comprises just over 11,000 acres.
	Watershed/drainage area	23,000 acres
	Estuary description	Padilla Bay is characterized as shallow and flat with a muddy bottom. The bay is almost entirely intertidal (flooded at high tide and emptied at low tide). Supports extensive eelgrass meadows.
	Other comments	The area is highly agricultural and the bay's freshwater sources come from a number of agricultural sloughs.
Puget Sound	Location	The Puget Sound water quality planning area includes the sound south of Admiralty Inlet (including Hood Canal and Saratoga Passage); the marine waters north to the Canadian border, including portions of the Strait of Georgia; the Strait of Juan de Fuca south of the Canadian border, extending westward to Cape Flattery; and all the land draining into these waters.
	Watershed/drainage area	Over 16,000 square miles, 80% land, 20% water. Many small estuaries drain into Puget Sound, including the Skagit, Stillaguamish, Snohomish, Puyallup, Nisqually, and Hood Canal.
	Estuary description	Deepwater fjord estuary, average depth 450 feet, maximum depth 930 feet.
	Water temperature	45ºF to 55°F
	Other comments	Two-thirds of Washington's 5.9 million people live within the Puget Sound drainage basin

Sources: Good 1997; National Estuarine Research Reserve System; Puget Sound Water Quality Action Team; Washington Department of Ecology

Columbia River (Washington/ Oregon)

Lower Columbia River Estuary (National Estuary Program)

The lower Columbia River estuary was accepted into the National Estuary Program in 1995. The Columbia River is an interstate and international river, originating in Canada and flowing south 1,214 miles to the Pacific Ocean. It is the fourth-largest watershed in the United States, draining a total of 259,000 square miles and receiving waters from seven states and one province. The river has the second-largest volume of flow of any river in the United States.

Near the downstream end of the Columbia River Basin is the lower Columbia River estuary, tidally influenced waters that extend 146 miles to Bonneville Dam, plus waters in the main tributaries entering the river over that distance (for example, the Willamette River). More than a third of the Columbia River Gorge National Scenic Area (established in 1986) is located within the lower Columbia River estuary.

The lower Columbia River estuary supports a multitude of uses, including navigation, flood control, irrigation, power generation, recreation, critical habitat, and commerce generating upwards of $14 million in trade annually. The estuary is purported to support an economy valued at nearly $30 million. However, the migration of nearly half a million people to the estuary in the mid-1800s—and the ensuing development—has resulted in the degradation of both habitat and water quality. The total population of the entire lower Columbia River Basin is approximately 2.5 million.

With the exception of the Willamette River, most of the lower Columbia River's tributaries drain relatively small watersheds. The flow of the river is strongly influenced by climatic variations and tides.

The Columbia River, looking north to Washington

During low-flow periods, tides may cause river flow to reverse up to about river mile 80. Tidal salinity normally extends upstream to river mile 23; historically it has reached mile 46. High flows in the winter are caused by heavy precipitation in the tributary basins of the lower river, primarily the Willamette in Oregon and the Cowlitz in Washington. The discharge at the mouth of the river ranges from 100,000 to 500,000 cubic feet per second, with an average of about 260,000 cubic feet per second.

Since 1870, more than half of the tidal swamp and marsh areas in the lower river have been lost as a result of diking, draining, filling, dredging, and flow regulation. Since 1948, tidal wetland habitats in the lower 46 miles of the river have decreased by as much as 70 percent.

The lower Columbia River estuary supports many areas of special biological significance, including the natural area reserves of Pierce Island, Puget Island, and White Island; the national wildlife refuges of Ridgefield, Julia Butler Hansen, and Lewis and Clark; the Tenasillahee Island Research Natural Area; the Sauvie Island Wildlife Management Area; and the wildlife refuges of Steigerwald Lake, Franz Lake, and Pierce Ranch.

Over 175 species of birds use the food and habitat of the lower Columbia River estuary. Some of the islands in the lower river support large gull and tern nesting colonies. The estuary is an important area in the Pacific Flyway for migrating shorebirds, with peak counts of almost 150,000 birds.

At the entrance to the ocean, the Columbia River forms a large estuary that is an important feeding and breeding area for numerous shellfish, including oysters, clams, mussels, and the commercially valuable Dungeness crab. Historically, the Columbia River Basin produced some of the world's largest runs of chinook salmon and steelhead. Overall populations of the basin's anadromous fish stocks are estimated at less than 10 percent of their historic size, despite major hatchery programs. Despite declines, Columbia River fish runs are still very important and continue to support fisheries in Oregon, Washington, California, and Alaska. Over 50 hatcheries are in operation; artificial production now accounts for some 75 percent of all fish returning to the Columbia River system.

The lower river supports heavy maritime trade. In terms of overall tonnage, its ports constitute the second-largest port area on the West Coast; the Port of Portland is the largest port in the country for export of wheat and soda ash; the Columbia River is the second-largest grain-exporting port area in the world.

The Columbia River Basin, with 27 main-stem Columbia River dams and more than 60 smaller hydropower projects, constitutes the world's

largest hydroelectric power system. The system supplies hydroelectric power to most of the Pacific Northwest and areas beyond and provides flood control, irrigation, and river transportation.

Because of the limited involvement of PNCERS researchers in Columbia River issues, this paper gives the lower Columbia River estuary significantly abbreviated treatment. Basic information can be found in the References and Additional Reading.

Sources: The Lower Columbia River Estuary Program, 1999; McColgin, 1979

Oregon

(Nehalem Bay, Tillamook Bay, Yaquina Bay, Coos Bay, and others)

Overview of Oregon Estuaries

The large number of estuaries on the Oregon coast belies the fact that Oregon's total estuarine acreage is relatively small. Except for the Columbia River, all of Oregon's major and minor estuaries (approximately 53,000 acres) could fit inside of Grays Harbor estuary in Washington (approximately 58,000 acres). Most of the larger estuaries (for example, Coos and Yaquina Bays) have been altered through dredging, filling, or diking. Many of the smaller ones have escaped the major effects of development and remain in a natural state. All are included in Oregon's estuarine management program.

The distribution of estuaries along the Oregon coast reflects the geology and topography of the mountains that meet the ocean. Only

Siuslaw River estuary, Oregon

Elk River estuary, Oregon

the Columbia, Umpqua, and Rogue Rivers drain areas inland of the Coast Range.

Except for the wide valley carved by the several rivers feeding Tillamook Bay, and Nehalem Bay at the mouth of the winding Nehalem River, the estuaries on the north coast tend to be small, fed by streams that drain small watersheds that are enclosed in indentations between rugged headlands and sand spits. Netarts Bay, Sand Lake, and Salmon River are such estuaries.

Between the Salmon River estuary at Cascade Head and the Coquille River over 100 miles to the south are the estuaries of Siletz Bay, Yaquina Bay, Alsea Bay, the Siuslaw and Umpqua Rivers, and Coos Bay. Along this portion of the coast, the mountains are mostly older marine sediments and sands, clays, and muds eroded from ancient mountains to the south and east. Deposited on the ocean floor in a great trough from the Klamath Mountains to Vancouver Island, these sediments were uplifted by the force of colliding continents and eroded once again to create relatively wide river valleys with low gradients. Postglacial rising seas filled these river valleys with sediments and created the conditions for present-day estuaries.

South of the Coquille River estuary at Bandon, there are few estuaries. Along this stretch of coastline, the hard, resistant cores of the ancient Klamath Mountains withstand erosion and create steep gradients, even at the ocean's edge. The Rogue, Elk, Sixes, Chetco, and Winchuck Rivers have almost no tidelands and very little estuarine area. These rivers discharge directly into the ocean.

Sixes River estuary, Oregon

Nehalem Bay

Nehalem Bay, located on the north coast of Oregon in Tillamook County, is Oregon's fourth-largest estuary. Its 2,300 acres are bordered by Nehalem Bay State Park, two small towns—Wheeler (population 350) and Nehalem (population 250)—and numerous small public and private marinas. Recreational use of the estuary is high, with crabbing, fishing, and boating popular with locals and tourists.

Freshwater source: Nehalem River

Tillamook Bay (National Estuary Program)

Tillamook Bay is a shallow estuary, averaging only 6.6 feet (2 m) deep over its 13 square miles (8,289 acres). The watershed drains approximately 560 square miles of farming and forested lands that support this community of approximately 25,000. Five primary rivers drain the watershed: the Wilson, Trask, Tillamook, Miami, and Kilchis. Tillamook Bay and its rivers support recreational activities, a large percentage of Oregon's salmon population, and premier shellfishing areas.

At low tide, about half of the estuary bottom is exposed as intertidal sand or mudflats, presenting navigational challenges similar to those facing the first known European explorers who entered the bay in 1797. Today, these intertidal flats provide important growing areas for oyster culture.

Several deep channels, running roughly north-south, represent the geological signatures of river mouths drowned by the rising Pacific Ocean about 9,000 years ago. Boaters and fish, including salmon, de-

Nehalem Bay, Oregon

pend on these channels. The Oregon Department of Fish and Wildlife rates Tillamook Bay as the state's premier recreational shellfish fishing area.

The last ocean-bound ship left the town of Tillamook in 1912. Eager to improve ocean-borne commerce, developers dredged and modified the main navigational channels in the bay and river mouths. Heavy sediment loads convinced the U.S. Army Corps of Engineers to stop dredging the main bay in 1913. The Corps, which last dredged the mouths of the Trask and Wilson Rivers in an attempt to control flooding in 1972, discontinued river dredging primarily because of high costs. Today only the Port of Garibaldi at the northern end of the bay serves deepwater traffic.

Like most Pacific Northwest estuaries, Tillamook Bay is part of a coastal, temperate rainforest ecosystem. Much of the Tillamook Bay watershed, especially the uplands (areas above 500 feet elevation), is rich forest, blanketing the rainy Coast Range. Mean annual precipitation averages 90 inches (229 cm) a year in the lower basin and close to 200 inches (510 cm) a year in the uplands. The watershed's coniferous forests—trees such as Douglas-fir, true fir, spruce, cedar, and hemlock—cover about 89 percent of the total land area. Hardwood species such as alder and maple also grow throughout the region. Most of the older trees have been lost to fire and timber harvest. Today, Douglas-fir is the dominant species. Foresters describe this environment as "highly productive," from both biological and commodity perspectives.

Tillamook Bay, Oregon

In the lower watershed, forest gives way to rich alluvial plains used primarily for dairy agriculture. Meandering rivers and networks of small channels once provided plentiful fish habitat, large wood, and organic matter. Early settlers recognized the rich agricultural potential of this land and drained it with numerous dikes, levees, and ditches. Cattle also produce hundreds of thousands of tons of manure annually and much of the bacteria washing into Tillamook Bay. Urban and rural residential development contributes significant fecal bacterial contamination during heavy storms, and untreated storm water car-

Boats docked at Garibaldi, in Tillamook Bay, Oregon

ries grease, pesticides, sediment, and animal waste. Development also impairs floodplain function and lowland habitat.

The Tillamook Bay community relies on the fertile lands and streams that flow into the bay for work, recreation, and resources.

Freshwater sources: Tillamook, Trask, Wilson, Kilchis, and Miami Rivers

Sources: Oregon Estuary Plan Book; Tillamook Bay National Estuary Project Management Committee; Tillamook County NOAA Coastal Services Center

Yaquina Bay, Oregon

Yaquina Bay

Located on the central Oregon coast, Yaquina Bay is the fourth-largest estuary within the state, totaling just over 4,200 acres at high tide. The city of Newport (population 8,900) is located at the seaward end of the estuary, and the city of Toledo (population 3,250) about 10 miles inland. Yaquina Bay is located wholly within Lincoln County, Oregon.

Of Yaquina estuary's 4,200 acres, over 2,500 are classified as tidelands. Pacific herring spawn in the eelgrass beds each February in Yaquina Bay, while chinook and coho salmon spend critical portions of their juvenile lives there. Dungeness crab, clams, and mud shrimp are common here. The Brant's goose feeds on the eelgrass beds during its migration stopovers.

Also a popular stopping point for tourists and home port to numerous commercial and recreational fishers, Yaquina Bay is an eco-

Boats in Newport, Yaquina Bay, Oregon

nomically important estuary. Newport has Oregon's second-largest commercial fishing fleet (nearly 250 vessels), which supports a flourishing seafood processing and packaging industry. Commercial oysters continue to be cultured in the estuary between Newport and Toledo and provide seafood markets worldwide with fresh oysters. Yaquina Bay has five recreational boat storage facilities that are home to over 650 recreational boats.

Frequent dredging has sculpted Yaquina Bay estuary into one of Oregon's three deep-draft ports. The bay is dredged from the jetty entrance all the way to Toledo, 10 miles upriver.

Primary freshwater source: Yaquina River

Source: Yaquina Bay Data, OSU Hatfield Marine Science Center

Coos Bay

Coos Bay is located in Coos County, Oregon, on the southern Oregon coast, about 200 miles south of the Columbia River and 445 miles north of San Francisco Bay. Coos Bay is the largest estuary within Oregon, totaling approximately 12,300 acres at high tide. The Coos estuary is a drowned river mouth with 30 tributaries surrounded by steep, mostly forested hillsides.

The small amount of relatively level lands occurs either as diked agricultural land (usually former salt marsh) or as filled land on which development has already taken place (such as downtown Coos Bay, a former salt marsh). The drainage basin encompasses 605 square miles, with tidal influence extending 34 miles up the fork of the Coos River, the primary tributary.

The cities of Coos Bay (population 15,500) and North Bend (population 9,850) and the town of Charleston (population 300) are located

Coos Bay estuary, Oregon

on the bay. Coos Bay estuary is home to an international port, several industrial facilities, and a sizable fisheries community. In addition, the Coos watershed is heavily forested and has supported a significant wood-products industry. From about 1870 to World War I, coal mining and export was a significant economic activity in the hills around the Coos Bay estuary. As a result of these activities and heavy industrial uses in the past, sustainable management of Coos Bay estuary and watershed presents many challenges.

Primary freshwater source: Coos and Millicoma Rivers

South Slough Estuary (National Estuarine Research Reserve), Coos Bay

South Slough National Estuarine Research Reserve encompasses 4,770 acres along the southernmost arm of the Coos Bay estuary. The reserve includes 3,855 acres of upland forest, 115 acres of riparian habitat, and 800 acres of tidelands. The estuary is connected to the ocean through the mouth of Coos Bay, near Charleston, Oregon. South Slough is one of seven tidal inlets that collectively form the Coos estuary.

The South Slough watershed covers 19,295 acres. Winchester Creek flows north through the watershed for four miles before entering the reserve. Most of the other significant freshwater contributions to the slough flow from the more gently sloping eastern side of the watershed. Because of seasonal variations in freshwater flows, South Slough salinity profiles vary with the time of year.

Field trip to South Slough National Estuarine Research Reserve, Oregon

Approximately 75 percent of the watershed is in private or county ownership. The remaining quarter of the watershed comprises the South Slough National Research Reserve. The watershed includes at least 37 small streams, with most feeding one of the 7 primary stream systems that drain 75 percent of the watershed.

Over 80 percent of the tidal wetlands in this ecosystem have been lost to diking, draining, fill, and development. South Slough National Estuarine Research Reserve has undertaken a Winchester Tidelands Restoration Project to monitor the recovery of altered tidal habitats and associated uplands within the reserve.

In the late summer, up to 160 acres of eelgrass can be found in South Slough. These eelgrass beds, together with the deep channels in the estuary, shelter a large number of fish and invertebrates. The reserve supports populations of blue herons, osprey, gulls, and bald eagles. The estuary is a foraging and resting area for brown pelicans and a major stop on the coastal flyway for migratory birds.

Logging and associated road building have produced the most marked changes in the uplands of the South Slough watershed. In addition, creeks in the shallower parts of the slough were dredged during the early to mid 1900s for logging and other transportation needs. All timber in the drainage has been cut at some time, and, with regrowth, most of the watershed continues to be managed for commercial timber-harvest purposes by public and private owners.

Primary freshwater source: Winchester Creek

Sources: South Slough National Estuary Research Reserve; South Slough Estuary NERRS information site (no longer on-line)

Oregon Estuaries (North to South, Excluding the Lower Columbia River)

County	Estuary	Classification	Size (acres)
Clatsop	Necanicum	Conservation	278
	Ecola Creek	Conservation	50
Tillamook	Neskowin Creek	Conservation	30
	Nehalem Bay	Shallow draft development	2,309
	Tillamook Bay	Shallow draft development	8,289
	Netarts Bay	Conservation	2,743
	Sand Lake	Natural	528
	Nestucca Bay	Conservation	1,000
Lincoln	Salmon River	Natural	204
	Siletz	Conservation	1,187
	Big Creek	Natural	20
	Yaquina	Deep draft development	3,910
	Beaver Creek	Conservation	35
	Alsea	Conservation	2,146
	Yachats River	Conservation	40
Lane	Tenmile Creek	Natural	35
	Big Creek	Natural	35
	Berry Creek	Natural	30
	Siltcoos River	Natural	45
	Sutton River	Natural	45
	Siuslaw	Shallow draft development	2,245
Douglas	Tahkenitch Creek	Natural	25
	Umpqua River/ Winchester Bay	Shallow Draft Development	6,543
Coos	Tenmile Creek	Natural	35
	Coos	Deep draft development	12,300
	Coquille	Shallow draft development	771
	Twomile Creek	Natural	20
	Fourmile Creek/New R.	Natural	20
Curry	Floras Creek/ New R.	Natural	125
	Euchre Creek	Natural	45
	Rogue	Shallow draft development	627
	Hunter	Natural	50
	Chetco	Shallow draft development	102
Total acreage (excluding the lower Columbia River estuary)			**45,867**

Source: Oregon Estuary Plan Book 1987

Classifying Oregon's Estuaries

Oregon's Statewide Planning Goal 16 (Estuarine Resources) sets conservation-oriented policies for estuaries that seek to balance development with protection of estuarine habitats. Oregon's Land Conservation and Development Commission adopted administrative rules, based on Goal 16, that set limits for the amount and type of development in each estuary through a classification system.

Estuaries on the Oregon coast are classified as *natural, conservation, shallow draft development,* and *deep draft development.* These classifications are defined in the *Oregon Estuary Plan Book*, 1986:

Natural

Estuaries lacking maintained jetties or channels, and which are usually little developed for residential, commercial, or industrial uses. They may have altered shorelines, provided that these altered shorelines are not adjacent to an urban area. Shorelands around natural estuaries are generally used for agriculture, forestry, recreation, and other rural uses. Natural estuaries have only natural management units. Each estuary is subdivided into different areas or zones, called *management units,* that identify appropriate uses. Management units have been designated as natural, conservation, and development (Sand Lake, Salmon River, Big Creek [Lincoln County], Tenmile Creek [Lane County], Big Creek [Lane County], Berry Creek, Siltcoos River, Sutton River, Tahkenitch Creek, Tenmile Creek [Coos County], Twomile Creek, Fourmile Creek/New River [Coos County], Floras Creek/New River [Curry County], Euchre Creek, Hunter).

Conservation

Estuaries lacking maintained jetties or channels, but which are within or adjacent to urban areas which have altered shorelines adjacent to the estuary. Conservation estuaries shall have conservation and

Nestucca River estuary, Oregon

natural management units (Necanicum, Ecola Creek, Netarts Bay, Nestucca, Siletz, Beaver Creek, Alsea, Yachats).

Shallow Draft Development

Estuaries with maintained jetties and a main channel (not entrance channel) maintained by dredging at 22 feet or less. Shallow draft development estuaries have development, conservation, and natural management units (Nehalem Bay, Tillamook Bay, Suislaw, Umqua River/Winchester Bay, Coquille, Rogue, Chetco).

Deep Draft Development

Estuaries with maintained jetties and a main channel maintained by dredging to deeper than 22 feet. Deep draft development estuaries have development, conservation, and natural management units (Yaquina Bay, Coos Bay, Lower Columbia).

Each estuary is subdivided into different areas or zones, called *management units,* which identify appropriate uses. An estuary's classification guides the preparation of management plans by local governments and lends predictability to individual project reviews.

Coquille River estuary, Oregon

Rogue River estuary, Oregon

Northern California

Overview of Northern California Estuaries

On the California coast, San Francisco Bay is the largest estuarine embayment, followed by Humboldt Bay and San Diego Bay. Numerous other estuaries are far smaller but are ecologically important as well. Humboldt Bay and the estuaries of the Klamath and Smith Rivers are considered to be linked to estuaries farther north by physical and biological ocean processes that extend from the Strait of Juan de Fuca to Cape Mendocino, California.

The northern California coast is less intensively developed and populated than the central and southern areas and development pressure is proportionately lower. Nevertheless, proposals for expansion of industry, piers, wharfs, and a paper mill in Humboldt Bay threaten estuary and wetland resources there.

Major harbors on California's north coast (Del Norte, Humboldt, and Mendocino Counties) include Crescent City Harbor in Del Norte County, Humboldt Bay in Humboldt County, and Noyo Harbor in Mendocino County. In addition to these harbors, there are several smaller harbors, such as Trinidad and Shelter Cove in Humboldt County, and Albion and Point Arena in Mendocino County. They principally serve the commercial fishing industry and recreational fishers.

The northern California coast is less intensively developed and populated than the central and southern areas, and development pressure on estuaries is proportionately lower. Nevertheless, proposals for expansion of industry, piers, and wharves in Humboldt Bay threaten estuary and wetland resources there.

In addition to being important to commerce, the northern California coastal area is environmentally significant and rich in natural resources. California's north coast bays, estuaries, and other tidal inlets provide a variety of habitats supporting species of resident and migratory wildlife.

Sources: California Department of Fish and Game, CZM Effectiveness Study

Humboldt Bay

At approximately 12,160 acres, Humboldt Bay is the fifth-largest estuary on the Pacific coast between Grays Harbor, Washington, and San Diego Bay. In California it is the second-largest estuary after San Francisco Bay. Humboldt Bay is a relatively shallow, well-mixed, tidally driven estuary with limited freshwater input except during the rainy, winter months. Humboldt Bay, which ranges from 0.5 to 4 miles wide, is 14 miles long and consists of two shallow tidal basins, North Bay and South Bay, connected by a relatively narrow channel. Although no large rivers enter the bay, numerous small tributaries contribute

freshwater. Some of these tributaries flow freely; others are gated to prevent saltwater intrusion to reclaimed pasturelands.

Habitat diversity in and around Humboldt Bay is varied—mudflats, eelgrass beds, diked seasonal wetlands, sand spits, uplands, salt marsh, brackish marsh, and freshwater marsh. The margin of Humboldt Bay supports emergent wetlands dominated by *Spartina densiflora*. Eelgrass beds are important marine resources in the bay waters. Historically, supratidal wetlands surrounded the bay, but many of these areas have been diked and drained with tide gates to create pastures for seasonal grazing and other agricultural uses.

The remaining intertidal, seasonal, and shoreline habitat supports the most visible and at times most spectacular wildlife of Humboldt Bay: birds. Humboldt Bay is one of the most important stopover points along the Pacific Flyway. The bay is the winter home for thousands of migratory ducks, swans, and shorebirds. More than 200 bird species, including 80 kinds of waterfowl and four endangered species, regularly feed, rest, or nest on the bay or in adjacent marshes and willow groves. Humboldt Bay also supports a diverse fish fauna: sharks, rays, herrings, anchovies, flatfish, chinook and coho salmon, cutthroat and steelhead trout, and numerous others.

Wiyot Indian tribes occupied the area around Humboldt Bay for several thousand years until the mid 1800s when Europeans settlers arrived. Fourteen former Wiyot village sites have been identified on Humboldt Bay. Native Americans continue to exercise their rights to fish and gather shellfish for subsistence at many other locations on the north coast of California, especially near large coastal inlets, such as the Klamath River.

European settlers reached Humboldt Bay and made permanent settlements beginning in 1849. Once steamship service and overland rail service were established, there was a viable trade outlet for the area's abundant timber and fisheries resources. However, these resources were depleted shortly after WWII and the economy has since shifted.

The area is now supported by the presence of Humboldt State University, a successful oyster culture industry, limited logging, fishing, dairy operations, and recreation and tourism. Other Humboldt Bay notables:

- Humboldt Bay is the largest estuary and port between Coos Bay, Oregon, and San Francisco Bay.
- Humboldt Bay is a home port for commercial fishing.
- The Pacific Gas Electric power plant is located in Humboldt Bay.
- Ninety-five percent of the oysters sold in California are grown in Humboldt Bay.

- Important commercial shipping facilities are located on Humboldt Bay.
- Approximately 70,000 people live around Humboldt Bay.

Sources: California Department of Fish and Game; Arcata Fish and Wildlife Office Service 2001

3 Agencies

This chapter deals with agencies that have estuary management responsibilities and authorities. Estuaries in the Pacific Northwest are managed by an overlapping set of authorities of a variety of federal, state, local, and tribal agencies. Some of these agencies are oriented toward function while others are oriented toward geography. For instance, state water quality agencies can apply their authorities to uses or functions anywhere within an estuary to protect water quality, whereas a state park agency or federal wildlife agency might have authority to manage activities or regulate uses only within a state park or national wildlife refuge.

Federal Government Agencies

Bureau of Land Management

Nationwide, the U.S. Bureau of Land Management manages 262 million acres of public lands, principally rangeland and forest lands, for different uses. However, the Bureau of Land Management manages coastal shorelands along the Oregon coast that include estuarine shorelands at Coos Bay and along North Spit, and lands surrounding the small New River estuary (the mouth of Floras Creek and related drainages) south of Bandon.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service manages national wildlife refuges and administers the Endangered Species Act together with other agencies. Along the Pacific Coast, the U.S. Fish and Wildlife Service

has become an important agency in acquiring and managing lands in and around estuaries as part of an international effort to conserve and restore wetlands important to migratory waterfowl.

In the Pacific Northwest, the U.S. Fish and Wildlife Service manages the following estuary-related refuges and resources:

Washington

Grays Harbor National Wildlife Refuge, established in 1990, encompasses 1,500 acres in the northeast corner of the Grays Harbor estuary. Migratory shorebirds make extensive use of the estuary and the refuge. Habitats within the refuge include intertidal mudflats, salt marsh, and uplands. The refuge protects the Bowerman Basin, a key estuary for about one million northbound shorebirds that feed and rest here before flying north to nest.

Willapa Bay National Wildlife Refuge, established in 1937 as the Willapa Migratory Waterfowl Refuge, encompasses several units, totaling 11,000 acres. Extensive expanses of American glasswort and eelgrass attract migrating shorebirds. The refuge is a key wintering area for Brant, Canada Geese, and other waterfowl.

Columbia River

The Julia Butler Hansen Refuge for the Columbian white-tailed deer includes about 4,750 acres of diked Columbia River floodplain and undiked islands in the river just upstream from the main estuary. Vegetation is a patchwork of small woodlots, old fields, managed fields, brushy thickets, tidal marshes, and forested tidal swamps. This is critical habitat for the endangered Columbian white-tailed deer.

Oregon

Nestucca Bay National Wildlife Refuge was established in 1991. It includes about 730 acres, including key marsh habitat, pastures, grasslands, woodlands, tidal marsh, mudflats, and freshwater bogs. The short-grass fields around the estuary support 10 percent of the world population of dusky Canada geese.

Siletz Bay National Wildlife Refuge encompasses a large complex of salt marsh, brackish marsh, tidal sloughs, and mudflats at the southern end of Siletz Bay. The refuge, bisected by a major highway and traversed by other dikes that impair natural tidal flow, was established in 1991 to allow the salt marsh to return to its natural tidally influenced state.

Bandon Marsh National Wildlife Refuge, totaling 712 acres, was established in 1983 to protect a large salt marsh in the Coquille River estuary that is an oasis for migrating shorebirds, waterfowl, and threatened and endangered species, including coho salmon, the bald eagle,

and the California brown pelican. In 1999, the refuge was expanded to include a large area of former salt marsh that had been diked to create pastureland. The U.S. Fish and Wildlife Service and the Coquille Indian Tribe are cooperating to restore natural tidal flow and to identify and protect the many important archaeological sites in the area.

California

The Humboldt Bay National Wildlife Refuge is located on Humboldt Bay near the town of Arcata, California. The refuge protects wetlands and bay habitats for migratory birds, especially black Brant. The U.S. Fish and Wildlife Service is working with local officials and landowners to address water quality problems in the estuary from surrounding agricultural and forestry practices. The refuge includes the Lanphere Dunes, one of the most pristine remaining dune ecosystems in the Pacific Northwest.

Environmental Protection Agency

The Environmental Protection Agency (EPA) is the lead federal agency for air and water pollution control, including preventing and responding to oil spills. The EPA and the U.S. Army Corps of Engineers are jointly responsible for implementing the Clean Water Act, including Section 404, regulating the disposal of dredged or fill materials, a set of activities that have done much to change the condition of many estuaries in the Pacific Northwest.

Washington and Oregon are within EPA Region 10 (which includes Alaska and Idaho). California is in EPA Region 9 (which includes Arizona, Hawaii, Nevada, and the U.S. Pacific Islands).

The EPA is directly involved in estuary management through several activities, including the National Estuary Program and the Coastal Nonpoint Source Program. The National Estuary Program was established by Congress in 1987 to improve the quality of estuaries of national importance. States may apply to the EPA for assistance under Section 320 of the Clean Water Act, which directs the EPA to develop plans for attaining or maintaining water quality in an estuary. Each National Estuary Program is charged with creating and implementing a comprehensive conservation and management plan (CCMP) that addresses all aspects of environmental protection for the estuary, including issues such as water quality, habitat, living resources, and land use. The EPA has supported three National Estuary Program efforts in the Pacific Northwest: the Puget Sound National Estuary Program, established in 1987; the Tillamook Bay National Estuary Program, established in 1994; and the Lower Columbia River National Estuary Program, established in 1995.

The Coastal Nonpoint Source Program (Section 6217 of the 1990 reauthorization of the National Coastal Zone Management Act) requires states to develop plans and management measures to protect coastal waters from effects of nonpoint pollution, which is pollution that occurs when rain water washes over streets, yards, and farmlands and carries oils, pesticides, and fertilizers into rivers, estuaries, and oceans. The act requires that plans must be coordinated with other existing federal and state water quality protection programs, so that all protection efforts are integrated and potential overlap is reduced. The EPA works with NOAA, state water quality agencies such as the Oregon Department of Environmental Quality, and state coastal management agencies, to complete nonpoint source control plans.

The EPA does coastal environmental research to acquire information to support estuary management and protection. It maintains a coastal ecology lab at Yaquina Bay, Oregon, that focuses on the effects of chemical and other anthropogenic stressors in the estuarine environment. On a regional scale, the EPA conducts the Environmental Monitoring and Assessment Program that sampled 700 sites in estuaries along the west coast during 1999-2000, with more focused sampling in Tillamook Bay, Oregon, to assess aquatic biological systems as integrators of stresses and to aggregate data from local, state, and regional levels.

Federal Emergency Management Agency

The Federal Emergency Management Agency is an independent agency of the federal government whose mission is "to reduce loss of life and property and protect critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery." The agency advises state agencies on floodplain management and disaster response, especially in response to river flooding and wave inundation from storm events in and around estuaries.

NOAA Fisheries Service

NOAA Fisheries Service, formerly known as the National Marine Fisheries Service, has jurisdiction over a wide range of ocean fisheries, including anadromous fish such as salmon and steelhead. NOAA Fisheries is responsible for evaluating the status of these stocks, and in the case of several species of salmonids in the Pacific Northwest, listing them as threatened under the federal Endangered Species Act. NOAA Fisheries then has authority to adopt regulations to protect habitat deemed "critical" to the recovery of the species and to prevent further loss. In the case of Pacific Northwest estuaries, NOAA Fisheries comments on federal waterway permits, principally from the U.S. Army Corps of Engineers, that are required for a variety of local and state

activities in estuarine waters. NOAA Fisheries reviews and must approve these permits to ensure protection of salmonid habitat and avoid impacts to these species as a result of dredging, dock placement, and other in-water work. NOAA Fisheries has worked closely with the salmon restoration programs in all three West Coast states to support watershed enhancement activities and restoration of habitat in rivers and estuaries.

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration (NOAA) has many subagencies and programs that carry out a variety of responsibilities for protecting and enhancing coastal and marine resources. One of these program activities is to work with coastal states in a variety of efforts: to carry out the National Coastal Zone Management Act through the Office of Ocean and Coastal Resources Management, to implement the National Estuarine Research Reserve System, to support the National Estuary Program and the National Nonpoint Pollution Control Program, and to run a variety of research and information programs that support estuary and coastal management at the state and local level.

U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (the Corps) is the lead federal agency for waterway management in the U.S. The Corps is responsible for building and maintaining such navigational aids as jetties and channels and for regulating activities in the nation's waterways, such as dredging and material disposal, filling, placement of in-water structures, and bank stabilization up to the mean or ordinary high-water line. The Corps is involved in every estuary in the region that has a jetty, bulkheads, docks, maintained channels, buoys, and other navigational facilities.

Coast Guard

The U.S. Coast Guard has a major presence with a wide range of responsibilities and authorities in estuaries with boating and shipping activities. The Coast Guard is responsible for maintaining safe navigation in U.S. waters, which includes vessel inspections, placement and maintenance of buoys, channel markers, warning devices, charts, and so on. It conducts search-and-rescue operations, which in the Columbia River and other well-used ports, means both vessels and aircraft. The Coast Guard is also the lead federal agency for federal ballast water exchange programs and for oil spill prevention, response, and cleanup in U.S. coastal waters and deepwater ports.

U.S. Forest Service

Like the Bureau of Land Management, the U.S. Forest Service is a major landowner in the coastal zone of the Pacific Northwest and has similar planning processes (land and resource management plans). Along the Oregon coast, in particular, the U.S. Forest Service manages three areas that have estuarine components:

- The Oregon Dunes National Recreation Area in Coos, Douglas, and Lane Counties, encompasses a number of small natural estuaries, such as Tenmile, Siltcoos, and Takenitch Creeks, that flow through the dunes and into the ocean. Protection and management of these estuaries is accomplished through the overall plan for managing the national recreation area.
- The Cascade Head Scenic Research Area in Lincoln County includes most of the Salmon River estuary that is being restored to natural conditions as dikes are removed and wetlands restored.
- The Sand Lake Estuary Off Highway Vehicle Riding Area in Tillamook County is a dune area that abuts the north side of the Sand Lake estuary and is managed primarily for off-highway vehicle recreational use.

Sand Lake estuary, Oregon

State Government—Washington

Environmental Hearings Office

The Environmental Hearings Office includes the Pollution Control Hearings Board, which hears appeals against orders and decisions by the Department of Ecology and other agencies, as provided by law, and the Shorelines Hearings Board, which hears appeals against permit decisions and against those shoreline penalties issued jointly by local government and the Department of Ecology or by the Department of Ecology alone.

Washington State Department of Agriculture

The Washington State Department of Agriculture has regulatory authority over the application of pesticides. The Department of Agriculture reviews applications, grants permits, and enforces activities related to application of the pesticide carbaryl, which is used by oyster growers in Grays Harbor and Willapa Bay to control the population of mud shrimp and other burrowing organisms. Because oysters here are cultivated "on the bottom," mud shrimp and other burrowing animals can bury young oysters with mud. Carbaryl is used to kill these burrowing organisms in favor of oyster production, a practice that is increasingly controversial.

Washington Department of Fish and Wildlife

The Washington Department of Fish and Wildlife has a number of programs with estuary management.

- The Habitat Management Program regulates the protection and restoration of estuaries and works on habitat restoration and management, with a focus on salmon recovery and watershed restoration.
- The Fish and Shellfish Management Program sets annual sportfishing regulations that apply in estuaries and streams for salmon, sturgeon, and shad. The program also conducts pre- and postseason stock assessments, carries out spawning surveys, and participates in planning forums with the Salmon Culture Division.
- The Wildlife Management Program is charged with the protection, preservation, and perpetuation of Washington's wildlife resources (including endangered species management), as well as managing game and sport fish (trout and steelhead). Wildlife's research arm is currently involved in studies of marbled murrelet and common murre populations and of harbor seal toxins.

Washington State Department of Health

The Washington State Department of Health has several authorities that apply to estuaries. The Office of Shellfish Programs is responsible for the licensing and certification of commercial shellfish operations and classifies commercial shellfish-growing areas to determine their suitability for harvest. It is also charged with the protection of consumers from illnesses related to shellfish consumption.

Washington Department of Natural Resources

The Washington Department of Natural Resources manages more than 5 million acres of forest, range, agricultural, and aquatic lands throughout the state to produce income to support state services and to provide other public benefits. The department manages 2.6 million acres of state-owned aquatic lands, including the beds of Puget Sound, estuaries, navigable rivers, lakes, and other waters, part of the state's tidelands, and much of the shores of navigable lakes and other freshwater bodies.

The Department of Natural Resources is currently developing a program of aquatic reserves on publicly owned aquatic lands. The purpose of such reserves would be to maintain natural biodiversity, protect and restore ecosystem functions, and maintain appropriate public access to aquatic lands for scientific, educational, and recreational uses.

Washington State Parks and Recreation Commission

The Washington State Parks and Recreation Commission manages a system of 125 developed state parks (including 21 marine parks), covering 260,000 acres. About 25 of these parks are related to estuary shoreline areas and resources of Puget Sound. There are no state parks on either Grays Harbor or Willapa Bay estuaries.

Washington State Conservation Commission and Local Conservation Districts

The Washington State Conservation Commission provides procedural guidance and administrative support to local conservation districts, which were established in state law (Chapter 89.08 RCW) in 1939. Conservation districts are units of local government formed to coordinate soil and water conservation efforts. The commission administers grants for conservation projects, assists with audits, guides conservation district procedures and operations, coordinates district programs across the state, and promotes cost-effective use of public funds.

The Grays Harbor Conservation District covers the watershed areas around Grays Harbor estuary, and the Pacific Conservation District includes the watershed surrounding Willapa Bay and the

Washington shore of the Columbia River estuary. The Wahkiakum Conservation District abuts the shore of the Columbia River just upstream from the main estuary. Ten conservation districts, one in each county, abut shorelands of Puget Sound and the Strait of Juan de Fuca.

Washington Department of Ecology

The lead agency charged with coordinating state coastal and ocean resource management and planning activities is the Washington Department of Ecology. The agency implements the state's federally approved Coastal Zone Management Program and the state Shoreline Management Act (the principal component of its Coastal Zone Management Program). The Shoreline Management Act establishes a cooperative program between local and state governments, in which local governments develop and administer local shoreline master programs and the state agency provides support and oversight.

In partnership with the USEPA, the Department of Ecology is responsible for water-resource development and water quality management. The strategic initiatives of the Department of Ecology include meeting the current and future water needs of people, farms, and fish and developing a comprehensive approach to watershed management that covers water quality, quantity, and habitat. The Department of Ecology is the lead agency in Washington for planning for and responding to oil spills.

Puget Sound Water Quality Action Team

The Puget Sound Water Quality Action Team works with tribal and local governments, community groups, citizens, businesses, and state and federal agencies to develop and carry out two-year work plans that guide the protection of water quality (including nonpoint pollution, oil spills, and dredged material) and biological resources in the Puget Sound. The biennial work plans are based on the Puget Sound Water Quality Management Plan, Washington's strategy for protecting Puget Sound. Members include a governor-appointed chair; the directors of 10 state agencies; a city and a county representative and a representative of federally recognized tribes, each appointed by the governor; and nonvoting representatives of three federal agencies.

The Puget Sound Water Quality Action Team program includes a number of elements, among which is the Puget Sound Council, which advises the Action Team on work plan priorities and tracks the progress of state and local agencies in implementing the plans. The Puget Sound Management Plan, Work Plan, and Shared Waters Program all guide state and local agencies in addressing ongoing water quality issues in Puget Sound.

Columbia River (Washington and Oregon)

Columbia River Estuary Study Taskforce

The Columbia River Estuary Study Taskforce (CREST), formed in 1974, is a council of governments that includes the local counties, cities, and port districts surrounding the Columbia River estuary in both Oregon and Washington. Current members include Clatsop (Oregon), Wahkiakum (Washington), and Pacific (Washington) Counties; the cities of Astoria, Warrenton, and Seaside in Oregon and Ilwaco in Washington; the port districts of Astoria, Ilwaco, and Wahkiakum (No. 2); and the Clatsop Soil and Water Conservation District. The governing body of CREST is the CREST Council, comprising an elected official and an appointed alternate from each jurisdiction. CREST is not a regulatory agency but is a regional organization providing a forum for members to identify and discuss issues of regional importance; to monitor and comment on governmental activities related to the development and management of the natural, economic, and human resources of the Columbia River estuary; and to improve communication and cooperation among member governments.

Lower Columbia River Estuary Program Partnership

Initiated by Washington and Oregon in 1995 as part of the National Estuary Program under the U.S. Environmental Protection Agency, the Lower Columbia River Estuary Program Partnership is now a nonprofit program that is implementing a comprehensive management plan for the 146 miles of the lower Columbia River and estuary. The partnership involves agricultural interests, industry, ports, environmental groups, tribes, recreational groups, commercial fishing interests, and federal, state, and municipal governments and agencies from the mouth of the Columbia River to the "head of tide" at Bonneville Dam on the main stem and Willamette Falls at Oregon City. The partnership, which is voluntary, seeks to carry out a management plan that is based on scientific studies of the river and its needs, the visions and objectives developed for each of the seven priority issues, and significant input from citizens. The *Management Plan* has no regulatory authority, and actions to implement it are voluntary.

State Government—Oregon

Department of Agriculture

The Oregon Department of Agriculture regulates oyster and mussel cultivation as an agricultural activity, investigates and classifies those state waters suitable for oyster cultivation, and leases state tidelands classified as plats suitable for commercial oyster cultivation. The Division of Natural Resources within the Department of Agriculture assists soil and water conservation districts and oversees the confined

animal feeding program, noxious weed program, and other resource concerns that affect estuarine water quality.

Department of Environmental Quality

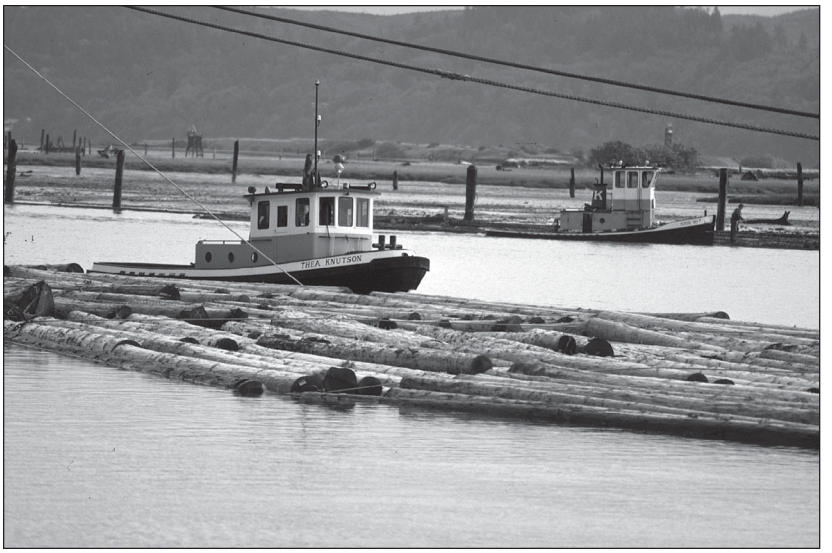
The Oregon Department of Environmental Quality (DEQ) is responsible for water, air, and land quality in Oregon's ocean area. DEQ monitors and controls water pollution in coastal watersheds and estuaries before this water reaches the ocean and regulates discharge of treated municipal sewage or industrial waste into estuaries and the ocean. DEQ establishes standards of water quality for each of the Oregon Water Resources Department's 18 basins in Oregon and is responsible for managing both point and nonpoint source pollution. In addition, DEQ is the lead agency on oil spill prevention and response in the marine environment.

Department of Fish and Wildlife

The Oregon Department of Fish and Wildlife (ODFW) regulates commercial and recreational fisheries in freshwater, estuaries, and the ocean; protects marine wildlife; manages marine habitat in state ocean waters (including rocky shores); and advises other agencies and local governments on proper measures to protect and enhance habitat. ODFW must be consulted by other state agencies regarding the effects of development on marine fish and wildlife and their habitats, including estuaries. ODFW regulates recreational clam digging and crab catch in estuaries in Oregon, regulates private fish hatcheries, and is responsible for state-operated fish hatcheries.

Department of Forestry

The Department of Forestry administers state-owned forestlands, including the Tillamook State Forest, the Elliott State Forest, and other state forest lands in the coastal zone totaling over 600,000 acres. The Department of Forestry administers the Oregon Forest Practices Act on all nonfederal lands. This act regulates timber harvest activities, including riparian set-backs, replanting, and other practices, and sets policy to encourage the growth and harvest of trees consistent with sound management of other forest resources, such as wildlife habitat, fish habitat, and water quality. The Department of Forestry has developed a Northwest Region long-range plan to guide the management of state forestlands in northwestern Oregon, principally for the Tillamook State Forest, which covers about 550 square miles and includes numerous watersheds that drain into estuaries on the northern Oregon coast. This plan's objectives are to promote timber growth and harvesting while maintaining the integrity of the forest ecosystem.



Log raft with tugboat

Department of Land Conservation and Development

The Oregon Department of Land Conservation and Development (DLCD), designated by law (ORS 196) as the state's coastal management agency, has primary responsibility for administering the statewide land-use planning program under ORS 197 in the coastal zone. The bases for DLCD's program are statewide planning goals, especially Goal 16, Estuarine Resources, and Goal 18, Coastal Shorelands, which establish the coastwide estuary management program that is carried out by local governments through comprehensive plans. DLCD also receives federal funds to support these coastal program activities, including planning assistance to local governments and other state agencies. DLCD, through the Land Conservation and Development Commission, reviews and approves all local comprehensive plans and amendments to ensure compliance with the statewide planning goals.

Division of State Lands

The Division of State Lands is the administrative agency for the State Land Board, comprising the governor, secretary of state, and state treasurer, which holds a wide range of public lands in trust for the public. These trust lands include submerged and submersible lands under all estuaries, lakes, navigable waterways (rivers and streams), and the state's territorial sea (three nautical miles wide) The Division of State Lands regulates removal and fill of the seabed, estuaries, and streams under the Removal-Fill Law (including any dredged or seabed material); activities that affect wetlands; and the placement of docks and other waterside structures. It also shares authority over rocky intertidal areas along the ocean shore with the Oregon Parks and Recreation Department.

Oregon Economic and Community Development Department

The Ports Division of the Oregon Economic and Community Development Department assists the state's port districts in promoting economic development.

Oregon Health Division

The Oregon Health Division, in the Department of Human Services, monitors the water quality of Oregon estuaries as it relates to the quality of oysters and other shellfish grown and harvested for human consumption. The Oregon Health Division reviews and approves plans for new public water systems and major improvements to existing systems, including systems for recreational vehicle parks. Furthermore, it can order water or sewer services by cities or districts to areas where inadequate installation poses a danger to public health.

Oregon Parks and Recreation Department

The Oregon Parks and Recreation Department has authority over the "ocean-shore recreation area," which includes the ocean shore that is submerged by the daily tide as well as the adjacent dry sand beach. This area does not include estuary beaches. The agency has very few parks or recreational facilities in estuarine areas.

Oregon State Marine Board

The Oregon State Marine Board regulates boating activity in state waters, provides funds from boat registration fees and other sources for boating facilities such as docks and boat launches, and works with local government to enforce local regulations. The State Marine Board is an important agency in providing facilities that ensure access to the water in estuaries along the coast.

Water Resources Department

Along with the Water Resources Commission, the Water Resources Department administers state laws regulating the use of surface water and groundwater. The department promotes wise use of state waters through basin plans and state water management policies. The commission protects public resources and uses, including fish, water quality, and recreation, by setting minimum stream flows and in-stream water rights.

Watershed Councils

Watershed councils are nonregulatory organizations that were established through the Oregon Plan, a statewide program encouraging public participation and direct stakeholder involvement in watershed stewardship and restoration of native salmon stocks. There are over 90

watershed councils in Oregon, many with strong estuary stewardship programs, dedicated to enhancing watershed health through protecting riparian zones and improving fish habitat.

State Government—California

California Coastal Commission

The lead agency responsible for carrying out California's coastal management plans, the California Coastal Commission is one of the three designated state coastal management agencies that administer the federal Coastal Zone Management Act in California. The other two agencies are the California State Coastal Conservancy and the Bay Conservation and Development Commission, whose jurisdiction is exclusively San Francisco Bay. The commission is an independent entity consisting of 16 members (12 voting, 4 nonvoting) that carries out a variety of planning, permitting, and resource protection programs. Headquartered in San Francisco, with district offices along the coast, the commission staff works with each of 73 cities and counties in the coastal zone to develop local coastal programs and land use plans. The commission also reviews port master plans for the industrial ports along the coast (Hueneme, Los Angeles, Long Beach, and San Diego) and plans for universities with land along the coast (UC Santa Cruz, UC Santa Barbara, UC San Diego, Pepperdine University, and San Diego State).

California State Coastal Conservancy

The California State Coastal Conservancy, established by voter approval, has nonregulatory management responsibilities for the entire coast, including all coastal watersheds. The conservancy uses entrepreneurial techniques to purchase, protect, restore, and enhance coastal resources and to provide access to the shore. The conservancy relies on partnerships with local governments, other public agencies, nonprofit organizations, and private landowners to acquire land, design and implement public access, restore coastal land and urban waterfronts, and enhance wetlands and watershed enhancement. It also provides gap funds and technical assistance to local governments, other public agencies, and nonprofit organizations for these purposes. The California State Coastal Conservancy program has four components: (1) resource enhancement, (2) acquisition, (3) technical assistance, and (4) public information.

California State Lands Commission

Members of the California State Lands Commission include the lieutenant governor, the state controller, and the state director of finance. The staff is composed of specialists in mineral resources, land manage-

ment, boundary determination, petroleum engineering, and the natural sciences. The lands commission has management authority over all state-owned lands, including lands from mean high tide seaward to the three-mile territorial sea boundary. These lands embrace estuarine areas and much of the tidal marshlands fringing estuaries. The commission is responsible for developing and implementing the state's ballast water program and working with other state agencies to develop and implement the state's invasive species control program.

California Department of Fish and Game

The California Department of Fish and Game manages California's fish, wildlife, and plant resources, and their habitats, for their ecological values and public recreation. It is responsible for wildlife and fishery management programs. The Department of Fish and Game, in consultation with the California Coastal Commission and the Department of Boating and Waterways, studies degraded wetlands and conducts wetland restoration feasibility studies.

State Water Resources Control Board

The Porter-Cologne Water Quality Control Act is the principal law governing water quality regulation in California. It applies to surface waters, wetlands, and groundwater and to both point and nonpoint sources. The statute established the State Water Resources Control Board and nine regional water quality control boards and charged them with implementing provisions of the Water Quality Control Act. The state board provides program guidance and oversight, allocates funds, and reviews decisions made by the regional boards. The regional boards have responsibility for individual permitting, inspection, and enforcement actions within each of the nine hydrologic regions.

California Fish and Game Commission

A separate entity from the Department of Fish and Game, the California Fish and Game Commission has been involved in the management of California's fish and wildlife resources since 1870. It is composed of up to five members, appointed by the governor and confirmed by the senate. The commissioners are not full-time state employees, but individuals involved in private enterprise with expertise in various wildlife-related fields.

The commission meets at least 11 times each year to publicly discuss various proposed regulations, permits, licenses, management policies, and other subjects within its areas of responsibility. It also holds a variety of special meetings to obtain public input on items of a more localized nature, requests for use permits on certain streams, or establishment of new ecological reserves. Probably the best-known respon-

sibility of the commission is its general regulatory powers function, under which it decides seasons, bag limits, and methods of take for game animals and sport fish.

Office of Spill Prevention and Response

Housed in the Department Fish and Game, the Office of Spill Prevention and Response is the lead state agency charged with oil spill prevention and response within California's marine environment. The Lempert-Keene-Seastrand Oil Spill Prevention and Response Act of 1990 established the Office of Spill Prevention and Response and provides its administrator with substantial authority to direct spill response, cleanup, and activities that assess damage to natural resources.

4 Tribes

In the Pacific Northwest, tribal villages historically dotted estuary shores as they provided resource-rich summer camps, year-round shelter and safe harbor from the Pacific Ocean, and an abundance of fish, shellfish, and building materials. With the arrival of European settlers on the Pacific coast in the mid 1800s, many tribes were moved to reservations away from traditional village sites or were wiped out by disease or slaughter.

The role of the tribes in the various state and federal programs as they relate specifically to estuary management today is minimal. Since the 1970s, however, the role of the tribes has increased significantly in areas such as habitat protection and restoration, cultural heritage, salmon conservation, and salmon and shellfish resource allocation—all of which take place within the context of estuary management.

Below is a discussion, by state, of tribes whose activities—at some level—relate to estuary management. In a few instances, we have mentioned tribes who, though not active in estuary management, have a prominent presence in the estuary. Included are descriptions of tribal organizations such as the Columbia River Intertribal Fisheries Commission and the Northwest Indian Fisheries Commission.

Washington Resource Issues

Salmon

As of 2000, nine salmonid populations in the Pacific Northwest were protected under the Endangered Species Act: Snake River sockeye and upper Columbia River steelhead are listed as "endangered," and Snake

River spring/summer chinook, Snake River fall chinook, Snake River steelhead, Umpqua River cutthroat trout, lower Columbia River steelhead, Oregon coastal coho, and Columbia River bull trout are listed as "threatened."

In western Washington, NOAA Fisheries recently included Puget Sound chinook, Hood Canal/Strait of Juan de Fuca summer chum, and Lake Ozette sockeye salmon as "threatened" species. These listings, particularly Puget Sound chinook, mark one of the first times the Endangered Species Act has been implemented in a large metropolitan area.

Western Washington Indian tribes occupy a unique place in the Endangered Species Act issue. The tribes signed treaties with federal government representatives in the 1850s that guaranteed them the continued right to fish in all "usual and accustomed places" in exchange for the peaceful non-Indian settlement of most of the land west of the Cascade Mountains.

Those treaties were ignored or forgotten for decades; it wasn't until the 1974 Boldt Decision *(US* v. *Washington)* that the tribes were reestablished as co-managers of salmon and steelhead resources in western Washington. The courts, including the United States Supreme Court, have ruled that the tribes are entitled to half of the harvestable surplus of salmon and steelhead in western Washington. Along with this right to fish came the responsibility of managing treaty-reserved resources.

Because tribes have always depended on natural resources for their economic, cultural, and spiritual survival, they have become increasingly concerned with the Endangered Species Act as the list begins to grow. Following are examples of salmon recovery programs and initiatives being pursued by western Washington tribes.

Wild Stock Restoration Initiative

Through the Wild Stock Restoration Initiative, the tribes are now defining management goals and objectives for fisheries and are developing both regional and watershed-specific plans.

The Salmon and Steelhead Stock Inventory and Analysis

The Salmon and Steelhead Stock Inventory and Analysis will ultimately result in a blueprint for joint tribal-state cooperative action to document current habitat conditions, assess the role of habitat degradation and loss on the condition of salmon and steelhead stocks, develop stock- or watershed-specific strategies for habitat protection and restoration, and define a cooperative process to implement habitat restoration and protection strategies.

Comprehensive Coho and Comprehensive Puget Sound Chinook

The goal of Comprehensive Coho and Comprehensive Puget Sound Chinook management plans are to restore the productivity, production, and diversity of salmon stocks originating in the streams tributary to Puget Sound and the Washington coast to levels that can sustain ceremonial, subsistence, and other fisheries. This will be accomplished through the protection, restoration, and enhancement of salmon habitat; responsible management of fisheries to ensure that adequate spawning adults escape to use the available habitat; and hatchery programs that provide fishery benefits and enhance the productivity of natural stocks.

Tribal Salmon Recovery Plan

Despite efforts by the tribes to engage the state of Washington in a joint plan to address impending Endangered Species Act listings, the tribes have been excluded from the state's salmon recovery planning process. Consequently, the tribes are preparing their own plan.

The plan will be used by tribes in their watersheds and will provide a framework for incorporating other regional plans. The tribal plan focuses on the management of habitat, harvest, and hatcheries, and will serve as a tool for NOAA Fisheries to create a high standard for habitat protection when it lists salmon species under the Endangered Species Act. It is hoped that other agencies and organizations will endorse or adopt the plan for implementation. Regional or watershed initiatives are at the heart of the plan. Specific recovery plans will be developed for each watershed and will guide how fisheries, habitat, and hatcheries will be managed.

Source: Northwest Indian Fisheries Commission, *Treaty Indian Tribes and the Endangered Species Act*

Shellfish

Washington is one of the few states in the nation where tidelands are privately owned. Most states have kept tidelands in public hands so everyone can enjoy them. The state sold off the tidelands several decades after the treaties were signed in the 1850s that promised the tribes half of the shellfish. The treaty right to harvest shellfish was never extinguished; the sale of tidelands did not change the tribes' treaty right.

Shellfish have been a mainstay of western Washington Indian tribes for thousands of years. Clams, crab, oysters, shrimp, and many other species were readily available for harvest year-round, and the relative ease with which large numbers could be harvested, cured, and stored

for later consumption made shellfish an important source of nutrition—nearly as important as salmon.

Shellfish remain important for economic, subsistence, and ceremonial purposes. The rapid decline of many western Washington salmon stocks, due in large part to habitat loss from the region's burgeoning human population, has pushed shellfish to the forefront of many tribal economies. The tribes have two distinct types of shellfish harvests: commercial, and ceremonial and subsistence. Commercial harvests are fisheries for profit. Shellfish harvested during a commercial fishery is sold to licensed shellfish buyers who in turn sell shellfish, either directly to the public or to other commercial entities, such as a wholesaler, a restaurant, or another distributor. Tribes collect taxes from tribal members who sell shellfish. Those taxes are returned to the tribal programs to help pay for natural resource management. Ceremonial and subsistence harvests are intended for tribal use only.

Source: Northwest Indian Fisheries Commission, *Tribal Shellfish Resource Management*

Water Quality

The Coordinated Tribal Water Quality Program was developed by the 26 federally recognized tribes in the state of Washington in 1990. Tribes have worked with the EPA to implement the program for the past nine years. EPA funds are enabling the tribes to conduct water quality programs critical to the management of their treaty-protected resources and to provide for the health of their members and the environment. Federal funding of the program is necessary under the trust responsibility of the United States to implement the Stevens Treaties.

The Coordinated Tribal Water Quality Program is designed to provide base-level staff infrastructure for tribes to organize and begin addressing the water quality issues that threaten their reservations and treaty-protected resources. Water pollution in Washington threatens the health of tribal members and their treaty resources without respect to political boundaries. Tribal jurisdictions interlock with many other jurisdictions, including some of the most densely populated and industrial areas in the state.

Three commonalties guide program design and implementation:

- All tribes are confronted by serious water quality issues.
- All tribes require necessary infrastructure to adequately address these issues.
- A watershed-ecosystem approach is the best approach to solving these issues because of their multi-jurisdictional nature.

The tribes in Washington developed and adopted the program as a watershed-protection strategy to safeguard the resources on which they

depend for their economic, spiritual, and cultural survival. This strategy provides for the development of infrastructure, program implementation, and statewide coordination.

Source: Northwest Indian Fisheries Commission, *Coordinated Tribal Water Quality Program*

Washington Tribes

Northwest Indian Fisheries Commission

The Northwest Indian Fisheries Commission was created in 1974 by the treaty Indian tribes in western Washington as a result of the *US* v. *Washington* litigation that affirmed fishing rights reserved by the tribes in treaties signed with the federal government in the 1850s.

The commission's role is to assist the tribes in conducting biologically sound fisheries and to provide member tribes with a single, unified voice on fisheries management and conservation issues. Member tribes are Nisqually, Squaxin Island, Puyallup, Jamestown S'Klallam, Port Gamble S'Klallam, Lower Elwha Klallam, Skokomish, Swinomish, Sauk-Suiattle, Upper Skagit, Tulalip, Makah, Stillaguamish, Muckleshoot, Suquamish, Nooksack, Lummi, Quinault, and Quileute.

Shoalwater Tribe (Pacific County)

With a population about 200, the Shoalwater Bay Tribe is the smallest tribe in Washington. It is a federally recognized tribe.

Quinault Nation (Grays Harbor County)

The Quinault Nation is the only tribe in the *U.S.* v. *Washington* case area to have complete self-regulatory status. It functions under a set of by-laws that the tribe adopted August 24, 1922. Tribal members exercising treaty rights are not subject to state regulations or permit requirements. The Quinault Nation's Department of Natural Resources (and within this department, the Fisheries Division) consults with the Washington Department of Fish and Wildlife with respect to salmon and steelhead management, research, and enhancement activities.

The Quinault Reservation of 189,621 acres is located in northwestern Grays Harbor County and southwestern Jefferson County, 45 miles north of Hoquiam. The Quinault Tribe has 2,453 enrolled members.

Chehalis Confederated Tribes (Grays Harbor County)

Members of the Chehalis Confederated Tribes come from the Hoquiam, Hooshkal, Humptulips, Klimmin, Nooskhom, Satsop, Wynooche, and Wishkah Tribes. The Chehalis Reservation is located

in the southeastern corner of Grays Harbor County, bordering Thurston County, southeast of Oakville. It covers 4,225 acres made up of 24 acres of tribal trust land and 1,763 acres of individual trust land. There are 525 enrolled members.

Although the Chehalis Confederated Tribes is not involved in estuary management, it has an active fisheries program.

Chinook

Although not involved in estuary management, the Chinook Tribe/Chinook Nation is the prominent tribe on the lower Columbia River and on Willapa Bay. Historically, it was also the most important tribe on those estuaries. The tribe is currently in the process of fighting for federal acknowledgment, which would give it more authority to help with the management of the estuaries. The Chinook Tribe/Chinook Nation has a population of about 2,000.

Cowlitz

The Cowlitz were acknowledged as a tribe by the federal government in January 2002. Based in Longview, Washington, the Cowlitz number around 2,200. The tribe is involved with the Federal Energy Regulatory Commission on dam relicensing projects on the Lewis and Cowlitz Rivers. It is also in contact with NOAA/NOAA Fisheries regarding work on the Columbia River estuary.

Puget Sound Tribes

Puget Sounds tribes are the Nisqually, Squaxin Island, Puyallup, Jamestown S'Klallam, Port Gamble S'Klallam, Lower Elwha Klallam, Skokomish, Swinomish, Sauk-Suiattle (less involved in estuary management than are the other Puget Sound tribes), Upper Skagit, Tulalip, Makah, Stillaguamish, Muckleshoot, Suquamish, Nooksack, Lummi, Quinault and Quileute.

Sources: Tribal Web pages; personal communication with Jay May, Shoalwater Tribes (9/11/02); Roman Iyer, Chehalis Confederated Tribes (9/02); Roy Sampsel, Rex Rhoades, and Ray Gardner, Chinook Indian Tribe/Chinook Nation (9/10–11/02); Mike Iyall, Cowlitz Tribe (9/02); and Mike Grayum, Northwest Indian Fisheries Commission (9/02)

Columbia River (Washington and Oregon)

In 1977, the Columbia River Inter-Tribal Fish Commission was formed by the four tribes with treaty rights to Columbia Basin salmon: the Nez Perce Tribe, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Confederated Tribes and Bands of the Yakama Indian

Nation. Headquartered in Portland, the commission coordinates tribal efforts and provides technical support on issues related to habitat protection, fish production, harvest, and water quality, including the protection of human health. The commission's members are the fish and wildlife committees of each tribe.

Each of the four tribes has federally recognized reserved rights to cultural and natural resources in the Columbia River Basin, stemming from 1855 treaties with the United States. Among other things, the treaties ensure the tribes the right to fish at all their usual and accustomed places in the Columbia River and its tributaries. Each tribe is a sovereign government and has an interest in natural resource management in the lower Columbia River and estuary.

Source: Bureau of Indian Affairs; Lower Columbia River Estuary Program; Northwest Portland Area Indian Health Board

Columbia River Basin Tribes (Nez Perce, Umatilla, Warm Springs, Yakama, Cowlitz, Chinook)

Nez Perce

The approximately 3,000 members of the Nez Perce Tribe reside on a 750,000-acre reservation with headquarters in Lapwai, Idaho. The Nez Perce Tribe has co-management responsibilities with the other tribes for the Columbia River, where Nez Perce tribal members continue to fish.

Confederated Tribes of the Umatilla

The nearly 2,100 members of the Confederated Tribes of the Umatilla Indian Reservation live on a 172,000-acre reservation with headquarters in Mission, Oregon. For decades, the tribe's focus has been on the Umatilla and Grande Ronde Rivers, where fish restoration has been the paramount activity. In 1984, the first fall chinook salmon in 70 years returned to the Umatilla River after the tribes, in partnership with the state of Oregon, reintroduced them. In addition to the reviving Umatilla River fishery and other fisheries, the tribe continues to have co-management responsibilities for the Columbia River, where many of its members still fish.

Confederated Tribes of the Warm Springs

The 3,000 members of the Confederated Tribes of the Warm Springs Reservation of Oregon reside on a reservation of nearly 640,000 acres, with headquarters in Warm Springs, Oregon. The U.S. Fish and Wildlife Service operates a hatchery on the reservation, and the tribe has co-management responsibilities of the Columbia River and important tributaries, such as the John Day, Deschutes, and Hood Rivers. Tribal

members continue to fish with dip nets and set nets at the falls near Sherars Bridge on the Deschutes.

Confederated Tribes and Bands of the Yakama

The nearly 8,400 members of the Confederated Tribes and Bands of the Yakama Indian Nation live on the 1.2 million-acre Yakama Indian Reservation in south-central Washington. The Yakama Tribe employs approximately 40 people in its fisheries program, which emphasizes an interdisciplinary and sustainable approach to natural resource management. The Yakama Nation is working with the U.S. Department of Energy to use abandoned settling ponds at the Hanford Nuclear Reservation to acclimate juvenile fall chinook before releasing them into the Columbia River. The Yakama Nation co-manages the Columbia River, as well as important tributaries such as the Wind, White Salmon, and Klickitat Rivers. The tribe continues to fish at its usual and accustomed places in the Columbia River Basin.

Oregon Tribes

The Confederated Tribes of Siletz

On November 18, 1877, after years of working together as a united people, the Siletz Tribe was restored and reasserted their Indian identity with the enactment of the Siletz Restoration Act, PL 95-195. The Siletz Reservation Plan was approved in September 1980. The reservation now contains the 39-acre Government Hill parcel and 3,630 acres of timber lands in Lincoln County, as well as several parcels of land purchased by the tribe. The Confederated Tribe of Siletz has 3,022 members. The tribe assists the U.S. Fish and Wildlife Service and the U.S. Forest Service in studying the effects of enhancing the wildlife refuge within the Siletz estuary.

The Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians

The Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians are the aboriginal inhabitants of the central and south-central coast of Oregon. Their traditional lands, which once covered 1.6 million acres, include the estuaries of Coos Bay, and the Umpqua and Siuslaw Rivers. The tribes have been operating under a confederated government since the signing of the treaty of August 1855. They currently possess a 6.1-acre reservation and tribal hall erected in 1940, but past claims have not yet been settled. Nevertheless, their interest in their original 1.6 million acres is acknowledged by the federal government, and activities by the government in those lands must be reviewed by the tribes first.

The Coquille Indian Tribe

The Coquille Restoration Act recognizes the sovereignty of the tribe and its authority as tribal government to manage and administer political and legal jurisdiction over its lands, businesses, and community members. The tribe does very little with estuary management, but it does work with the Oregon Department of Fish and Wildlife to lease part of the estuary for aquaculture.

Members of the Coquille Indian Tribe are descended from people who inhabited the watersheds of the Coquille River system, a small portion of Coos Bay at the South Slough, and areas north and south of the Coquille River mouth, where it enters the ocean at present-day Bandon. The Coquille Tribe has 695 enrolled members.

The Klamath

The Klamath Tribes, numbering over 3,000 members, live in south-central Oregon. Since regaining federal recognition in 1986, the Klamaths have been intensely involved in water-quality and endangered species issues on the upper half of the Klamath River system. The main focus of their efforts has been to restore functional ecosystems in and above Upper Klamath Lake. Extensive aquatic ecosystem degradation resulting primarily from agricultural development has caused severe water quality problems (exacerbated by depleted river flows) extending all the way to the ocean. The extent to which the tribes and their partners succeed in restoring the upper basin watershed will affect the entire Klamath River system.

Since 1917, when Copco Dam was built on the Klamath River without any provision for fish passage, anadromous fisheries have been excluded from the upper basin. The Klamath Tribes have never stopped trying to restore these fisheries to the upper basin and are currently striving to bring this about through the relicensing process for the Klamath Hydroelectric Project. The operating license for the Klamath Hydroelectric Project, a five-dam complex owned by PacifiCorp, expires in 2006, and PacifiCorp is seeking a new operating license covering the next 30 to 50 years. The outcome of this relicensing process will be pivotal to the restoration of anadromous fisheries to a major portion of the Klamath drainage.

Sources: Confederated Tribes of Siletz; Northwest Portland Area Indian Health Board; tribal Web sites; personal communication with Mike Kennedy, Confederated Tribes of Siletz (9/02); Frances Somday, Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians (9/02); Mark Healy and Don Ivy, Coquille Indian Tribe (9/10/02); and Larry Dunsmoor, Klamath Tribe (9/12/02)

Northern California Tribes

The lands surrounding Humboldt Bay were settled primarily by the Wiyot Indians for several thousand years. Their history in the area all but ended with the migration of Euro-American settlers in the late 1800s. A pilgrimage of gold miners discovered the land in 1849, and by 1860, over half of the Native Americans of Humboldt Bay had perished from disease or slaughter.

Native Americans continue to exercise their rights to fish and gather shellfish for subsistence at many other locations on the north coast of California, especially near large coastal inlets, such as the Klamath River.

In 1981, the Hoopa Valley Tribe established the Tribal Environmental Protection Agency, the first tribal environmental agency within EPA Region 9 to further develop, monitor, and enforce both federal and tribal environmental laws. The Tribal Environmental Protection Agency has been working closely with tribal forestry, fisheries, public utilities, police, staff attorneys, and the tribal court on the development, monitoring, and enforcement of environmental policies, codes, ordinances, and standards. The tribal agency currently administers several environmental programs, including a superfund pilot, air quality, lead-based paint poisoning prevention, water pollution control, hazardous waste management and solid waste management.

In 1997, the Hoopa Valley Tribe became the first tribe in California to develop and establish a water quality control plan, which provides jurisdiction to all waters of the reservation, including the Trinity River. Finally, to build environmental capacity for long-term program management, the tribe entered into an environmental protection agreement with the EPA.

Sources: San Diego State University, *Directory of California Indians and their Reservations: An Online Dictionary*; EPA Region 9 Tribal Office

The Hupa

The Hupa traditionally occupied lands in the far northwestern corner of California, along the lower Trinity River and in the Hoopa Valley. Their diet and way of life centered around the semiannual king salmon runs that occur on the Trinity River. This river flows through the Hoopa Valley Reservation, created in 1864, which is in the heart of their traditional territory. Over 2,200 Indians live on this reservation.

The Yurok

The Yurok was the southernmost tribe of the Pacific Northwest coast. Several thousand Yurok lived in small villages on the banks of the lower Klamath River in northwestern California when they were first encountered by Europeans in the 1770s. A reservation was established in the mid-nineteenth century. Over 4,000 individuals, living mainly in the

same region, claimed Yurok ancestry as of 1990. The population on the reservation is about 1,343. The Yurok Tribe is the senior water rights holder for the Klamath River and has both watershed and fisheries departments.

The Wiyot

The Wiyot, or Weott, Indians traditionally were located on the far northwestern coast of California, along the shores of Humboldt Bay and the mouths of the Mad and Eel Rivers. Their way of life centered on the coastal-tideland gathering of shellfish and other marine resources. There were as many as 3,500 Wiyot living in their region in the early nineteenth century. Today, although there are only about 400 people of Wiyot descent, the tribe plays an active role in the activities occurring along the 40 miles of coastline that are their traditional lands. The tribe is also active in the Humboldt Bay and Eel River watersheds.

Sources: San Diego State University, *Directory of California Indians and their reservations: An Online Dictionary;* and personal communication with Yurok Tribe (9/02) and Nina Hapner, Wiyot Tribe (9/02)

5 Management Specifics

This section details estuary planning efforts in each of the three states in the PNCERS region and provides local government information for select estuaries in each state.

Washington

Washington was the first state to receive federal approval of its Coastal Zone Management Program under the 1972 National Coastal Zone Management Act. Approved in 1976, Washington's program is based on a network of state laws and local ordinances implemented by local and state agencies under the authority of the Shoreline Management Act. Under the act, coastal cities and counties are required to develop shoreline master programs that incorporate the goals of the federal Coastal Zone Management Act. These local shoreline plans are reviewed for conformity with state law and approved by the Department of Ecology, the lead administrative agency.

The Shoreline Management Act establishes priority for shoreline uses that

- recognize and protect the statewide interest over local interest
- preserve the natural character of the shoreline
- result in long-term over short-term benefit
- protect the resources and ecology of the shoreline
- increase public access to publicly owned areas of the shorelines
- increase recreational opportunities for the public in the shoreline

Local jurisdictions may issue a shoreline substantial-development permit if the proposed use is consistent with both the local shoreline

master program and the policies of the Shoreline Management Act. Local zoning and land use requirements are integrated with the shoreline master program process.

Grays Harbor and Puget Sound have an additional layer of management that coordinates estuarywide activities and lays out estuary planning goals that go beyond the requirements of the Shoreline Management Act.

Padilla Bay (National Estuarine Research Reserve)

The Padilla Bay Reserve is a cooperative program of the Washington Department of Ecology and NOAA under the National Estuarine Research Reserve Program. Reserve programs (educational and outreach) are implemented through facilities at the Breazeale-Padilla Bay Interpretative Center, which also serves as the base for research and monitoring projects.

Puget Sound/Georgia Basin

The Puget Sound Water Quality Action Team considers that "Puget Sound, the Strait of Juan de Fuca and the Strait of Georgia are three parts of a single ecological unit—the inland marine waters of Washington and British Columbia" and refers to the area as the Salish Sea. Because these inland waters are functionally one system, Washington State and British Columbia have entered into formal agreements to address a number of environmental issues through an intergovernmental council, the Puget Sound/Georgia Basin International Task Force.

Puget Sound

Planning and management of estuarine resources and uses in Puget Sound are highly complex. Protection of the sound's water quality and habitat for living resources is driven by two-year work plans based on the Puget Sound Water Quality Management Plan. The plan provides the framework for managing and protecting Puget Sound. It coordinates the roles and responsibilities of federal, tribal, state, and local governments and encourages the involvement of businesses, individuals, and organizations. According to the Puget Sound Water Quality Action Team, in Puget Sound there are "108 cities, 12 counties, 12 conservation districts, 12 local health jurisdictions, 28 local port districts, 3 regional governmental bodies, 22 tribes, 14 state agencies, 9 federal agencies . . . and hundreds of special purpose districts for water, sewer, groundwater protection, drainage and irrigation."

This plan satisfies the state requirement for a comprehensive conservation and management plan (CCMP) for the Puget Sound Estuary Program. As a CCMP, the plan addresses federal actions affecting Puget Sound. Under the Clean Water Act, the Puget Sound CCMP is supported, in part, by federal technical and financial assistance.

The water quality plan/CCMP recognizes the authority of other state and local water quality and resource protection programs and strives to coordinate such programs and reduce duplication. Efforts to protect water quality are enhanced by providing regional technical assistance to help local governments implement the work plans. The action team advocates full funding for existing federal and state programs that provide grants and loans to protect Puget Sound. The action team also advocates enhancing the authority of local jurisdictions to raise their own funds.

Work plans—based on the Puget Sound Management Plan—are developed every two years and identify priorities for action. The work plans contain federal, tribal, state, and local government actions to protect the sound and its resources. The Puget Sound Water Quality Action Team and the Puget Sound Council develop the work plans, and the council oversees their implementation. The first work plan was prepared and finalized in July 1997.

Priorities for Puget Sound's work plan are

- to fix and prevent on-site sewage system problems
- to protect and restore shellfish beds
- to reduce nonpoint pollution
- to improve habitat
- to protect the shared waters of Puget Sound in Washington and the Georgia Basin in British Columbia
- to educate

Priority management issues include

- toxics
- conventional pollutants
- pathogens
- human population growth
- habitat loss and alteration
- introduced and pest species
- sedimentation
- oil spills

Sources: EPA Office of Water; Puget Sound Water Quality Action Team

Grays Harbor

Grays Harbor is one of two major estuaries on the Washington coast and is the only one with a maintained deep navigation channel and major port. The otherwise shallow estuary encompasses approximately 58,000 acres.

A combination of high resource values and an important industrially and commercially based local economy led to numerous conflicts

in the 1970s. Maintaining water quality and preserving wildlife habitat were at odds with providing for navigation, industry, aquaculture, and recreation. To resolve these disputes, a task force of federal, state, and local agencies with management responsibilities came together to create a special management plan for the entire estuary. Funded in part by a federal Coastal Zone Management Act grant, the task force prepared the Grays Harbor Estuary Management Plan. First published in 1986 and approved as an amendment to the Washington State Coastal Zone Management Plan in 1992, the Grays Harbor plan appears to have been only marginally successful in achieving coordinated management at an estuarywide scale.

The Grays Harbor Estuary Management Plan was designed to complement local shoreline master programs, coordinate agency efforts, provide guidance to decision-making processes, and make permitting and decision-making processes more predictable. The estuary plan does not eliminate or modify the authority of local, state, or federal agencies.

The Grays Harbor plan functions within a three-tiered policy framework that regulates management at three levels: estuary, planning area, and management unit. The first policy level is a broad-based policy that is the estuary management goal by which all projects must be measured. The second level provides for eight planning areas. Boundaries for the eight designated planning areas were based on a number of criteria: land ownership, political jurisdictions, existing uses, areas of existing or possible conflict, and physical features. In the plan, each planning area is described briefly, outlining existing uses (for example, wildlife observation, industrial port, disposal area for dredge material), highlighting possible conflicts (for example, human development in key areas versus critical fish habitat preservation and restoration) and pointing out natural assets such as floodwater storage and existing transportation infrastructure. Permitted uses and development possibilities were outlined in the plan and attempts were made to balance human needs with the needs of the natural system.

The third level contains the most specific policies at the management unit level, where projects are evaluated and policies realized. Management unit boundaries were established at the plan's inception. They are adjacent to the shoreline and lie between the ordinary high water line and the upland plan boundary line that was established whenever possible by "specific ground or property features." The 43 different management units in the plan were established to "provide specific guidance to planning and development as well as management of the natural resources throughout the estuary."

Department of Ecology guidelines require management units in the local shoreline master plans to be assigned an environmental type or a

combination of types (for example, natural, conservancy, rural, or urban). Each type is associated with a different level of development and conservation action. In an attempt to go beyond the requirements of the state's shoreline master program, Grays Harbor planners doubled the number of management categories to be used in the Grays Harbor Estuary Management Plan. The resulting eight categories are defined as follows.

Natural—preserves or restores designated areas to their natural or original conditions. Such areas will remain relatively free of human influence and contain severe restrictions on the intensity and type of use that is allowed.

Conservancy natural—maintains the general natural character of areas. Direct human influence in such areas will be minimal. The primary emphasis of the conservancy natural designation is to ensure that future uses and changes will enhance rather than degrade the natural characteristics of that area.

Conservancy managed—protects areas for purposes that directly use or depend on natural systems. Although such areas are not intended to be preserved in their natural state, the activities that occur in these areas are required to be compatible with the natural systems. "Managed" is the key word in this classification, which allows uses that depend on the natural system for production of food, recreation, recognized scientific research, or public access for recreational uses. (Recreational uses will be water dependent and designed to maintain the quality of the natural features of the area.)

Rural agricultural—protects existing and potential agricultural land from the pressures of urban expansion and rural, low-density development. Agricultural uses include intensive cultivation practices that are dependent on regional, national, and international markets and involve agricultural food crops as well as tree farming.

Rural low density—restricts intensive development along undeveloped bank lines and maintains open spaces and opportunities for recreational uses that are compatible with a general rural character. Agricultural uses are allowed within the rural low-density areas, although they will relate more to local markets or individual subsistence farming.

Urban residential—protects areas where the predominant use is or should be residential. The urban residential category is designed to maintain a residential character with respect to

scale, density, and general types of activities allowed. Public water access and limited local service commercial uses are appropriate within urban residential areas.

Urban mixed—areas in which there is or should be a mix of compatible urban uses. In general, residential densities are higher than those of rural areas, industrial and commercial uses are service or community oriented, and public access to the water is allowed for recreation.

Urban development—areas where the predominant uses are or will be industrial and commercial in nature. The intent of the urban development designation is to promote efficient use of such areas, primarily for water-dependent or water-related commerce and industries that are related to the region's primary economy.

Special—contains features that require management through special conditions that are unique to that management unit or when the general definition of any of the other management categories is inadequate to describe the projected management of special-designated units.

The Grays Harbor plan was designed with a balanced approach and adaptive management at its center. A planning task force was to meet in February of each year following the adoption of the plan to "review development and permit activities of the previous year and to assess the usability of the plan." The task force could suggest amendments, although it was assumed that any changes in the plan would be primarily for administrative purposes or to clarify details of the policy as opposed to substantive revisions.

The Grays Harbor Estuary Management Plan Task Force first reconvened in 1990 to review the 1986 plan. An amended plan was adopted by the task force in 1992 but was never implemented. The task force again reconvened in 1997 to review and update the plan. This task force made substantial progress toward updating the plan, but in 1999 the task force decided to suspend its work because of uncertainties created by two externalities: (1) the pending listing of one or more salmonid species under the Endangered Species Act and (2) proposed changes to the shoreline master program guidelines regulation for implementation of the Shoreline Management Act.

Although the updated and revised plan has yet to be formally adopted, the Grays Harbor Estuary Management Plan remains a functional management tool for local planners.

Willapa Bay

The Willapa Bay Water Resources Coordinating Council is appointed by the Pacific County Board of Commissioners to coordinate the community interests in multiple uses of Willapa Bay. The council oversees the drafting and implementing of such plans as the Willapa Bay Water Quality Plan. The council meets monthly.

Willapa Bay does not currently have an estuarywide management plan, per se. There are a number of issue-based planning efforts either in progress or in the planning stages that have had varying degrees of success. An example of an issue-base management effort is the Willapa Bay Spartina Management Plan initiated by the Washington Department of Agriculture and carried out with cooperation from agencies such as the Department of Fish and Wildlife and the Department of Natural Resources.

Until 1999, management concerns at the stakeholder level were often represented by the Willapa Bay Alliance, a nonprofit community organization whose mission was to "protect ecological resources while promoting sustainable economic development." The alliance successfully coordinated stakeholders (industry, tribes, environmentalists, and local community members), sponsored problem-solving workshops and community meetings (for example, the Willapa Indicators Community Summit), and conducted research on the socioeconomic and biological conditions of the Willapa Bay estuary.

The Willapa Bay Alliance was absorbed into the Columbia Pacific Resources Center, which is changing its name to the Coastal Resources Alliance. This science-driven group is focusing its research and management efforts on dealing with Willapa Bay's ever-growing Spartina problem, along with other projects.

Management Challenges

Oyster growers in Willapa Bay (and Grays Harbor) are the center of a management controversy: Since the 1960s growers have used the pesticide carbaryl (also called Sevin) to control naturally occurring burrowing ghost shrimp and mud shrimp and thus to protect commercial oyster habitat. The pesticide has been banned in most areas and is currently being used only in Willapa Bay, Grays Harbor, and shellfish beds in Colombia, South America, because of concerns about both environmental and human health impacts. The pesticide is applied, following strict permit regulations, to a maximum of 600 acres in Willapa Bay annually and 200 acres in Grays Harbor. However, the concern remains, specifically over the effects of the pesticide on naturally occurring Dungeness crab, another commercially harvested species.

In January 2001, oyster growers in Willapa Bay and Grays Harbor signed an agreement to conduct research and phase out carbaryl in favor of an integrated pest management system. Parties to the agreement were the Washington Department of Ecology, Washington Department of Agriculture, Washington Department of Fish and Wildlife, Washington State Commission on Pesticide Regulation, Willapa Bay/Grays Harbor Oyster Growers Association, Pacific Coast Shellfish Growers Association, and Pacific Shellfish Institute.

Sources: Washington Department of Ecology News Release 2001; Feldman et al, 2000; Willapa Bay Alliance 1996; Wolf, 1993; U.S. Army Corps of Engineers, Evaluation Framework, 1998

Columbia River (Washington/Oregon)

Comanagement of the Lower Columbia River estuary by agencies in Washington and Oregon started in 1974 through the Columbia River Estuary Study Team, an association of local governments from both states. A major goal of the program was to collect information about the state of the environment in the lower 146 miles of the river. The findings of the bi-state program eventually led to the nomination of the lower Columbia River estuary to the National Estuary Program in 1995. In 1999, the Lower Columbia River Estuary Program published its management plan. Implementation of the plan began that same year.

Lower Columbia River Estuary

Given the interstate and international character of the Columbia Basin and the extensive federal property and national policy interests in the basin, the federal government continues in many ways to be the single most dominant player in managing activities on the river.

Nevertheless, because the stakes are so high (the estuary and the river support a $30 to $40 million economy) and because there is also significant state and local authority over various basin activities, the federal government does not have the ability to force solutions. At the state level, it is worth noting that in the estuary program planning area, land use regulations differ significantly on the two sides of the river. Whereas Oregon has a comprehensive, statewide, land use planning scheme, Washington's growth-management scheme places minimal requirements on counties and cities below certain threshold growth rates.

Sources: Lower Columbia River Estuary Program; Duncan, Neuman, and Swift, 1999

Oregon

Coastal management in the state of Oregon is delegated to the Land Conservation and Development Commission's staff and the Department of Land Conservation and Development. Oregon's enabling legislation is the Land Use Planning Act whereby coastal cities, counties, and port districts are required to develop comprehensive plans that incorporate specific state planning goals. These plans are reviewed and approved by the Department of Land Conservation and Development.

The state of Oregon's authority to regulate estuarine alterations is based on the state's ownership of the beds and banks of most waters in the state and the state's public trust responsibility to manage public resources—including water, fish, and wildlife—in the public interest. Federal laws are based on the national government's general mandate to protect public health and welfare and its specific authority over all navigable waters. The authorities delegated to various state and federal agencies are outlined below.

Twenty-two cities and 13 port districts have planning or management responsibilities for Oregon's major estuaries. Cities, in coordination with counties, are responsible for preparing and administering estuary plans. Port districts support development and maintenance of navigation improvements for water-oriented industry and commerce, as well as commercial fishing and recreational boating and fishing. Ports also play a key role in planning and implementing economic development strategies for the areas they serve.

The affected cities and counties, with input from the public and other interested units of government, prepare a plan for each estuary. Plans divide each estuary into a number of different zones or areas, called management units, and identify appropriate uses for each management unit.

Under Statewide Planning Goal 16 (estuarine resources), the Land Conservation and Development Commission, the lead agency in estuary management for Oregon, adopted a coastwide estuary classification system that defines the overall level of development permitted in each estuary. This system is designed to preserve diversity among Oregon's estuaries and guide development to estuaries that have already been altered and that can support more development.

Estuaries are classified as *natural, conservation, shallow draft development,* or *deep draft development* estuaries (see chapter two of this publication for more information). Another subclass is reserved for the smallest—"minor"—estuaries along the coast. Minor estuaries are formed where smaller rivers and creeks meet the ocean. Despite their small size, most minor estuaries do have valuable estuarine habitat

and support anadromous fish runs. In addition, most of them are largely unaltered by human development. Minor estuaries are required to be placed in either a conservation or natural classification in an estuary plan.

Local plans divide each estuary into a series of management units. Each management unit is a discrete geographic area defined by biological and physical characteristics and features, within which particular uses and activities are promoted, encouraged, protected, or enhanced, and others are discouraged, restricted, or prohibited. The type of management units—and therefore the uses—allowed in an estuary depend on its classification. Natural estuaries may include only natural management units. Conservation estuaries may include both conservation and natural management units, while development estuaries may include all three types of management units.

Through the resource capabilities test, local governments consider the effects of each conditional use on other uses, the resources in the area, and the identified management objective. On the basis of these considerations, a *conditional use* will either be allowed or limited in such a way that it is consistent with the uses, resources, and management objectives for the area. The resource capabilities test can be applied either during plan development or through the review of a particular project.

Whether or not a use is consistent with these values and objectives will depend on a site's ability to tolerate a particular type or level of use, considering the resources present at the site, other uses in the area, and the size, scale, or location of the proposed use. Local governments weigh these factors to determine the appropriateness of a proposed use.

A use or activity is considered appropriate when

- Either the impacts of the use on estuarine species, habitats, biological productivity, and water quality are not significant or the resources of the area are able to assimilate the use and activity and their effects and continue to function in a manner that protects or conserves important natural resource values or uses
- Important natural resource values in natural management units are significant wildlife habitats, natural biological productivity, and values for scientific research and education
- Important resource values and uses in conservation management units are renewable resources, natural biological productivity, recreational and aesthetic values, and aquaculture

Local governments, through a review of permits for specific projects, apply most of these requirements. However, some plans have addressed

project review requirements in the comprehensive plan. In a few cases, plans have deferred these requirements to resource agencies to apply through agency permit reviews.

Sources: *Oregon Estuary Plan Book,* 1987; Oregon Department of Land Conservation and Development

Tillamook Bay National Estuary Project

The Tillamook County Performance Partnership is an organizational entity designed to implement the Tillamook Bay Comprehensive Conservation and Management Plan. The partnership is a consortium of community leaders, state and federal agencies, private citizens, and municipalities who have a vested interest in the economic and environmental health of the Tillamook Bay estuary. The group has over 120 members. The management plan, produced by the Tillamook Bay National Estuary Project (TBNEP), was approved in 1999.

TBNEP is poised to work with local communities and the scientific community to solve problems in the bay and address management conflicts and issues. TBNEP consists of five committees: the policy committee, management committee, scientific and technical advisory committee, citizen action committee, and financial strategies advisory committee.

Priority issues identified in the CCMP include habitat loss and simplification, water quality, erosion and sedimentation, and flooding. The TBNEP office is located at the north end of Tillamook Bay at the Port of Garibaldi. They have an eight-person staff, including three contractors.

Under the current resource management framework, numerous barriers stand in the way of implementing effective management strategies and reaching protection goals:

Complex funding streams: Multiple agencies are often involved in the review of grants. As a result, much of the funding that could be spent on project implementation is lost to agency overhead. Also, many grants are not large enough to cover administrative staffing or are targeted only to "tangible projects."

Limited availability of cost share: Many plans are not being implemented because local governments do not have the funds to match federal and state grants. Greater flexibility in types of match (in kind, for example) could eliminate this barrier.

Lack of agency coordination: Different agencies often work on similar, overlapping projects (riparian restoration, for example).

None of Tillamook County's major watersheds meets the clean water standards established by the Environmental Protection Agency and the Oregon Department of Environmental Quality. Nonpoint source

Objectives and Uses for Each Management Unit Designation

Management Unit	Description
Natural Sand Lake, Salmon River, Big Creek (Lincoln County), Tenmile Creek (Lane County), Big Creek (Lane County), Berry Creek, Siltcoos River, Sutton River, Tahkenitch Creek, Tenmile Creek (Coos County), Twomile Creek, Fourmile Creek/New River (Coos County), Floras Creek/New River (Curry County), Euchre Creek, Hunter Creek	*Areas included:* major tracts of salt marsh, tideflats, and seagrass and algae beds
	Management objectives: to ensure the protection of significant fish and wildlife habitat, continued biological productivity in the estuary, and scientific research and educational needs. These areas are to be managed to preserve the natural resources in recognition of dynamic natural, geological, and evolutionary processes.
	*Permissible uses** • Undeveloped low-intensity, water-dependent recreation • Research and educational observation • Navigational aids, such as beacons and buoys • Protection of habitat, nutrient, fish, wildlife, and aesthetic resources • Passive restoration measures • Dredging necessary for on-site maintenance of existing functional tide gates and associated drainage channels, and bridge-crossing support structures • Riprap for protection of uses existing as of October 1977, unique natural resources, historical and archeological values, and public facilities • Bridge crossings
	*Resource capability uses*** • Aquaculture that does not involve dredge or fill or other estuarine alteration, other than incidental dredging for harvest of benthic species or removable in-water structures, such as stakes or racks • Communication facilities • Active restoration of fish and wildlife habitat or water quality and estuarine enhancement • Boat ramps for public use, where no dredging, fill, or navigational access is needed • Pipelines, cables, and utility crossings, including incidental dredging necessary for their installation • Installation of tide gates in existing functional dikes • Temporary alterations • Bridge-crossing support structures and dredging necessary for their installation
Conservation Necanicum, Ecola Creek, Netarts Bay, Nestucca, Siletz, Beaver Creek, Alsea, Yachats	*Areas included:* tracts of significant habitat smaller or of less biological importance than those included in natural management units, and recreational or commercial oyster and clam beds not included in natural management units. Areas that are partially altered and adjacent to existing development of moderate intensity that do not possess the resource characteristics of natural or development units are included in this classification.
	Management objectives: to provide for long-term uses of renewable resources that do not require major alterations to the estuary, except for the purpose of restoration. These areas are to be managed to conserve natural resources and benefits.

Objectives and Uses for Each Management Unit Designation, cont.

Management Unit	Description
	Permissible uses:* Permitted and "conditional" uses allowed in natural management units (except temporary alterations)
	*Resource capability uses*** • High-intensity, water-dependent recreation, including boat ramps, marinas, and new dredging for boat ramps and marinas • Minor navigational improvements • Mining and mineral extraction, including dredging necessary for mineral extraction • Other water-dependent uses requiring occupation of water surface area by means other than dredge or fill • Aquaculture requiring dredge or fill or other alteration of the estuary • Active restoration for purposes other than protection of habitat, nutrient, fish, wildlife, and aesthetic resources • Temporary alterations
Development *Shallow Draft:* Nehalem Bay, Tillamook Bay, Siuslaw, Umpqua River/Winchester Bay, Coquille, Rogue, Chetco *Deep Draft:* Yaquina Bay, Coos Bay, Lower Columbia	*Areas included:* deepwater areas adjacent to or in proximity to the shoreline, navigation channels, subtidal areas for in-water disposal of dredged materials, and areas of minimal biological significance needed for uses requiring alteration of the estuary
	Management objectives: to provide for navigation and public, commercial, and industrial water-dependent uses consistent with the level of alteration allowed by the overall estuary classification
	*Permissible uses** • Dredge or fill, as allowed elsewhere in the goal • Navigation and water-dependent commercial enterprises and activities • Water transport channels where dredging may be necessary • Flow-lane disposal of dredged material, monitored to assure that estuarine sedimentation is consistent with the resource capabilities and purposes of affected natural and conservation management units • Water storage areas where needed for products used in or resulting from industry, commerce, and recreation • Marinas • Aquaculture • Extraction of aggregate resources • Restoration
	*Resource capability uses*** • Water-related and nondependent, nonrelated uses not requiring dredge or fill • Mining or mineral extraction • Other uses and activities allowed in natural and conservation management units
** Permissible uses* are uses that are considered consistent with achieving the state management objective. Permissible uses are routinely approved, provided they meet other standards in Goal 16 for impact minimization. *** Resource capability* uses may or may not be consistent with the management objective, depending on the size and location of the use and the resource affected.	

Source: Oregon Estuary Plan Book 1987

pollution poses the primary threat to water quality. Point source pollution is also a significant problem.

Further, in its review of the current approach to restoration activities in the bay, the Tillamook County Performance Partnership finds that while many agencies and organizations maintain a common objective to improve watershed and ecosystem health, each maintains separate processes and funding sources. The Tillamook County Performance Partnership also finds that collaborative processes that have developed in Oregon (watershed councils, for example) are forced to spend considerable time and energy seeking a wide variety of funding sources and adhering to all of the independent processes, procedures, and requirements.

Sources: NOAA, Coastal Services Center, Performance Indicators Visualization and outreach Tool Project for Tillamook Bay; Tillamook Bay National Estuary Program; Tillamook County Performance Partnership

South Slough National Estuarine Research Reserve

The South Slough National Estuarine Research Reserve was established in 1974, the founding member of the NOAA-coordinated National Estuarine Research Reserve System. Oregon State law guides administration of the reserve. The programs of the reserve are administered by a management commission, which, under the general operating guidance of the State Land Board, establishes the operating policy of the reserve. The management commission has the authority to appoint reserve staff and to develop administrative rules that may be required to meet the intent of the law. The management commission consists of representatives from the Division of State Lands, Coos County commissioners, the Oregon International Port of Coos Bay, the University of Oregon, Oregon State University, NOAA's Office of Ocean and Coastal Resource Management, schools in the reserve area, and the public at large.

The Friends of the South Slough Reserve, Inc., was formed in 1988 to promote the South Slough National Estuarine Research Reserve and its programs. The group provides educational and interpretive services to the public and operates a gift shop at the Interpretive Center.

Sources: National Estuarine Research Reserve System; South Slough National Estuarine Research Reserve

Northern California

Coastal management in the state of California is delegated jointly to the California Coastal Commission and the Bay Conservation and Development Commission (for activities within San Francisco Bay only). California's enabling legislation is the California Coastal Act (1976), whereby coastal cities and counties are required to develop local coastal programs that incorporate policies outlined in the Coastal Act. Briefly, these policies require protection and expansion of public access to the shoreline; protection, enhancement, and restoration of environmentally sensitive habitats; protection of productive agriculture lands, commercial fisheries, and archeological resources; protection of the scenic beauty of coastal landscapes and seascapes; the establishment of urban-rural boundaries (to address urban sprawl); the expansion of existing industrial ports and electricity-generating power plants as well as for the siting of coastal-development industrial uses; and protection against the loss of life and property from coastal hazards. These programs are reviewed and approved by the California Coastal Commission.

The California Coastal Act of 1976 requires that each coastal jurisdiction prepare a local coastal program, including a coastal land use plan. The local coastal program also includes zoning ordinances and zoning district maps and, where required by the coastal land use plan, other applicable implementation measures. Once the local coastal program is reviewed and certified by the local government and the California Coastal Commission as consistent with the Coastal Act's policies, it becomes the guiding and regulatory document for development and resource conservation in the coastal zone.

Humboldt Bay

In Humboldt County, the coastal zone has been segmented into six distinct planning areas, and a coastal land use plan has been developed for each area:

North Coast Area Plan
Trinidad Area Plan
McKinleyville Area Plan
Humboldt Bay Area Plan
Eel River Area Plan
South Coast Area Plan

Although the coastal land use plan is a requirement of the Coastal Act, lands located within the coastal zone are also subject to the gov-

ernment code that requires a general plan. While these two requirements overlap, they also complement each other.

The coastal land use plans, in response to Coastal Act requirements, tend to be much more detailed than this general plan. The policies of the coastal plans address development and resource protection issues (diking, filling, shoreline structures, and so on) typically not included in a general plan. The coastal land use plans, however, do specify the types, intensities, and densities of land use in the coastal zone.

Humboldt County's current general plan includes a framework plan (originally adopted in 1984 and most recently amended in 1998) and supporting local coastal plans and community plans. These supporting plans were prepared over a 16-year period, with one (Avenue of the Giants) recently completed and one (McKinleyville) nearing completion. As a consequence, the plans do not rely on the same land use, economic, demographic, and environmental data. Although the organizational framework is similar, recommendations are not always well coordinated, nor are they responsive to current economic realities.

Historically, the county's zoning had separate coastal regulations from inland regulations; this facilitates the California Coastal Commission's review and approval of the county's implementation program for the local coastal plan. Recently, the county prepared a draft ordinance that consolidated these regulations into a single document.

District Boundaries and Jurisdiction

The Humboldt Bay Harbor District regulates all pilotage and towage and all waterways and ungranted tidelands and submerged lands within Humboldt Bay, and it acts as local sponsor for federal navigation projects within the district. The district regulates and controls the construction of wharves, docks, and improvements of all types contemplated on the waterways of the district, and the construction, maintenance and operation, and use of all wharves, warehouses, structures, improvements, or appliances, used in connection with, or for the accommodation or promotion of, transportation or navigation on any improvement project of the federal government entering the district. The same is true for other navigable waterways, improved or unimproved, that lie within the district. The district also enforces police and sanitary regulations in connection therewith (Harbors and Navigation Code, State of California).

The Humboldt Bay Harbor, Recreation, and Conservation District is preparing a comprehensive natural resource management plan for Humboldt Bay, with funding primarily from the California Coastal Conservancy.

Source: Humboldt Bay Harbor, Recreation, and Conservation District

Arcata Fish and Wildlife Office

The Arcata Fish and Wildlife Office is in the process of developing a prospectus that outlines an integrated coastal program for Humboldt Bay. The prospectus highlights the potential to integrate existing programs and launch new conservation programs.

Arcata Fish and Wildlife activities have included fisheries assistance to tribes, development of flow recommendations on the Trinity River, initiation of a flow study on the Klamath River, ongoing juvenile salmonid monitoring in the upper watersheds, stranding research, and other fisheries and aquatic habitat-related investigations.

In the draft prospectus, other programs with similar objectives are identified, including California Coastal Conservancy projects in Humboldt Bay; the Humboldt Bay Harbor, Conservation, and Recreation District Management Plan; and conservation projects carried out by the community. Community initiatives highlighted include Humboldt Bay Watershed Council, Fish Action Committee, Redwood Coast Community Action Agency, and Eel and Mattole River Watershed groups.

Source: Arcata Fish and Wildlife Office

Humboldt Bay National Wildlife Refuge

Humboldt Bay National Wildlife Refuge was established to preserve and restore precious bayshore wildlife habitat for the variety of migratory waterfowl, especially black brant, that depend on Humboldt Bay in the fall, winter, and spring. In 1971, the U.S. Fish and Wildlife Service, recognizing the importance of Humboldt Bay for migratory birds, purchased a few acres for a new refuge. The refuge is still in the acquisition and development stage.

Ultimately, the Arcata Fish and Wildlife Service plans to acquire and manage 8,935 acres in and around Humboldt Bay. Currently, the refuge includes 2,200 acres of seasonal wetlands, salt marshes, grasslands, open bay, and mudflats.

Source: Humboldt Bay Wildlife Refuge; U.S. Fish and Wildlife Service

Arcata Marsh and Wildlife Sanctuary

Before the establishment of the Arcata Marsh and Wildlife Sanctuary, the city of Arcata's waterfront consisted of an abandoned county landfill, abandoned and vandalized lumber mill buildings, and the sewage treatment plant. The development of Arcata's integrated wetland wastewater treatment facility and the Arcata Marsh and Wildlife Sanctuary turned the blighted area into a popular addition to the city of Arcata. With an estimated 100,000 visitors each year, the 154-acre area has 4.5 miles of publicly accessible trails.

Source: Arcata Marsh and Wildlife Sanctuary

6 Issues

Coastal resource managers in the Pacific Northwest face a suite of issues. Some are common to managers in Washington, Oregon, and northern California but may not require a uniform solution across state lines. Some issues in common are control of shellfish harvest (both recreational and commercial), public access to estuarine waters and beaches, disposal of dredged materials, control of nonpoint source pollution, and other water quality issues. Other issues, such as control of invasive nonnative species in estuarine waters and marine oil spill response, are not only held in common but shared between or among the states and require joint or coordinated programs or policies.

Seven management topics or issues that are either common or shared among the states and agencies of the Pacific Northwest are discussed in this chapter. The topics were chosen primarily for their timeliness and their relevance to PNCERS research.

Sources: Hildreth et al., 1989; Hildreth, 1991

Recreational Use of Estuarine Resources—Shellfish Harvest and Public Access

Managing the recreational use of estuarine resources is approached slightly differently in each state. For example, recreational harvest of shellfish is closely regulated in Washington and tracked through permits, while in Oregon no permits are required and recreational harvest is not formally reported. Common management issues related to recreational use of estuaries are physical access to recreational resources (that is, boating facilities, shoreline availability), public health concerns (are the resources safe to eat?), and user conflicts. From a technical

perspective, other common concerns are monitoring recreational use and tracking recreational harvest.

Clamming

Washington

Washington's approach to recreational shellfish harvest management has changed significantly over the years. For example, open season for razor clams, once nine months long, with digging permitted every day, currently runs for as few as 15 to 35 days of harvest a year. Each beach is managed as a separate entity with individual open seasons, whereas previously all the major beaches on the coast had the same seasons. Harvest seasons are established by the Washington Department of Fish and Wildlife based on detailed population analyses, tribal allocation (the Quinault Tribe at Grays Harbor, for example), and testing for marine toxins by the Washington Department of Health Recreational Shellfish Program. Additionally, socioeconomic concerns are taken into consideration and public meetings are held to collect input.

Oregon

Before September 1993, the Oregon Health Division was responsible for opening and closing bays to recreational and commercial harvest. That responsibility now rests with the Oregon Department of Agriculture. Oregon's major bays are classified as "conditionally approved" for shellfish harvest, pending monthly monitoring of water quality and shellfish condition under Interstate Shellfish Sanitation Program guidelines. Cooperative monitoring efforts have been coor-

Digging for clams

dinated to ensure that this frequency is met and to conduct intensive and sanitary surveys.

The Oregon Department of Environmental Quality periodically samples water in the three Oregon estuaries where most of the commercial and recreational shellfish harvesting occurs. Tillamook Bay is sampled 10 times a year, Yaquina Bay once a year, and Coos Bay, including South Slough, 5 times a year. The state Department of Agriculture and county health departments monitor these bays in months when the Department of Environmental Quality is not monitoring. The Department of Environmental Quality also monitors water quality in the Umpqua, Nehalem, and Netarts Bays on a monthly basis.

No licenses or permits are required for recreational shellfish harvest in Oregon.

Crabbing

Harvest Regulations—Washington

As with clams, a license is required for recreational harvest of crabs in Washington. Shellfish (and seaweed) may not be taken from private beaches without permission of the owner or lessee. (Most of Puget Sound and Hood Canal beaches are privately owned.) On public beaches, harvest must be within public beach boundaries. Daily limits apply for all public beaches and all shellfish. Private tideland owners and lessees are exempt from personal daily use limits when taking clams, oysters, and shellfish from their own tidelands.

Recreational harvest of Dungeness and red rock crab is open year-round (except Puget Sound) for ring nets, star traps, collection by hand, dip nets, SCUBA, or any hand-held instrument that will not penetrate the shell. Pot seasons vary, depending on location, and daily limits vary, depending on species and area.

Recreational crabbers are required to record their catch of Dungeness crab in much the same way that those who catch salmon or halibut do. The reporting requirement for Dungeness crab is designed to give state fisheries managers a more accurate picture of the recreational harvest and provide for more equitable allocation among sport, commercial, and tribal fishers.

Harvest Regulations—Oregon

No licenses or permits are required to harvest crabs (or other shellfish, except abalone) in the "marine zone," which includes the marine waters of the Pacific Ocean, coastal bays, and beaches. Waters are open all year, 24 hours a day, except in special closed areas (for example, intertidal marine gardens, subtidal research reserves, intertidal research reserves, habitat refuges) and shellfish preserves. Both Yaquina Bay and Netarts Bay have been designated as shellfish preserves. Harvesting or collecting clams is prohibited in posted shellfish preserves, al-

though special collection permits may be issued for scientific and educational purposes.

Crabs may be taken using crab rings, pots, or baited lines (limited to three per person). Dungeness crabs may be taken in bays, estuaries, beaches, tide pools, piers, and jetties all year. Ocean harvest of Dungeness crab is closed August 15 to November 30.

Harvest Regulations—Humboldt Bay, California

Recreational harvest of Dungeness crab *(Cancer magister)* in Humboldt County is open from about the first of December to the end of July. Commercial harvest of Dungeness crab is prohibited in Humboldt Bay.

Public Access and Recreation

Public access to coastal waters, beaches, and shores for recreation is recognized nationally as one of the principal issues for coastal management programs. The National Coastal Zone Management Act, as amended, encourages states to adopt coastal management programs that, among other things, will "provide for . . . public access to the coast for recreation purposes."

California's 1976 Coastal Act protects access rights to coastal beaches and tidal lands, bays, harbors, inlets, and estuaries, and the right to public access is codified in the state constitution. Additionally, at the local level, California's coastal program is structured so that state Coastal Act policies designed to protect and enhance public access are implemented through the local coastal programs.

In Washington, efforts to increase and broaden public access are paid for through the Aquatic Lands Enhancement Account, a special fund derived from income produced on state-owned aquatic lands. The Washington Department of Natural Resources uses this income to help local governments purchase beach access points, build boat ramps, and create shoreline walks, boardwalks, and other facilities on the beach. Washington's Seashore Conservation Act of 1967 (amended in 1988) explicitly dedicates Washington State ocean beaches to public recreation.

With 2,200 miles of inland marine shoreline, Puget Sound has public access sites occupying some 425 miles of shoreline, or about 19 percent. However, since only half of that public shore has access from the uplands, the public has real access to about 10 percent of the inland marine waters of Puget Sound.

In Oregon, the public's right to beach access for recreational purposes is established in state law (the Beach Bill). This law specifies that along the ocean shore, the "wet sand beach" up to the ordinary high tide line belongs to the public and that, in addition, the public has a perpetual recreational easement to use the "dry sand beach" landward

of ordinary high tide to a "line of vegetation" specified in law or the 16-foot elevation line. The recreational easement applies even where the dry sand area is privately owned by upland property owners. This right is managed and protected by the Oregon Parks and Recreation Department. The Division of State Lands shares management jurisdiction over beaches, including estuaries.

Public access to beaches and waters of Oregon estuaries is less clear-cut and is provided for primarily through the statewide planning program goals and guidelines and through local comprehensive plans and implementing ordinances that are required to ensure public access.

Commercial Use of Estuarine Resources: Oyster Culture

Commercial oyster culture is a significant source of income for estuaries in each of the three states. Willapa Bay in Washington is one of the leading oyster producers in the nation. Tillamook Bay, Coos Bay, Winchester Bay, Yaquina Bay, and Netarts Bay are significant producers for Oregon. Humboldt Bay produces 95 percent of the oysters sold in California.

Commercial growers and resource managers in Washington, Oregon, and California have similar concerns: water quality, threatened habitat, and conflicts over cultivation practices and their environmental effects, such as the introduction of nonnative species and the use of pesticides to control ghost shrimp. Each state has developed its own approach to dealing with these problems.

Washington

Washington State is the leading producer of farmed shellfish in the United States. The annual wholesale value of commercial clam, oyster, and mussel production in Puget Sound alone is between $30 and $50 million. In 1995, oysters contributed approximately $3.3 million in Grays Harbor County (Grays Harbor) and $12 million in Pacific County (Willapa Bay). Nearly 10,000 acres of privately owned or leased tidelands in Willapa Bay produce about 3 to 4 million pounds a year—about 15 percent of the national oyster crop, most of which is shipped as freshly opened (shucked) oysters.

Oregon

Commercial aquaculture along coastal Oregon is devoted solely to the cultivation of mollusks, chiefly oysters and mussels, the latter of which are grown only in Winchester Bay on the Umpqua River. Currently, oysters are under cultivation on Coos Bay, Winchester Bay, Yaquina Bay, Tillamook Bay, and Netarts Bay on privately held lands and state-leased lands.

Pacific Oyster Production in Grays Harbor, Willapa Bay, and Washington State

Year	*Grays Harbor*		*Willapa Bay*		*Washington State total (includes Puget Sound)*	
	Gallons	**Pounds**	**Gallons**	**Pounds**	**Gallons**	**Pounds**
1987	-	-	-	-	1,071,543	9,376,000
1988	122,743	1,074,000	556,914	4,873,000	1,032,800	9,037,000
1989	151,543	1,326,000	516,457	4,519,000	1,020229	8,927,000
1990	110,971	971,000	467,543	4,091,000	924,343	8,088,000
1991	88,343	773,000	395,200	3,458,000	794,057	6,948,000
1992	112,289	982,000	373,143	3,265,000	779,085	6,817,000
1993	128,457	1,124,000	316,914	2,773,000	836,800	7,322,000
1994	153,143	1,340,000	343,886	3,009,000	1,705,486	14,923,000
1995	98,514	862,000	381,829	3,341,000	902,857	7,900,000
1996	96,379	843,312	444,639	3,890,594	838,001	7,332,515
1997	82,079	718,187	276,451	2,418,950	667,958	5,932,135
1998	88,024	770,213	317,947	2,782,039	741,714	6,489,998
1999	127,089	1,112,030	378,132	3,308,657	771,048	6,746,672

Acreage of state-leased lands in Oregon is reported as follows:

Tillamook	4,461 acres
Netarts	213
Yaquina	519
Coos	240
Total	5,433 acres

Until the early 1990s, oysters were produced primarily on state-leased lands. Acreage of port- and county-leased lands was not available for all estuaries. One report estimates there are 1,585 acres of port and county oyster-growing land in Coos Bay that produced 38,086 gallons/333,253 pounds of oysters in 1995.

California

Oyster growing is California's oldest aquaculture industry. What began in the early 1850s as a transplant seed industry is today a valuable asset to the state's economy. Current production is primarily in Humboldt Bay (Humboldt County), Drakes Estero (Marin County), Tomales Bay (Marin County), and Morrow Bay (San Luis Obispo County). The industry grows a variety of species, including Pacific, Kumamoto, European, and eastern oysters. The California Department of Fish and Game reports that 95 percent of the oysters sold in California are grown by two or three growers in Humboldt Bay.

Almost all of the oysters grown in California (98 percent) are Pacific oysters produced from hatcheries in Washington and Oregon and several small specialty hatcheries in California. Other varieties produced in California include the Miyagi variety of the Pacific oyster

Freshly harvested oysters at the Silver Point Oyster Company on Haines Inlet, Coos Bay, Oregon.

(*Crassostrea gigas*), the Pacific Kumamoto oyster (*Crassostrea sikamea*), the European oyster (*Ostrea edulis*), and the eastern oyster (*Crassostrea virginica*).

Oyster-growing areas are leased from the state through the Fish and Game Commission or from local jurisdictions that have been granted authority over state water bottoms.

Oil Spill Prevention and Response

Oil spills can have dramatic and significant adverse effects within estuaries because of the high natural resource values, the broad areas of potential exposure across mudflats and marshes, the low-energy water environment, and the complex shoreline. Over time, a wide range of technical measures to combat spills has become available, including a variety of booms to prevent spread of surface oils into sensitive areas and to concentrate and collect oil from the water's surface for treatment by relatively nontoxic chemical dispersants. However, estuary managers have also learned that anticipation, contingency planning, and preparedness are essential to prevent and reduce the damage.

Federal

The primary federal laws that address oil spills are the Clean Water Act; the Comprehensive Environmental Response, Compensation, and Liability Act; and the Oil Spill Prevention and Response Act of 1990.

Under the National Contingency Plan, the EPA is the lead federal agency for oil spills occurring in inland waters, and the United States Coast Guard is the lead federal agency for spills in coastal waters and deepwater ports. The EPA requires owners and operators of certain oil spill facilities to prepare and implement spill, prevention, control, and counter-measures plans. The EPA conducts facility inspections and enforces the oil spill liability and penalty provisions of the Oil Spill Prevention Act. Under the federal Clean Water Act, the party causing a petroleum spill is responsible for cleanup costs.

Washington

The Department of Ecology is the lead agency for the state program managing spills. Its responsibilities include spill prevention, preparedness, response, and restoration.

Oregon

The Department of Environmental Quality (DEQ) is the lead agency for oil spills. Oregon's prevention and preparedness program includes the following elements.

Vessel plans: Vessels traveling the Columbia and Willamette Rivers are required to carry spill response plans that provide clear instructions for dealing with a spill. DEQ reviews and approves the plans.

Oil spill on a Pacific Northwest beach

Facility plans: Certain facilities are also required to have spill response plans that are reviewed and approved by DEQ. There are 22 covered facilities in Oregon, mostly in the Portland area.

Geographic response plans: Geographic response plans detail geographic information, equipment requirements, location of resources, and the equipment and preferred response activities needed for particular sections of the Willamette and Columbia Rivers and the coast. Each plan is for a specific river segment and includes identification of aquatic and wildlife habitats and water withdrawal points and uses, resource protection and spill containment strategies, maps, location of necessary materials, and other information. Geographic response plans are developed cooperatively by government agencies, river users, and response providers. Some sections of the rivers do not yet have geographic response plans.

Drills: DEQ attends scheduled response and cleanup exercises as an observer or active participant.

California

The Office of Spill Prevention and Response, which is housed within the Department Fish and Game, is the lead state agency charged with oil spill prevention and response within California's marine environment. The Lempert-Keene-Seastrand Oil Spill Prevention and Response Act of 1990 established the Office of Spill Prevention and Response and provides the agency administrator with substantial authority to direct spill response, cleanup, and activities for assessing damage to natural resources.

The Lempert-Keene-Seastrand Oil Spill Prevention and Response Act also created the Marine Facilities Division in the California State Lands Commission. The goals of the Marine Facilities Division are to ensure the safe and pollution-free transfer of crude oil and product between tank vessels and land-based facilities; to adopt marine terminal regulations that ensure the best achievable protection of public health and safety and the environment; and to coordinate with federal, state, and local agencies having similar goals, to maximize the use of limited agency resources while preventing overlap.

Dredging (Removal/Fill)

Estuaries are important ports for ships that transport a variety of goods into and out of the region. The relatively shallow channels in Pacific Northwest estuaries require ongoing dredging to maintain adequate channel depth, which can lead to issues of placement or disposal of the

dredged material. The following federal laws and agencies pertain to dredged material:

- The Clean Water Act governs discharges of dredged material into "waters of the United States," defined as all waters landward of the baseline of the territorial sea. Section 404 of the act requires a permit for the discharge of dredged or fill material into U.S. waters. Section 401 requires state certification that any federally permitted project discharging into U.S. waters will not violate state water quality standards, which are based on federal water quality criteria.
- The National Environmental Policy Act usually functions as an umbrella authority assuring that all applicable environmental requirements are complied with for federal dredging projects.
- A Rivers and Harbors Act Section 10 permit is required for any dredging activity in navigable waters, regardless of the location of the disposal site.
- On the federal level, the Army Corps of Engineers and the EPA share the responsibility for regulating the discharge of dredged material. The EPA retains oversight authority regarding the Corps' decision to issue a permit and may veto permit approval if it concludes that the discharge of dredged or fill materials would have an "unacceptable adverse effect" on municipal water supplies, shellfish beds and fisheries, wildlife, or recreational areas.

U.S. Army Corps of Engineers dredgers

Washington

Review and approval of dredging activities in Washington State is managed under policies and guidelines established by a coordinated state and federal consortium designated as the Dredged Material Management Program. This program consists of representatives from two state agencies (the Department of Ecology and the Department of Natural Resources) and two federal agencies (the U.S. Army Corps of Engineers and the EPA). The policies and guidelines under which the Dredged Material Management Program manages dredging activities are contained in guidance manuals specific to discrete water bodies—for example, Puget Sound, Grays Harbor, Willapa Bay, and the lower Columbia River.

In Washington State, the Departments of Ecology, Natural Resources, and Fish and Wildlife share the regulation of dredged material. The Department of Ecology is authorized to certify under the Clean Water Act Section 401 that a proposed discharge will comply with state water quality standards. The Department of Ecology may apply any requirement or policy of state law that protects aquatic habitat. Where the state has no jurisdiction—for example, tribal lands and military installations—the EPA provides Section 401 certification.

Columbia River

Dredging projects in the Columbia River estuary are particularly challenging because of the large size and complex jurisdictional relationships between two states, federal agencies, and local governments. The U.S. Army Corps of Engineers maintains the federal navigational channel in the Columbia River from the mouth of the Columbia (river mile -3) upriver to McNary Dam (river mile 292). Disposal of dredged materials is carried out within the estuary by placement in designated sites (for example, Rice Island) and in the "flow lane," as well as in the ocean.

Oregon

As in Washington, the EPA regulates ocean disposal of dredged material. The Oregon Division of State Lands administers the state's Removal-Fill Law that regulates dredging and dredged material disposal in state waters and sets strict standards for resource protection. The Division of State Lands also administers the requirement for mitigation of dredge or fill in intertidal areas as called for in each coastal comprehensive plan.

Local government shoreland zoning ordinances, provided for in the comprehensive plans, dictate that when dredging or filling is permitted in tidal marshes or flats, its "effects must be offset by creating or improving another part of the estuary. Mitigation and restoration

sites are lands that have potential, if modified, to create, restore or enhance biological or habitat values. Breaching of dikes to restore tidal action is a typical mitigation technique."

The Department of Environmental Quality is the agency for certifying under the Clean Water Act's Section 401 that a proposed discharge will comply with state water quality standards. The department certifies and may use any requirement or policy of state law that protects aquatic habitat to condition the Section 401 certification.

California

Port development in California (including dredging to maintain ship channels or filling water areas to increase land for port terminals) is subject to the regulatory, planning, or technical consultation authorities of the following agencies:

- California Coastal Commission (California Coastal Act; Coastal Zone Management Act)
- California Department of Fish and Game (California Fish and Game Code)
- State Coastal Conservancy (Public Resources Code, Division 21; Coastal Zone Management Act)
- State Water Resources Control Board and regional water quality control boards (Clean Water Act; Porter-Cologne Water Quality Control Act)
- State Lands Commission (Public Resources Code)

The Coastal Conservancy is designated as the state's coordinator for urban waterfront development. In this role, and through its resource enhancement and public access programs, the Coastal Conservancy has been involved in port affairs, including mitigating the impacts of dredging on fish and wildlife, developing facilities for commercial fishing, and working to obtain public access to coastal waters through port properties. The Coastal Conservancy has developed a regional mitigation bank along Humboldt Bay to offset the impacts from an industrial area.

Water Quality

Federal

The Clean Water Act of 1972 and the Safe Drinking Water Act of 1974 are the main statutes regulating water quality in the United States. Both are administered by the EPA. Recent amendments to both acts, including the creation of the National Estuary Program as part of the 1987 Clean Water Act amendments, further direct the EPA and state agencies to manage watersheds in a more comprehensive manner and im-

EPA water quality system

prove interagency coordination. This includes working with other state agencies to identify and assess nonpoint sources of pollution.

Around some estuaries of the Pacific Northwest, activities that significantly affect water quality, such as livestock grazing, forest practices, and agriculture, are regulated by other agencies, such as the Bureau of Land Management, the U.S. Forest Service, and the U.S. Department of Agriculture.

Washington

In Washington State, the Washington Department of Ecology is the lead agency responsible for programs delegated under the federal Clean Water Act. The Department of Ecology establishes state water quality standards apart from federal EPA standards, issues permits for point-source discharge activities, certifies federally licensed and permitted activities to ensure compliance with state standards, identifies water quality limited water bodies (303[d] list), and establishes total maximum daily loads for pollutants violating state standards on the 303(d) list.

The Washington Department of Health has assumed primary enforcement and monitoring responsibility under the federal Safe Drinking Water Act. In implementing this program, the department depends on regulations established by the EPA.

Water quality in Washington State is regulated and managed primarily through the Water Pollution Control Act, the Dairy Nutrient Management Act, the Puget Sound Water Quality Protection Act, and the Shellfish Protection Districts Act. Water quality is also addressed in the Shoreline Management Act.

Oregon

The Department of Environmental Quality is the lead agency responsible for programs delegated under the federal Clean Water Act. DEQ certifies that federally licensed and permitted activities comply with state water quality criteria under Section 401 of the Clean Water Act and administers the National Pollutant Discharge Elimination System's (Sections 301 and 402) discharge permit program. Under this program, the Department of Environmental Quality develops water quality standards that protect specified beneficial uses for water bodies and identifies waters that do not meet state water quality standards (303[d] list).

The Department of Environmental Quality also works with the Oregon Department of Forestry to minimize adverse impacts from forestry practices on water quality and with the Oregon Department of Agriculture to address impacts to water quality from agricultural practices. This cooperative effort is particularly important in an area such as Tillamook Bay, where approximately 40 square miles (104 square kilometers) of agricultural lowland supports about 28,600 dairy cattle.

Runoff from animal waste can affect the water quality in estuarine systems.

California

The State Water Resources Control Board and the nine regional water quality control boards have primary responsibility in California for the protection of water quality.

The Porter-Cologne Water Quality Control Act, which established

nine regional boards and the state board, is the principal law governing water quality regulation in California. The act applies to surface waters, wetlands, and groundwater and to both point and nonpoint sources of pollution. The following are its main provisions:

- The quality of all the waters of California shall be protected.
- All activities and factors affecting the quality of water shall be regulated to attain the highest water quality within reason.
- California must be prepared to exercise its full power and jurisdiction to protect the quality of water in the state from degradation.

An implementation plan is required under California's Porter-Cologne Water Quality Control Act and 40 CFR §130.6 for inclusion in the Basin Plan. The first sediment total maximum daily load and implementation plan adopted by the North Coast Regional Water Board was for the 73,223-acre Garcia River watershed in Mendocino. With the exception of the sediment-reduction effectiveness monitoring, as described in the Garcia Implementation Plan (Garcia Monitoring Plan), monitoring by landowners is on a voluntary basis.

The Clean Water Act of 1972 gave the State Water Resources Control Board and the EPA the authority to establish total maximum daily load under Section 303(d).

Nonpoint Source Pollution

Estuaries are especially vulnerable to nonpoint source pollution that can result from water-based or land use activities, including atmospheric deposition; surface water runoff from agricultural lands, urban areas, and forest lands; subsurface or underground sources; and discharges from boats or other marine vessels. Nonpoint source pollution may include sediment, chemicals, toxics, nutrients, debris, and pathogens that rainwater and snowmelt pick up and carry into the nearest body of water. Although degradation from any single activity or site usually will not violate water quality standards, the cumulative effects of all the activities in a basin can be significant and result in water quality violations.

Federal

Congress amended the Clean Water Act in 1987 to establish the section 319 Nonpoint Source Management Program to help focus state and local nonpoint source efforts. Under Section 319, state, territories, and Indian tribes receive grant money that support a wide variety of

activities, including technical and financial assistance, education, training, technology transfer, demonstration projects, and monitoring to assess the success of specific nonpoint source implementation projects.

Also added to the 1987 Clean Water Act reauthorization was Section 518. This section authorized the EPA to treat federally recognized Indian tribes in the same manner as states and to grant up to one-third of 1 percent of national 319 grant funds to tribes.

The Coastal Nonpoint Pollution Control Program was adopted as part of the 1990 amendments to the Coastal Zone Management Act (Coastal Zone Act Reauthorization Amendments, Section 6217). Jointly administered by the EPA and NOAA, the program is intended to protect coastal waters from nonpoint source pollution. With the program, Congress directed states with approved coastal programs to implement nonpoint source pollution control measures to protect coastal waters.

A central purpose of the Reauthorization Amendments Section 6217 is (1) to prompt coastal states to evaluate how their nonpoint source water pollution control programs are protecting coastal waters, (2) to enhance cooperation between land and water use management agencies, and (3) to ensure that enforceable mechanisms exist where voluntary efforts are not sufficient to restore and protect coastal waters.

The Coastal Nonpoint Pollution Control Program requires that states implement an extensive set of nonpoint source control management measures addressing such activities as forestry and agricultural practices, marinas, urban activities, hydromodification, and wetland protection. States must implement measures where necessary to meet water quality standards.

Washington

Washington's Department of Ecology is the lead agency for nonpoint water pollution prevention. WDOE has enforcement capability under the state Water Pollution Control Act when needed for correcting particularly difficult nonpoint water pollution problems. Rules to protect water quality from forest practices are jointly adopted by the Department of Ecology and the Forest Practices Board.

Using Section 319 funds, Washington has organized a cooperative watershed-based forest management program. To reduce stream sediment, the program has modified some areas of timber harvest to leave a wider stream buffer, take a smaller percentage of trees, provide sediment traps, and implement erosion control measures.

Oregon

The Department of Environmental Quality is responsible for maintaining water quality in state waters. The department regulates most activities that would affect water quality, including construction of new

sewage treatment plants. It is also responsible for regulating nonpoint source pollution (such as agricultural runoff) and hazardous waste disposal.

The Coastal Nonpoint Pollution Control Program is a comprehensive control program for nonpoint sources of pollution that encompasses the entire range of coastal salmonid species in Oregon. Implementation involves a host of state agencies, including the Department of Land Conservation and Development, the Department of Environmental Quality, the Oregon Department of Agriculture, the Oregon Department of Forestry, the Division of State Lands, the Oregon Department of Fish and Wildlife, the Water Resources Department, the Oregon Department of Transportation, and the State Marine Board. Management measures included in the Coastal Nonpoint Pollution Control Program are comprehensive in scope, covering agriculture, forestry, urban areas, marinas and recreational boating, channel modification, dams, stream bank and shoreline erosion, wetlands and riparian zones, and identification and protection of critical coastal areas.

Oregon has identified 10 program elements that categorize the efforts and capabilities necessary for an effective program of watershed management and control of nonpoint pollution: standards, assessment, coordinated watershed planning, education, demonstration projects, technical assistance, cost-share assistance, stewardship, watershed enhancement projects, and enforcement. The state's nonpoint pollution projects are targeted to address needs related to these 10 major program elements.

California

California's Coastal Nonpoint Pollution Control Program was developed by the California Coastal Commission and the State Water Resources Control Board pursuant to Section 6217 of the Coastal Zone Act Reauthorization Amendments. The reauthorization amendments expanded the partnership between the State Water Resources Control Board and the regional water quality control boards for reducing polluted runoff to include the California Coastal Commission.

The state and regional boards have numerous nonpoint source pollution-related activities, including problem monitoring and assessment, planning, financial assistance, and regulatory and nonregulatory management. Regional water boards regulate any discharge of materials that could affect water quality under the authority of the Porter-Cologne Water Quality Act.

Invasive Species Management

Aquatic nuisance species (that is, nonindigenous species, nonnative species, invasive species) pose a significant threat to the ecosystem health and economic wealth of Pacific Northwest estuaries. Invasive species management has evolved into a truly shared issue among the three states and with British Columbia because how this problem is managed in each estuary will have a significant impact on all the others.

Nonnative species can be introduced to coastal estuaries a number of ways. Organisms can "hitchhike" on boats, cars, trucks, and ships from one water body to another. Planktonic larvae can travel on ocean currents. Some species now considered invasive are thought to have arrived on the wooden hulls of ships. Other nonnative species were likely introduced in the early twentieth century as a result of the growth of the oyster industry, transported to the region in oyster seeds.

Today, the most significant pathway is through ballast water from large ships plying the ocean trade. An estimated 50,000 commercial vessels enter U.S. waters from foreign ports each year. The largest of these vessels are capable of holding between 20 and 50 million gallons of ballast water. In U.S. ports alone, ships discharge ballast water at a rate of 2.4 million gallons an hour. In a UC Davis study, ballast water sampled from 160 ships in Coos Bay, Oregon, held more than 400 species.

While invasive species number in the hundreds on the West Coast, prevention, control, and eradication efforts are directed primarily at zebra mussels, European green crab, Chinese mitten crab, and nonnative cordgrass *(Spartina)*. These are priority species on many lists because of the potential economic and ecological impact that their establishment poses.

Three invasive species that are in various stages of becoming established in Pacific Northwest estuaries are *Spartina*, European green crab, and Chinese mitten crab.

Spartina

Spartina is a smooth cordgrass species that aggressively colonizes mudflats and salt marshes, displacing native plant and animal species and altering the ecological landscape by transforming mudflats into salt marshes. At least four *Spartina* species are present on the West Coast—*Spartina densiflora* (Chilean native), *Spartina alterniflora* (East Coast native), *Spartina anglica* (a hybrid English-East Coast U.S. species), and *Spartina patens* (East Coast native). *Spartina alterniflora* is present in the estuaries in Washington, Oregon, and California and is the main focus of control eradication efforts on the West Coast.

European Green Crab *(Carcinus maenas)*

Carcinus maenas was discovered relatively recently in Pacific Northwest coastal estuaries. Its present range on the West Coast is thought to be from Monterey Bay, California, to British Columbia, Canada. Green crabs were first found in Washington and Oregon estuaries (in Tillamook Bay, Winchester Bay [Umpqua River], Coos Bay, and Yaquina Bay) in 1998 and in British Columbia in 1999. Research data strongly suggest that the introductions to Oregon, Washington, and British Columbia occurred through larval transport via strong ocean currents associated with the unusually large El Niño events of 1997 and 1998.

Chinese Mitten Crab (*Eriocheir* spp.)

Chinese mitten crabs are burrowing crabs native to the Yellow Sea estuaries and coastal rivers of China and Japan. They live in freshwater but spawn in the sea. They were first collected by commercial shrimp trawlers in southern San Francisco Bay in 1993. Since then, mitten crabs have spread rapidly in California. In the summer of 1998, as many as 30,000 adult mitten crabs a day migrated downstream and clogged the fish filtering and trash screens at the U.S. Bureau of Reclamation pump stations in Tracy, California, which provide water for southern California. If the crabs were to become established in the Columbia River system, managers expect a similar situation.

Federal

At present, no single federal agency has clear authority over all aspects of invasive species management. Under a 1999 executive order, however, federal agencies were required to collaborate in developing a National Invasive Species Management Plan (January 2001) that is to be biennially updated. These efforts were coordinated by the interagency Invasive Species Management Council and the council's advisory committee. Council members include the Secretaries of State, Treasury, Defense, Interior, Agriculture, Commerce, and Transportation and the administrator of the EPA.

Regional efforts

Aquatic Nuisance Species Prevention Program

In 1999, the Bonneville Power Administration, recognizing the potential impact to its operations on the Columbia River, funded the Aquatic Nuisance Species Prevention Program with the goal of developing a coordinated plan for the Columbia River basin. The program, carried out by the Pacific States Marine Fisheries Commission, focuses on zebra mussels and Chinese mitten crab.

Columbia River Aquatic Species Nuisance Initiative

Created to address the issue of invasive species in the Columbia River, the Columbia River Aquatic Species Nuisance Initiative is a joint effort of the Ports of Portland and Astoria and Oregon Senator Ron Wyden.

Marine Invasive Species Team

The Marine Invasive Species Team, a collaboration of the Oregon and Washington Sea Grant offices, is a regionwide effort to provide managers, industry, local government, and the public access to research and expertise.

Pacific Ballast Water Group

Pacific Ballast Water Group members represent industry, state and federal government agencies, environmental groups, and others. The group, recognizing the need for cooperative efforts and a coordinated approach to ballast water management and the prevention of invasive species introduction, meets regularly to address discharge standards and specific issues that transcend traditional jurisdictional boundaries.

Western Regional Panel on Aquatic Nuisance Species

Formed under a provision of the National Invasive Species Act, the Western Regional Panel on Aquatic Nuisance species coordinates aquatic nuisance species programs and activities in the West.

Washington

Washington State's Aquatic Nuisance Species Management Plan focuses on prevention of accidental introductions and also addresses intentional introduction for aquacultural, commercial, or recreational purposes. Aimed at implementing proven, feasible, cost-effective management practices, the plan depends on private, public, tribal government, and local government cooperation and federal funding through cost-sharing provisions of the 1996 National Invasive Species Act. In the plan, the Washington Department of Fish and Wildlife is named as the lead agency. Priority species include the European green crab, zebra mussel, Chinese mitten crab, *Spartina alterniflora,* and *Spartina anglica.*

Until recently, ballast water discharge was regarded as a federal matter in Washington State and was regulated under the Lacey Act. In the 2000 regular session the state legislature passed Substitute House Bill 2466, which requires ships to comply with the U.S. Coast Guard ballast water management program by July 2002 to control the introduction and spread of invasive species in Washington waters.

Oregon

The *Oregon Aquatic Nuisance Species Management Plan,* prepared in June 2001 by the Center for Lakes and Reservoirs at Portland State University with input from a variety of agencies and interest groups, establishes a system for ranking invasive species and lists a broad array of prevention, monitoring, control, educational, and research strategies. This comprehensive program envisions an annual implementation cost of $3 million.

The plan is based on a species classification system:

Class 1: Species not present in Oregon, species reported in limited populations, or species with high potential to invade or report. Includes *Spartina alterniflora* and Chinese mitten crab (*Eriocherio* spp.), which have been reported in limited populations.

Class 2: Species whose impact may be mitigated or controlled with appropriate management; species managed through actions that involve mitigation of impact, control of population size, and prevention of dispersal to other water bodies.

Class 3: Species that are established throughout Oregon with impacts but with no available or appropriate management techniques; species with low potential to invade or establish in Oregon. These species warrant future evaluation and research to ascertain the potential impacts, possible control, and dispersal prevention. Includes European green crab.

The Oregon plan is organized around five objectives:

Objective 1: Coordinate and implement a comprehensive management plan through the establishment of an Invasive Species Council

Objective 2: Prevent the introduction of aquatic nuisance species into Oregon by conducting risk assessment, identifying pathways, monitoring, and implementing a ballast water management program

Objective 3: Detect, monitor, and eradicate pioneering aquatic species

Objective 4: Where feasible, control established nonindigenous species that have significant impacts

Objective 5: Increase awareness about aquatic nuisance species risks and impacts

California

San Francisco Bay, a major national and international shipping port, is possibly the most invaded estuary in the world. It is the focus of control and management efforts in California and a living laboratory for invasive species scientists worldwide. A recent study on shipping patterns reported that nearly 4.6 million metric tons of ballast water were discharged into California ports between January 1 and August 31, 2000. Almost half of the ships discharging in California waters during that same period originated in Far Eastern ports (Japan, China, North and South Korea); 30 percent came from Mexican ports.

Invasive species research responsibilities beyond the ballast water program are shared by the California State Lands Commission, the California Department of Fish and Game, the State Water Resources Control Board, and the Board of Equalization. Among these responsibilities is research on the extent of current invasions and potential long-term management and control solutions.

The California Department of Fish and Game, Office of Spill Prevention and Response is responsible for conducting research to determine the location and extent of nuisance aquatic species populations in coastal and estuarine waters of the state.

The California State Lands Commission is responsible for developing and implementing the state's Ballast Water Inspection and Monitoring Program and evaluating the effectiveness of the ballast water program.

The State Water Resources Control Board is responsible for conducting studies to evaluate alternatives for treating and otherwise managing ballast water to prevent the introduction and spread of nuisance aquatic species

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