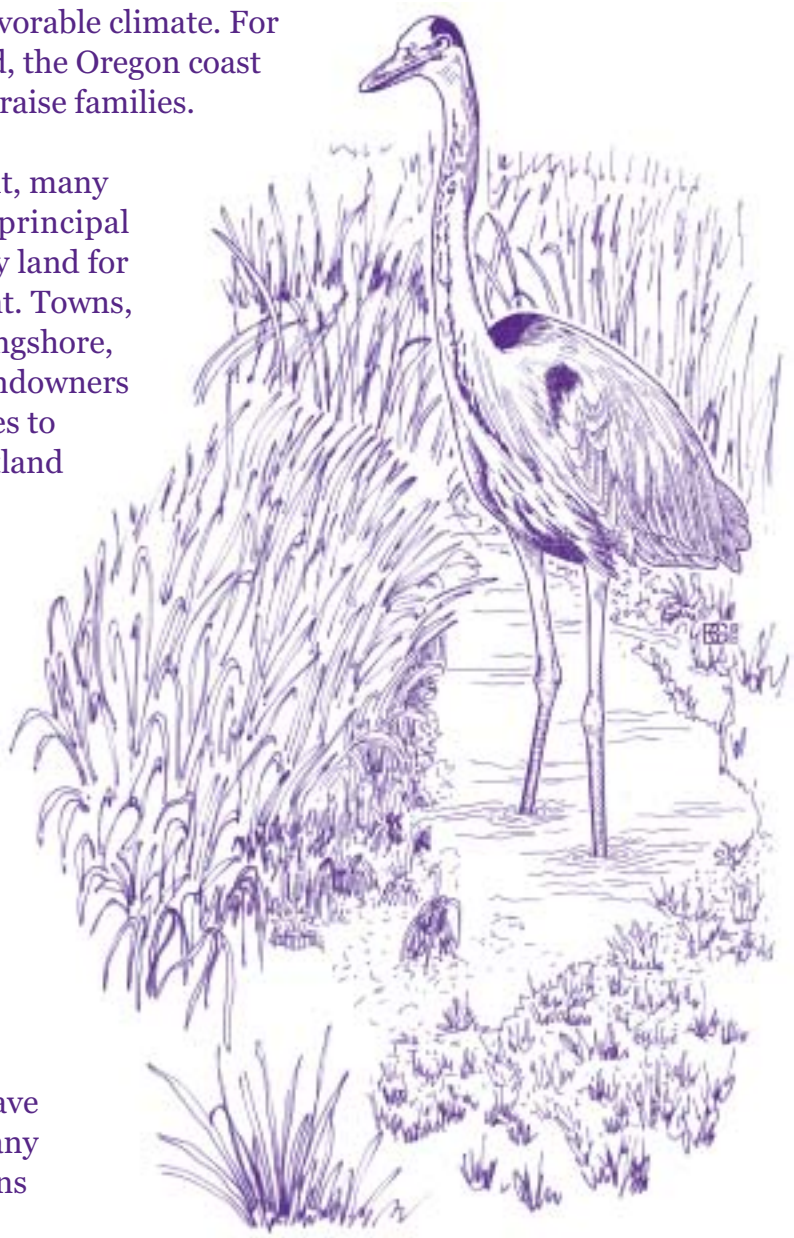
Returning the Tides to Pacific Northwest Estuaries

"Sustaining healthy estuaries over the long term requires an understanding of existing problems and challenges, clear goals and the means to achieve them, the ability to learn from the past and look to the future, and the will to make decisions."

—Jim Good, "Estuarine Science, Management, and Restoration," in *Watershed Stewardship: A Learning Guide*, 2002

Like prehistoric peoples and coastal tribes, settlers were drawn to the shores of Oregon's estuaries by abundant natural resources, navigable waters, and favorable climate. For them, as well as those who followed, the Oregon coast was a good place to live, work, and raise families.



During and after pioneer settlement, many of the wetlands skirting Oregon's principal estuaries were transformed into dry land for urban and agricultural development. Towns, mills, and port facilities spread alongshore, often on former wetlands. Rural landowners diked, ditched, and drained marshes to create croplands and pastures. Wetland losses continued through most of the 20th century, diminishing the combined acreage of Oregon's estuaries by 25 percent.

For a century, important environmental, economic, and other values of these ecosystems were narrowly understood or widely ignored. Since the 1970s, however, scientists, recognizing the crucial ecological functions wetlands perform and the societal benefits they provide, have worked to preserve and protect remaining estuarine wetland habitats. They have also designed and implemented many projects to restore valuable functions to altered habitats.

WETLANDS HAVE ECOLOGICAL, ECONOMIC, AND CULTURAL VALUE

Estuarine wetlands maintain or improve water quality and prevent shoreline erosion. They store flood waters and help to maintain stream levels during droughts. They are home to resident plants and animals and stopover areas for transient wildlife. Migrating waterfowl and shorebirds find food and refuge in their sheltered waters, as do many species of commercially and recreationally important fish and shellfish. Mammals, from voles to elk, forage in the fringing marshes of estuaries.

These goods and services are not only beneficial to many plants and animals, but are also valuable to people. What's more, coastal wetlands have aesthetic and cultural values that enhance our quality of life. They serve as outdoor classrooms and laboratories for scientific research and experimentation. They also support popular outdoor activities ranging from hunting and fishing to boating, wildlife observation, and photography.

Coastal marshes support multitudes of migrating waterfowl, including Canada geese.

Although it is impossible to put a simple dollars-per-acre price on wetlands, we know that they are essential to a healthy and productive environment, contribute billions of dollars to the nation's economy, and save taxpayers millions more in the protective services they provide. In other words, wetlands are priceless.

OREGON'S REMAINING WETLANDS ARE PROTECTED

While many of Oregon's coastal wetlands have been irretrievably lost to permanent development, most remaining wetlands are protected by law. Land-use plans and zoning regulations now protect 94 percent of Oregon's existing wetlands. Moreover, government agencies, corporations, and nonprofit organizations, as well as various interest groups and citizen volunteers are working to prevent further losses and to restore the ecological functions of degraded wetlands.

Various government agencies and laws encourage landowners to protect and restore wetlands on their property by offering technical and financial assistance. According to the National Oceanic and Atmospheric Administration (NOAA), 14 federal programs within five cabinet-level departments are devoted to restoring coastal habitats, and at least 11 federal laws authorize and fund restoration projects.

The federal Clean Water Act regulates dredging and filling in U.S. waters, and Oregon's Removal/Fill Law regulates removal of material and filling in state waters, including wetlands. The U.S. Army Corps of Engineers and Oregon Division of State Lands oversee the mitigation process and permit system required for any development project that will have impacts on Oregon's aquatic environment.

The U.S. Environmental Protection Agency (EPA) established the National Estuary Program in 1987 to identify nationally significant estuaries and encourage their local management, protection, and restoration. Of 28 estuaries enrolled, two are in Oregon: Tillamook Bay and Lower Columbia River Estuary.

The U.S. Fish and Wildlife Service protects and restores wetlands through its system of national wildlife refuges. Thousands of acres of Oregon tidal wetlands are being protected and restored at refuges in the Columbia River estuary, Nestucca Bay, Siletz Bay, and the Coquille River estuary.

NOAA administers a system of 25 national estuarine research reserves (NERRs), ranging in size from 1,000 to 20,000 acres. The mission of these reserves is to improve the understanding and management of estuarine wetlands. Five reserves are on the West Coast, including the South Slough NERR, near the mouth of Coos Bay.

Several nonprofit organizations, such as The Nature Conservancy and Ducks Unlimited, acquire lands that are then protected and managed by state agencies and volunteers. One such parcel is the 187-acre Cox Island Nature Conservancy Preserve, near Florence in the Siuslaw River estuary. This salt-marsh ecosystem supports nearby eelgrass beds and provides habitat for numerous species of waterfowl, birds, mammals, and aquatic organisms. Volunteers

work as caretakers, monitor preserve activities, and help control the spread of invasive plants.

RESTORATION IS UNDERWAY ON THE OREGON COAST

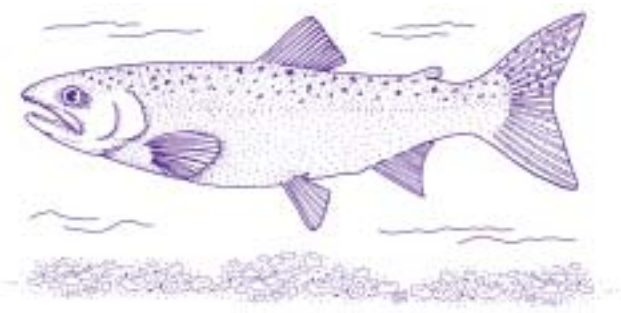
From the Columbia River to Oregon's south coast, agencies, organizations, and others are acquiring land, securing conservation easements, and designing, implementing, and monitoring restoration projects. Habitat restoration is underway at virtually every principal Oregon estuary and a number of smaller waterways. Several notable examples follow.

Neawanna Creek

The North Coast Land Conservancy, City of Seaside, and several state and federal agencies have purchased land and acquired easements to protect habitat along the lower reaches of Neawanna Creek, near the Necanicum River estuary. Additional acquisitions, wetlands restoration, and development of a coastal-studies center are among planned and ongoing improvements.

Nestucca Bay

The U.S. Fish and Wildlife Service and Ducks Unlimited are working to expand the Nestucca Bay National Wildlife Refuge, near Pacific City, and improve wildlife habitat. Plans include the acquisition of existing salt marshes, restoration of converted tidal wetlands, and protection of wetland habitats and upland buffer areas.



Estuaries provide habitat for coho salmon (*Oncorhynchus kisutch*), an important native species.

Siletz Bay

The Siletz National Wildlife Refuge lies between Lincoln City and Gleneden Beach in one of the most rapidly growing areas on Oregon's coast. It harbors a wide variety of wildlife in more than 500 acres of diverse habitats. Federal agencies, Ducks Unlimited, and the Confederated Tribes of the Siletz Indians are cooperating in the acquisition of 300 additional acres, the removal of a mile-long dike, and restoration of about 125 acres of tidal marshes.

Beaver Creek Marsh

Between Newport and Waldport, near popular Ona Beach State Park, the Wetlands Conservancy purchased the 77-acre Beaver Creek Marsh to protect habitat for waterfowl, native fishes, and other marsh wildlife. A number of government agencies and local supporters are working to expand protection and restore damaged habitat.

Lint Creek

Since the 1960s, an earthen dam stretched for 300 feet across Lint Creek, on the south side of Alsea Bay, near Waldport. Efforts there—supported by government agencies, Ducks Unlimited, and the local watershed council—resulted in the dam's removal and restoration of the creek's natural channel. The 30-acre project has eliminated a migration barrier to native fish, is restoring habitat for estuarine fish and shellfish, and has provided recreational users with creek access.

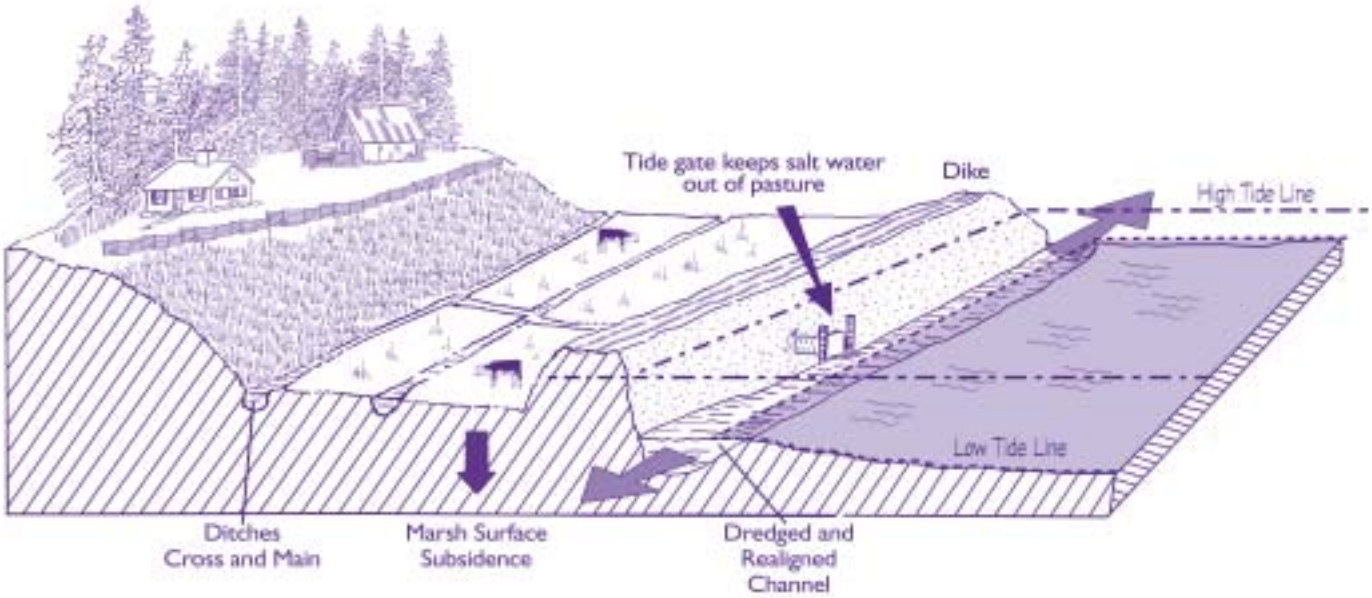
Bandon Marsh

A host of government agencies, nonprofit organizations, local associations, and the Coquille Indian Tribe are working to expand and restore habitat and protect culturally important archeological sites at the Bandon Marsh National Wildlife Refuge. Acquisition of a 407-acre parcel in 2000 more than doubled the size of this refuge on the Coquille River estuary. Other upstream properties under consideration would further increase habitat. About 400 acres of diked agricultural lands may be restored.

Salmon River Estuary

The Salmon River meets the sea on Oregon's central coast, north of Lincoln City. Its estuary forms beneath the brow of Cascade Head and is part of the Cascade Head Scenic Research Area, managed by the Siuslaw National Forest and the U.S. Forest Service Pacific Northwest Research Station. The site is significant as one of the earliest habitat-restoration projects on the West Coast, with a relatively long history of scientific experimentation and monitoring.

By 1974, most of the estuary's salt marshes had been diked for conversion to pastures and cut off from tidal flooding. To restore tidal hydrology, the Forest Service removed tide gates and dikes in 1978, 1987, and 1996. Using nearby undiked marshes as references, researchers have been able to monitor the progress of marsh rehabilitation in successive stages to determine rates of recovery and the effects of marsh succession.



Tidal circulation was lost when estuaries were diked and drained for human activity during the last century.

Restoring Vital Estuarine Habitats

All types of tideland habitats are important to estuaries' overall health. Several, however, are vital to the well-being of countless organisms, including humans: tidal flats, eelgrass beds, and tidal marshes.

TIDAL FLATS

Estuaries build tidal flats through the natural process of sedimentation. Rivers and creeks transport silt and clay particles from the watershed to the estuary. Sandy marine sediments ride tides into the estuary from the ocean. When riverine and tidal currents mingle and slacken, sediments settle to the estuary bottom, building subtidal sandflats near the estuary mouth, mudflats in the upper estuary, and sandy mudflats in the middle reaches.

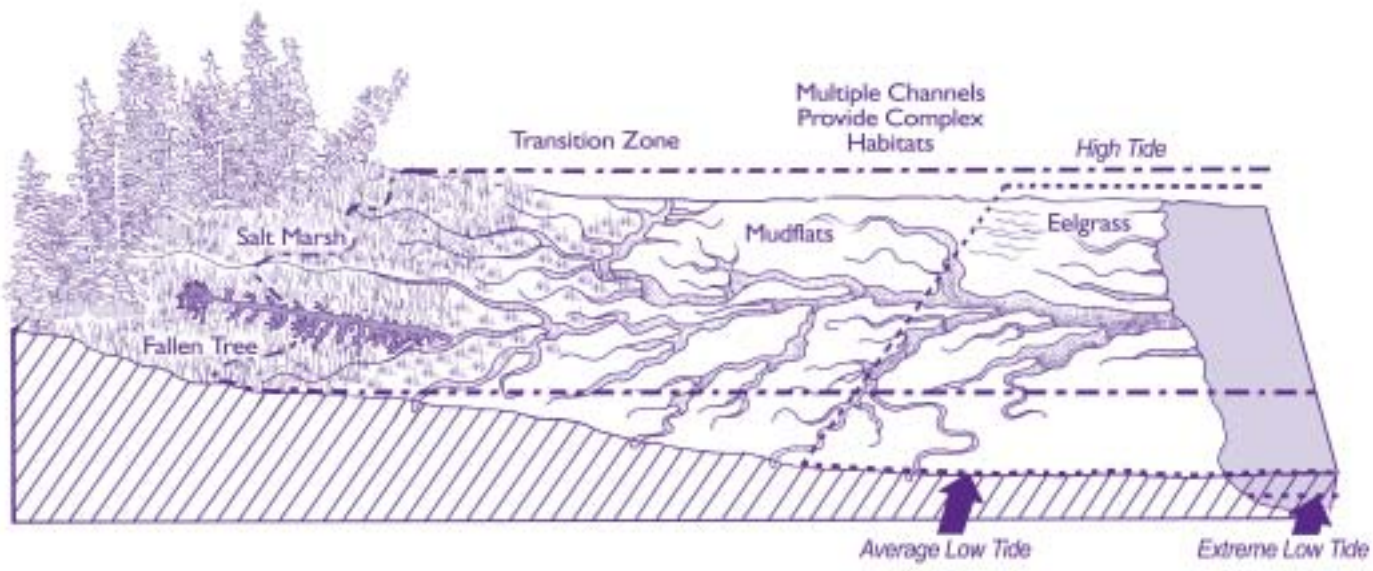
As subtidal flats grow, some eventually emerge as intertidal flats, with surfaces exposed during low tides. They're habitat for numerous bottom-dwelling invertebrates that feed on plentiful microscopic organisms and organic detritus. At low tide, wading birds, shorebirds, and clam diggers descend on the flats to partake of the estuary's plentiful buffet. As tides rise and flood the flats, other predators come to dine.

EELGRASS BEDS

Eelgrass meadows flourish along the lower edges of intertidal flats and subtidal slopes where sunlight penetrates, providing habitat for commercially and recreationally important fishes and shellfishes. They are nurseries and refuges for juvenile salmon, rockfish, and flatfish, as well as spawning grounds for herring.

Several species of ducks and geese feed directly on eelgrass's ribbonlike leaves. Migrating black brant, winter visitors to Oregon's estuaries, feed almost exclusively on the plant. But animals directly consume only about five percent of eelgrass.

The plant's main contribution to the estuarine food web is the production of decaying vegetation, which becomes part of the detritus supporting many organisms both within and beyond the eelgrass beds. When tidal and river currents sweep eelgrass detritus out to sea, it nourishes marine organisms in nearshore shallow waters and even offshore at great depths.



In recent years scientists have learned that by removing dikes and using the fill to build up pastures that have subsided, many natural wetland functions can be restored.

TIDAL MARSHES

Tidal marshes grow out of intertidal flats when plants take root in exposed sediments. As plants colonize and spread, they facilitate the marsh-building process by trapping more sediments and exposing greater area to further plant growth.

Tidal marshes form a transition zone between upland habitats and the estuary's eelgrass beds and tidal flats. Salt marshes thrive in the sandy sediments of the lower estuary. Brackish marshes occupy the middle fringes, where bottom sediments are a mixture of sand and silt. Freshwater marshes grow in the muddy sediments of the upper estuary, where freshwater inflows prevent saltwater intrusion.

The most salt-tolerant plants dominate the marshes of the lower estuary. Although some of the plants found in salt and brackish marshes also grow in freshwater tidal marshes, the farther upstream the greater the prevalence of freshwater plants.

The marshes, themselves, are also zonal. Plants dwelling in the lower zone of salt and brackish marshes are the most salt-tolerant and the most capable of withstanding frequent and long periods of inundation. Consequently, scientists use indicator species to designate low-marsh and high-marsh zones.

Most of the marshes' emergent vegetation dies back each fall, becoming part of the rich supply of detritus. About a fourth of this organic matter spreads through marshes to nourish plants and animals there, while tidal currents carry the rest to other estuarine and marine habitats.

As tideland habitat, marshes are incomparable in the ecological functions they perform and the biological, economic, and cultural benefits they provide. Like eelgrass meadows, they are home and hostel to resident organisms and seasonal visitors alike. They are also the estuary's major contributor to detrital food chains.

Tides are the lifeblood of these wetlands. When dikes, roads, and other impairments modify tidal inundation, marshes can change dramatically. As converted land subsides, many of the marshes' vital ecological benefits are lost.

They found that some salt-marsh plant species took hold soon after tidal inundation and upland species died immediately. It took several years to achieve full wetland vegetative cover and 10 years or more for plant communities to stabilize. In the older restoration areas, tidal creeks that had been clogged with sediments and widened by trampling have been rehabilitated and are being used by fish, including juvenile salmon.

Recent research has focused on the importance of salt marshes to juvenile salmon. Scientists have found that young chinook and coho salmon consistently use the marshes from April through May and that estuarine marshes may be much more important to juvenile coho than previously thought.

At the South Slough National Estuarine Research Reserve, scientists are conducting long-term monitoring to document the spread of plants and animals in the Winchester Tidelands Restoration Project. Only a few years ago, this marsh was a well-established pasture that had been created by diking and draining a portion of the slough nearly a century ago.

So far, about 70 percent of the estuary's marshes have been returned to tidal influence. Because of the nine-year intervals at which tide gates and dikes were removed, the project has provided researchers and students with a unique laboratory to study tideland habitat restoration over time.

Coos Estuary

Within the 4,800-acre South Slough National Estuarine Research Reserve lie about 600 acres of tidelands. An area along Winchester Creek known as the Winchester Tidelands consists of about 50 acres of former salt marshes, mudflats, and estuarine channels that were diked around the turn of the 19th century and converted to agricultural lands. Constructed ditches drained the land while dikes and tide gates excluded it from tidal circulation. Highly productive salt marshes and critical habitat for invertebrates, fish, waterfowl, shorebirds, and mammals were lost.

Reserve scientists assembled a multidisciplinary team of experts to develop plans for the Winchester Tidelands Restoration Project (WTRP). This multiphase recovery strategy calls for experiments to accelerate the restoration of functions in the reclaimed tidelands.

The active restoration of Kunz Marsh was the first of several restoration projects implemented at the reserve in 1996. For a variety of reasons, including compaction by grazing cattle, marsh surfaces had subsided more than two feet below original elevations. Scientists estimated that passive restoration and natural recovery of Kunz Marsh to original elevations could take 70 to 150 years. During that time, estuarine organisms would be deprived of the food and habitat that salt-marsh vegetation provides.

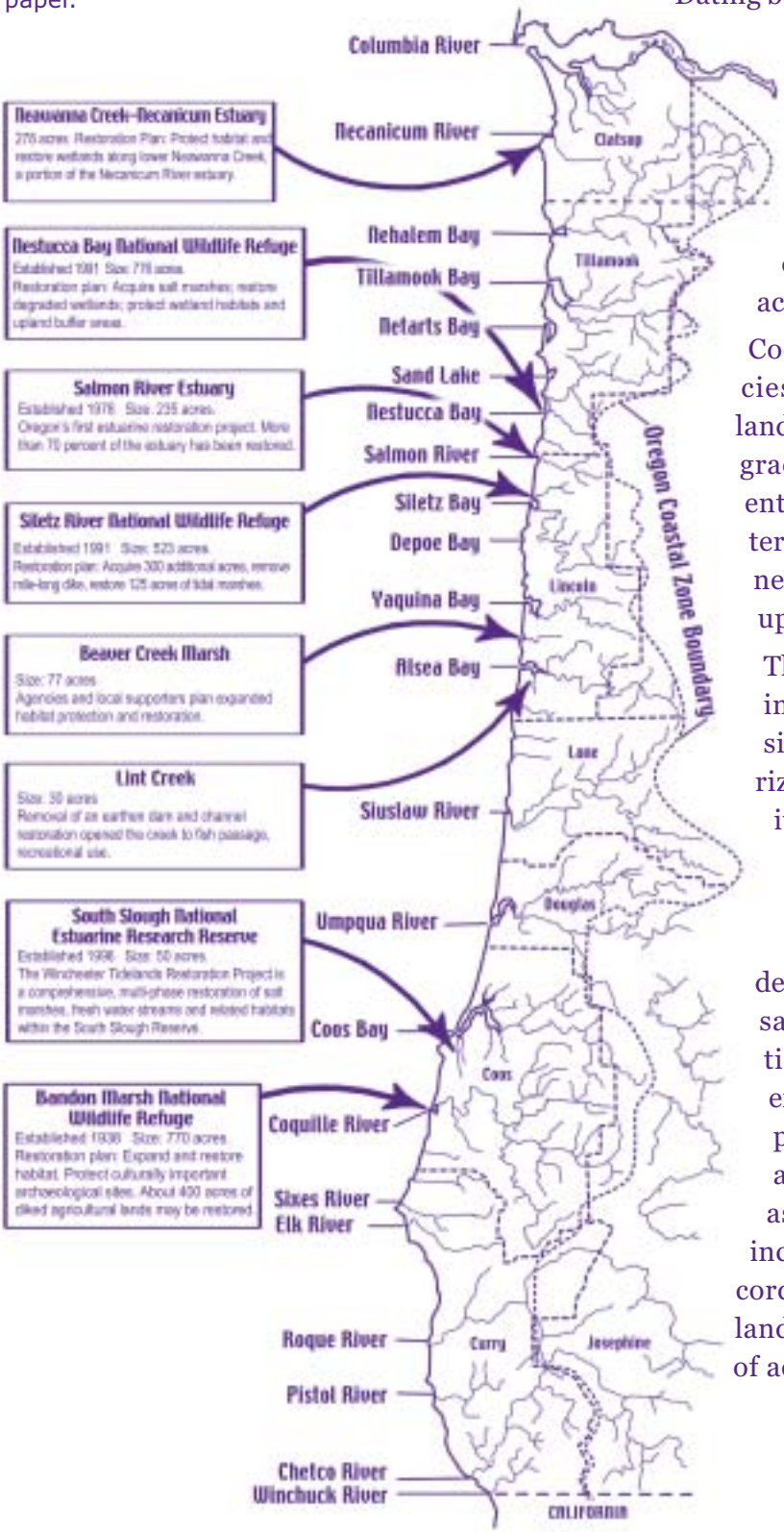
To speed up recovery, scientists excavated the Kunz Marsh dike and used dike material to create experimental cells at three different elevations. They removed and stockpiled organic topsoil prior to creating the cells. After grading and redistributing the stockpiled material, they removed the remaining dike to restore tidal circulation and allow the tides to create channels in the marsh. Invertebrates quickly began colonizing the area and shorebirds were using it within weeks.

In the next phase of the project, restoration professionals used explosives and heavy equipment to transform a straightened and channelized creek into a more complex, meandering stream. They also created fish habitat by introducing large woody debris—fallen trees and branches—into stream channels. They built wooden structures to create scour pools, raise the water table, saturate streamside soils, and enhance streamside vegetation. Fish, including juvenile coho salmon, are once again using the creek, and creek banks are vegetated.

These and other projects, large and small, are uniting Oregonians from diverse backgrounds with a common goal: to protect and preserve coastal habitats and restore those that have lost their ecological integrity.

Restoring Coastal Marshes

Since 1978, Oregonians have restored more than 2,800 acres of tidal wetlands. This map shows the locations of the coastal restoration projects described in this paper.



WHERE DO WE GO FROM HERE?

Dating back only to the 1960s, restoration of tidal wetland habitat has been called an art, a new science, and an emerging discipline. Throughout its short history, restoration has been experimental and, to some extent, still is. As more projects mature, however, and the body of knowledge grows, it becomes easier to accurately predict outcomes.

Cooperative efforts of government agencies, nonprofit organizations, industry, landowners, and the public are restoring degraded estuarine habitats. Restoration scientists and others are working at the watershed level to reestablish essential connections among saltwater, freshwater, and upland ecosystems.

The maturation of restoration science during the last decade or so has led to discussions of new directions and expanded horizons. Expert consensus seems to be that it's time to move on to large-scale restoration projects for greater environmental benefit.

Most restoration to date has been undertaken to satisfy regulations for compensatory mitigation—trade-offs of restoration parcels for permitted destruction of existing wetlands. At the urgings of experts, we're now looking to the prospects and profits of nonregulatory restoration as a way of not only improving but also increasing habitat. Instead of operating according to the policy of *no net loss* of wetlands, many people are embracing a concept of actual *net gain*.

GLOSSARY

brackish – *adj.* slightly salt, as some estuarine water, with salt content usually ranging from 0.5 to 1.7 percent.

detritus – *n.* loose, finely divided rock or remains of organic tissues.

food chain – *n.* the interdependent arrangement of organisms within an ecological community, in which those of the lowest order are fed upon by larger organisms which in turn become food for still larger animals.

food web – *n.* the entirety of interrelated food chains within an ecological community.

hydrology – *n.* the occurrence, circulation, distribution, and properties of water.

intertidal – *adj.* above the low-water mark and below the high-water mark.

preservation – *n.* the setting aside of wetlands in their existing condition.

restoration – *n.* full or partial reestablishment of historic wetland conditions that previously existed but where wetland functions and communities have been reduced or no longer exist.

riparian –*adj.* of or pertaining to the bank of a river or shoreline of a body of water.

salt marsh – *n.* a brackish wetland created by sediments of riverine and marine sources, which is periodically inundated by high tides, and where specially adapted plant and animal communities thrive.

subtidal – *adj.* below the low-water mark.

watershed – *n.* the drainage area of a river or other stream.

wetland – *n.* land that has wet soil, as a bog, marsh, swamp, or wet meadow.

RECOMMENDED READING

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Mitsch, William J. and James G. Gosselink. *Wetlands, Second Edition*. New York: Van Nostrand Reinhold, 1993.

Ridlington, Sandy, ed. *National Coastal Ecosystem Restoration Manual*. Corvallis, OR: Oregon Sea Grant, 2002.

WEB SITES

Cascade Head Experimental Forest and Scenic Research Area:
www.fsl.orst.edu/chef/

Coastal America:
www.coastalamerica.gov

National Estuarine Research Reserves:
www.ocrm.nos.noaa.gov/nerr/welcome.html

National Estuary Program:
www.epa.gov/nep/nep.html

National Marine Fisheries Service:
www.nmfs.noaa.gov/habitat

Natural Resources Conservation Service:
www.nrcs.usda.gov

The Nature Conservancy:
www.nature.org

Tillamook Bay National Estuary Project:
www.co.tillamook.or.us/gov/estuary/tbnep/nephome.html

South Slough National Estuarine Research Reserve:
www.southsloughestuary.org

The Oregon Estuary Plan Book:
www.inforain.org/mapsatwork/oregonestuary

Oregon Department of Fish and Wildlife:
www.dfw.or.us

National Oceanic and Atmospheric Administration:
www.noaa.gov

NOAA Coastal Services Center:
www.csc.noaa.gov

Office of Wetlands, Oceans, and Watersheds:
www.epa.gov/owow

Pacific Northwest Coastal Ecosystems Regional Study:
www.pncers.org

US Army Corps of Engineers:
www.usace.mil

USDA Forest Service:
www.fs.fed.us

US Environmental Protection Agency:
www.epa.gov

US Geological Survey:
www.usgs.gov

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