South Slough National Estuarine Research Reserve

Management Plan

Charleston, Oregon 2015-2020

2015-2020 Management Plan

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The South Slough of the Coos estuary embraces Winchester Creek, the principle stream of Oregon's South Slough National Estuarine Research Reserve. It's a place for scientists, students, and explorers of nature to learn about a fascinating ecosystem that forms where rivers meet the sea and fresh and salty waters are mixed by the tide.

In 2015 South Slough Reserve begins its fifth decade as America's original estuarine research reserve. From its beginning in 1974 grew today's National Estuarine Research Reserve System, a network of 28 coastal wetland sites established for long-term research, stewardship, education, and training about estuaries.

The mission of the Reserve is to increase the stewardship and understanding of Pacific Northwest estuaries and coastal watersheds. This management plan describes important topics that management and staff will address over the next five years to achieve its misssion.

Each reserve is a partnership between NOAA and a coastal state or U.S. trust territory. NOAA's Office for Coastal Management adminsters the Reserve System.

Citation

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Audience

The audience for this plan includes the National Oceanic and Atmospheric Administration's Office for Coastal Management, the National Estuarine Research Reserve System, their partners and stakeholders, and other interested people.

Acronyms

The use of acronyms is kept to a minimum. The following short names and acronyms are common among the intended audience. After first reference they occur throughout the plan without further reference:

NOAA – National Oceanic and Atmospheric Administration

SWMP – System-wide monitoring program

Reserve System – National Estuarine Research Reserve System

State lands – Oregon Department of State Lands

Science collaborative – National Estuarine Research Reserve System's Science Collaborative

Less common acronyms used include:

B-WET – Bay Watershed Education and Training

CDMO – Centralized Data Management Office

C.F.R – Code of Federal Regulations

KEEP – K-12 Estuary Education Program

O.A.R. – Oregon Administrative Rules

OIMB – University of Oregon's Oregon Institute of Marine Biology

O.R.S. – Oregon Revised Statutes

STEM – Science, technology, engineering, and mathematics

TOTE – Teachers on the Estuary

Chapter I

Introduction to the South Slough National Estuarine Research Reserve

The National Estuarine Research Reserve System

The National Estuarine Research Reserve System (Reserve System) was created by the Coastal Zone Management Act of 1972, as amended, to augment the National Coastal Zone Management Program which is dedicated to comprehensive, sustainable management of the nation's coasts.

The Reserve System is a network of protected areas representative of the various biogeographic regions and estuarine types in the United States. Reserves are established for long-term research, education and interpretation to promote informed management of the Nation's estuaries and coastal habitats (15 C.F.R. Part 921.1(a)). The Reserve System currently consists of 28 reserves in 23 states and territories, protecting over one million acres of estuarine lands and waters.

The Reserve System is a partnership program between the National Oceanic and Atmospheric Administration and the coastal states. NOAA provides funding, national guidance and technical assistance. The state partner manages reserve resources on daily basis working collaboratively with local and regional partners.

Strategic goals

Estuaries are biologically rich, economically valuable, and highly vulnerable ecosystems. The vision and mission of the Reserve System reflect the importance of these systems within our communities.

The Reserve System's vision is of resilient estuaries and coastal watersheds where human and natural communities thrive. The Reserve System's mission is to practice and promote stewardship of coasts and estuaries through innovative research, education, and training using a place-based system of protected areas.

Federal regulations 15 C.F.R. Part 921.1(b), outline five specific goals for the Reserve System:

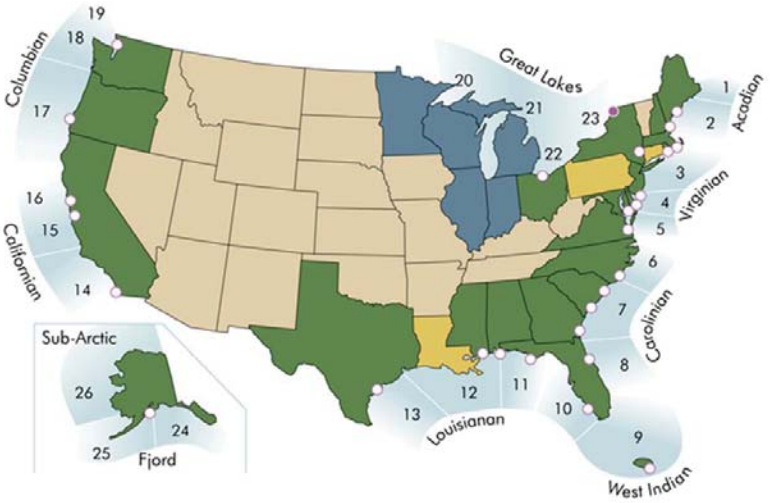
- Ensure a stable environment for research through long-term protection of National Estuarine Research Reserve resources
- Address coastal management issues identified as significant through coordinated estuarine research within the Reserve System
- Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation
- Promote Federal, state, public and private use of one or more reserves within the Reserve System when such entities conduct estuarine research, and
- Conduct and coordinate estuarine research within the Reserve System, gathering and making available information necessary for improved understanding and management of estuarine areas.

These foundational goals are complemented by those that are systematically set by the program every five years. Strategic planning has been an integral part of the Reserve System for nearly twenty years. The planning process is designed to bridge national program direction with local coastal management needs through a representative and participatory process that supports NOAA's mission of science, service, and stewardship.

The 2011-2016 Reserve System Strategic Plan focuses the Reserve's research, education, and training on three issues: climate change, habitat protection, and water quality.

The Reserve System's biogeographic regions

NOAA has identified eleven distinct biogeographic regions and 29 subregions in the United States, each of which contains several types of estuarine ecosystems (15 C.F.R. Part 921) (See *Appendices I and II*). When complete, the Reserve System will contain examples of estuarine hydrologic and

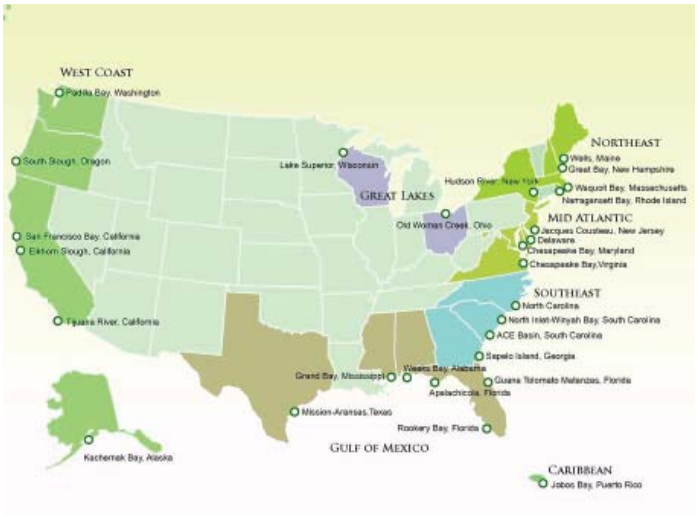


NOAA

Fig. 1—Biogeographic regionss of the Reserve System

biological types characteristic of each biogeographic region. As of 2012, the Reserve System includes 28 reserves and two states in the process of designating a reserve.

Reserve boundary size will vary greatly depending on the nature of the ecosystem. Boundaries must include an adequate portion of the key land and water areas of the natural system to approximate an ecological unit and to ensure effective conservation. Reserve boundaries encompass areas for which adequate state control has or will be established by the managing entity over human activities occurring within the reserve.



NOAA

Fig. 2—The National Estuarine Reserve System

National Estuarine Research Reserve administrative framework

The process for federal designation of a National Estuarine Research Reserve has many steps and involves many individuals and organizations. While each reserve is a partnership program between NOAA and a coastal state, there are many entities that collaborate to support designation of a reserve. Other partners include federal and state agencies, non-profit groups, universities and members of the local community.

For more information on the designation process see http://nerrs.noaa.gov/Background.aspx.

Reserve designation and operation

Upon designation, the reserve implements the approved management plan and is eligible for NOAA financial assistance on a cost-share basis with the state. A reserve may apply to NOAA for funds to help support implementation of the management plan largely funding operations, research, monitoring, education, interpretation, training, stewardship, development projects, facility construction, and land acquisition.

Management plans provide a vision and framework to guide reserve activities during a five year period and enable the reserves and NOAA to track progress and realize opportunities for growth. Each management plan contains the reserve goals, objectives, and strategies supported by programs focused on research and monitor-

ing, education and outreach, training, and stewardship.

They also outline administration, public access, land acquisition and facility plans and needs, as well as restoration and resource manipulation plans, if applicable. Reserves are increasingly confronted with complex questions regarding new uses in or near reserves that may or may not be compatible with the Reserve System's mission. A thoughtful and comprehensive management plan provides a foundation for addressing these challenges to protect and manage reserve resources wisely and ensure the public and coastal decision-makers value and protect coastal resources.

NOAA administers the Reserve System and establishes standards for designating and operating reserves, provides support for reserve operations and system-wide programming, undertakes projects that benefit the Reserve System, and integrates information from individual reserves and programs to support decision-making at the national level.

Additionally, NOAA periodically evaluates reserves for compliance with Federal requirements and with the individual reserve's federally-approved management plan, as mandated under Section 312 of the Coastal Zone Management Act (15 C.F.R. Part 921.40).

NOAA currently provides support for three system-wide programs including the System-Wide Monitoring Program, the K-12 Estuarine Education Program, and the Coastal Training Program. NOAA also provides support for initiatives focused on the Reserve System's priorities: climate change, water quality and habitat protection.

South Slough National Estuarine Research Reserve

On June 27, 1974 the South Slough Sanctuary was established as America's first National Estuary Sanctuary. Its designation culminated the efforts of local residents, Coos County planning officials, and concerned Oregonians, who recognized that the South Slough, with extensive natural shorelines, minimal development, and other outstanding features, was well-suited to the goals of Section 315 of the Coastal Zone Management Act which established the National Estuarine Sanctuary System.

Section 315 required that an area chosen for an estuary sanctuary must include land and water qualifying as "biogeographic and typological representations of estuarine systems" sufficient to sustain a healthy and viable ecosystem. The National Oceanic and Atmospheric Administration (NOAA) granted Oregon $400,000 to purchase land for a sanctuary around the South Slough and begin hiring staff.

Oregon matched that grant with private contributions and discounted land sales. An environmental impact statement was completed. The Nature Conservancy coordinated and negotiated the purchase of property on behalf of the state. By 1978, the Division of State Lands—now Department of State Lands (State lands)—had purchased 72.6 percent of the area originally proposed for the sanctuary.

In 1986 Congress reauthorized the Coastal Zone Management Act and changed the name of the program designated under Section 315. Consequently the South Slough Sanctuary was renamed the South Slough National Estuarine Research Reserve (Reserve).

Legal authority

State law defines the intent and purpose for the Reserve and designates State lands as the Reserve's state partner agency. State lands is under jurisdiction of the State Land Board. The land board consists of the Governor, Secretary of State, and State Treasurer. All administrative decisions at the Reserve must comply with the policies of the State Land Board.

The South Slough Ecosystem

The South Slough embraces a rich variety of habitat for fish and wildlife and other natural amenities that people of the area value and enjoy. Its history extends from time immemorial for some residents; for others it began in an era of migration, settlement, industrialization, and nation-building. All of these peoples' lifestyles were rooted in the natural resources they found in and around the slough: wood, fish and wildlife, fertile soil, and mild climate. Today their sovereign tribal and Euro-American descendants honor the traditions of this mixed heritage and embrace styles of living that characterize modern Coos Bay. It is the setting of the South Slough National Estuarine Research Reserve.

The Reserve is located in the South Slough, a part of the Coos estuary on the southern Oregon coast. The 5,000-acre (2,023.43-hectare) site is headquartered in Charleston on the campus of the University of Oregon's Institute of Marine Biology (OIMB) at the confluence of the Coos estuary and Winchester Creek, the main stream of the South Slough.

In 2010 the U. S. Census estimated 63,064 residents lived in Coos County—nearly one-third of Oregon's coastal population. The cities of Coos Bay and North Bend form the economic heart of the county. Collectively, they have about 25,518 residents (U. S. Census, 2010), making Coos Bay the largest population center on the Oregon coast.

See *Appendix U—A Closer Look at Coos Bay,* for a brief summary of Coos area history.

The Lower Columbian Biogeographic Region

The South Slough is typical of estuaries in the Lower Columbian Biogeographic Region, a distinctive area of the Pacific coast that spans approximately 415 miles

(664 km) of coastline between the Columbia River, on the border between Oregon and Washington, and Cape Mendocino, California.

Like most estuaries in this region, the Coos estuary is a drowned river mouth that formed as sea level began to rise at the end of the last ice age, about 20,000 years ago. Estuaries in this region experience heavy winter precipitation which results in rapid discharges of large volumes of fresh water and sediment during and after storms. The influence of salt water is more pronounced during summers when river flows are low. Other estuarine types found in the region include bar-built estuaries, blind estuaries, river-dominated estuaries and, in northern California, lagoons that occasionally admit salt water.

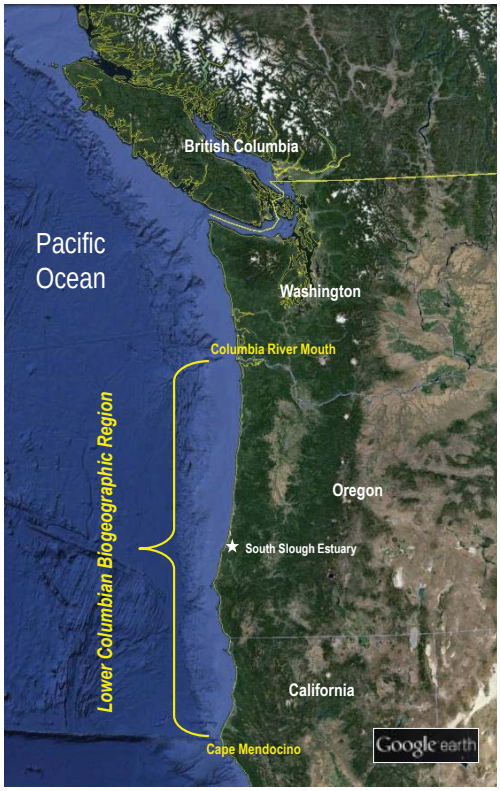


Fig. 3—The lower Columbian biogeographic region

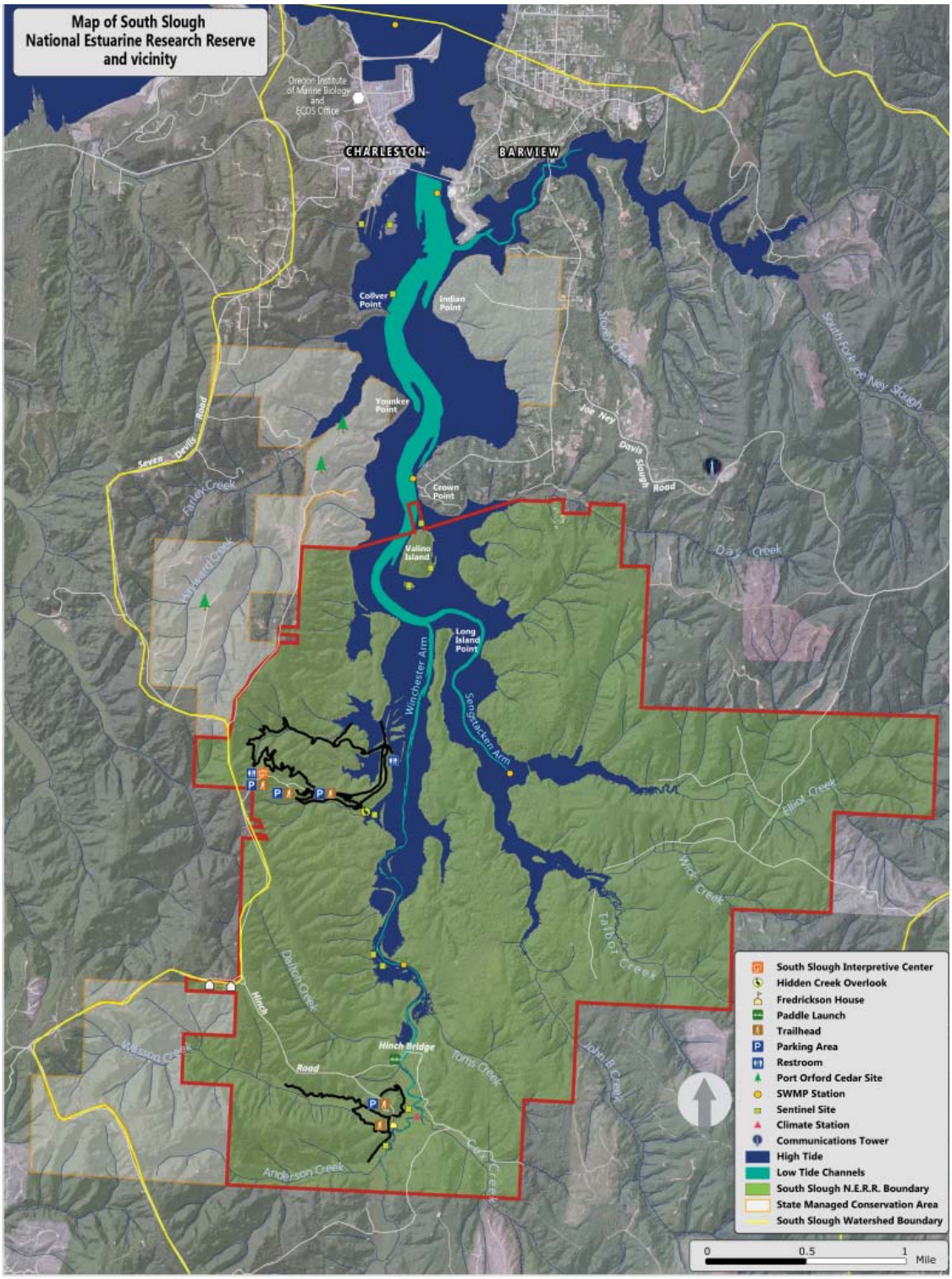
The southern Oregon coast experiences distinctly different summer and winter climate regimes in a typical year. Weather is generally warm and dry from May through September with an average rainfall of less than four inches (10 cm). Cooler, wetter weather occurs from October through April, when average annual rainfall is about 56 inches (142.24 cm). Regional temperatures annually range between 40° and 75° F (4.5° - 24° C).

In summer high barometric pressure and northerly winds prevail with winds averaging about 17 mph (27 km/hr). In winter the wind is generally from the south and southwest and averages about 15 mph (25 km/hr). Winter storms are generally driven by southwesterly gales that can produce from 2.75 inches to four inches (6.99 cm–10.16 cm) of rainfall during a 24-hour period. Winds during winter storms can exceed 75 mph (120 km/hr).

Temporal climate varies with changes in the Pacific Ocean, primarily due to the El Niño-Southern Oscillation and the Pacific Decadal Oscillation, and in recent years, the effects of global warming.

Geology and geomorphology

The hills, floodplains, sand dunes, and headlands in the vicinity of the Coos estuary are the results of a complex series of geomorphic events arising from the grinding of tectonic plates over the past 50 million years, changes in sea level that have



Collen Burch Johnson

Fig. 4—The South Slough Reserve and surroundings

occurred since the last melting of glaciers, local weakness in the earth's crust, and the activities of people. Estuaries are among the coastal margin's newest features, having developed largely over the last six thousand years following the melting of the glaciers, the rising of the seas, and the subsequent flooding and sedimentation of the ancient coastal river valleys.

The South Slough lies along a geologic syncline, or fold, which bears its name. Due to this formation, the slough's eastern and western slopes are of distinct geologic types. The eastern shore formation, which seldom exceeds 250 feet (76.20 m) of elevation, is typical of the Coos watershed. It is formed of highly-erodible, Quaternary marine terraces of unconsolidated to semi-consolidated sand, silt, and clay. The terraces slope gently and are worn down along creek beds to sandstone and siltstone that is overlain by loamy sand and sandy and silty loam.

The western side's Empire Formation, with scattered Quaternary marine terraces, is unique to the South Slough. Composed of hard impermeable sandstone, it rises 370 feet (112.78 m) above sea level in a long north-south ridge. The slopes are mantled with sand and silty loam and loamy sand.

Sediment samples taken from Winchester Creek show a buried layer of course-grained sand that overlies organic material (Peterson and Darienzo, 1989; Nelson *et al*., 1998), providing evidence that the South Slough was inundated by a tsunami, about 300 years ago (Satake *et al*., 1996). The tsunami was triggered by an earthquake in the Cascadia subduction zone and documented in Japan.

Soils and minerals

Soils and minerals are derived from several sources, including terrestrial runoff, oceanic deposition, and peat. Salt marsh soils are classified as rich organic histosols (Haagen, 1989) which typically consist of compacted clay, sand, and fine mud in alternating layers with mineral sand, silt, and peat.

Tide flats are composed of highly organic mud, and occur in areas of low tidal energy. Sand flats occur in areas of high tidal energy (generally nearer the mouth) and have a much lower organic content.

The predominant upland forest soil is silty loam from the easily erodible Templeton-Salander group. Sandy marine terraces of the Bullards-Bandon-Blacklock group are also present on the northeastern slopes.

Due to its marine origins, the South Slough includes small deposits of black sands, in which ancient waves and currents concentrated metallic minerals (primarily iron and chromium, with lesser concentrations of gold, titanium, zirconium, platinum, and garnet). Two to four thousand feet beneath the surface the Coaledo Formation, a U-shaped seam of coal, wraps around the slough. Natural gas (methane) deposits have been reported in the coal beds.

Hydrology

The Coos estuary is relatively shallow, with an average depth of 6.56 feet (2.00 m) below mean, lower low water. The tidal basin thoroughly mixes the fresh and salt water most of the year, but after heavy rainfalls the estuary becomes partially stratified, especially where the channel has been dredged. At low tide nearly the entire tidal volume is contained in the shipping channel.

Tides are mixed and follow a semi-diurnal pattern with two high tides and two low tides per day. Tidal currents are substantial, with average flows over 3.28 feet per second (1.00 m/s) (Baptista, 1989). Mean tidal range is 7.55 feet (2.30 m) at the mouth.

The location of the mouth was naturally defined by a shifting sand bar. Since the late 1800s it has been stabilized with jetties.

The highest tides measure about 10.8 feet (3.29 m) above mean, lower low water, and the lowest tides occur at -2.95 feet (-0.89 m) below mean, lower low water. Extreme tidal range is 11.15 feet (3.39 m).

At 13,300.5 acres (5,382.32 ha.) of area, it is the largest estuary completely within Oregon and sixth largest on the West Coast. The channel is 47 feet (14.33 m.) deep (MLLW) by 1150 feet (350.7 m) wide at the entrance marker, and 37 feet (11.27 m.) deep (MLLW), and ranging from 300 to 400 feet (91.5 to 45.5 m.) wide throughout its 15.2 mile (24.5 km.) length. The South Fork of the Coos River and the Millicoma River supply about two thirds of the fresh water that enters the bay. Freshwater flows average 5,500 cubic feet per second (cfs) during winter rains, and drops to 90 cfs during summer (USACE, 1993).

In the South Slough six perennial streams and more than 30 intermittent streams provide highly seasonal freshwater flows. The largest, Winchester Creek, maintains a narrow sinuous channel, approximately 6.56 feet (2.0 m) deep. Throughout the slough the average water depth is 3.28 ft. (1.00 m), with the deepest point measuring 18 feet (5.49 m).

Circulation patterns are strongly influenced by the tides, complex, and poorly understood (Juza, 1995; Roegner and Shanks, 2001). Maximum tidal velocities at Valino Island are nearly 3.28 feet per second (1.00 m/s), with average current velocities of about 1.3 feet per second (0.39 m/s). The flushing time for the slough is from six to eight tidal cycles (about three days).

Many of these tributaries are populated by resident and anadromous fish; others appear to be unoccupied by fish. Some, having been long buried by brush and sediment from logging, no longer flow above ground, and their biological attributes are unknown.

Water quality

The physical, chemical, and biotic characteristics of the water vary seasonally and with each tide cycle, and are influenced by conditions in the nearshore ocean, the estuary, and its freshwater tributaries. Water in South Slough is generally well-mixed throughout the gradient from marine to fresh riverine zones (Harris *et al*., 1979; Roegner and Shanks, 2001). Heavy rainfall may cause some stratification of the water column, but the twice-daily tides tend to minimize stratification when it occurs.

Salinity, density, specific conductivity, nutrients, and chlorophyll concentrations vary greatly along the gradient. Water temperature, dissolved oxygen, and acidity (pH) are less responsive to changes in salinity. Salinity varies considerably with rainfall during the year.

Core and buffer lands

The goal of the Reserve's stewardship mission is to maintain ecological and hydrological connectivity from ridgetop to estuary in order to sustain the ecological function of both forest and estuary. Stewardship activity is guided by the Upper Watershed Restoration Plan (Robinson, 2009).

South Slough's forested slopes are typical of the Coos watershed and the Coast Range. They include 30- to 50-year-old mixed conifer forests dominated by Douglas fir *(Pseudotsuga menziesii)*, clear-cut areas, and brushy slopes. The Reserve contains a few, small isolated stands of trees more than 80 years old, and a few individual trees estimated to be more than 100 years old.

Over the past four decades the absence of active management (logging) in the Reserve has resulted in the growth of dense, overstocked areas of forest infested with Swiss needle cast disease and Port Orford cedar disease; heavy build-up of tinder on the forest floor, and a general loss of diversity of plants and wildlife habitat. The combination of dry brush, steep slopes, and dead and dying trees sets the stage for a catastrophic wildfire that potentially could spread into neighboring private and public commercial forest lands and threaten the integrity of the forest-slough core.

The Reserve is at the southern end of the range for Sitka spruce *(Picea sitchensis)* and the northern extent of the range for Port Orford cedar *(Chamaecypraris lawsoniana)*. It is a critical refuge for the Sitka spruce-Port Orford cedar mixed forest type, due to its limited distribution and its perilous status resulting from the presence of *Phytophthora lateralis,* a long-established, endemic, non-native fungal pathogen decimating Port Orford cedars.

For more information about the Reserve's forests and plans for forest habitat restoration, see *Chapter 4—Foundation Programs.*

Habitat, natural communities, and biotic conditions

The South Slough contains an assortment of aquatic, terrestrial, and intertidal habitat, and corresponding diversity of flora and fauna. The Coos estuary is similar, but with three important differences: it contains habitat types not found in the South Slough; has experienced sustained, intensive development, and its tidal prism is larger, salinity higher, and tidal flushing time longer.

Estuary shorelands

Seven major slough systems and many smaller tributaries feed the Coos estuary. Except for South Slough, all of the sloughs have been intensively developed for transportation, commercial use or agriculture. Most are contained by levees and regulated by tide gates. Portions of the North Spit shore (on the bay side) have been developed for industry. In recent years tidal flows have been restored to portions of some sloughs, (e.g., Isthmus, Catching, and Coalbank sloughs) and in a few instances old tide gates have been removed or replaced with newer styles that are less detrimental to anadromous fish passing through the gates.

Riparian zones

The most prevalent streamside deciduous tree is red alder *(Alnus rubra)*. Pacific wax myrtle *(Myrica pacifica)* and river willows *(Salix spp.)* also appear. Stream banks are usually lush with Pacific sword fern *(Polystichum munitum)*, deer fern *(Blechnum spicant)*, and lady fern *(Altherium filix-femina)*, and often include oxalis *(Oxalis oregona)*. These gradually give way to plants of the forest, including salmonberry *(Rubus parviflorus)*, thimbleberry *(R. spectabilis)*, blackberries, both native *(R. ursinus)* and non-natives *(R. procerus, R. lacianata)*; salal *(Gaultheria shallon)*, evergreen huckleberry *(Vaccineum ovatum)*, red huckleberry *(V. parvifolium)*, and sword fern.

Forest riparian areas provide mammals, including raccoons *(Procyon lotor)*, black-tailed deer *(Odocoileus hemionus columbianus)*, with sources of food and water, and ease their movement between woodland and estuary. Tributaries provide habitat for amphibians such as the Pacific giant salamander *(Dicamptodon tenebrosus)* and red-legged frog *(Rana aurora)*.

Freshwater ponds and marshes

Freshwater ponds and marshes frequently form just up- and downstream from beaver dams and in sediment which has accumulated immediately above the high tide line. Throughout the twentieth century, the building of dikes resulted in the creation of many artificial freshwater marshes and wetlands. Most freshwater wet-

lands occur in the extensive stream systems of the southern and eastern portions of the watershed. A few isolated wetlands exist in the uplands.

American beaver *(Castor canadensis)* live near streams they have dammed. Cox Pond was formed when beavers dammed a tidal channel that had been reconstructed as part of the Winchester Tidelands Restoration Project; beavers created a new freshwater marsh instead. Northern river otters *(Lontra canadensis)* establish regular pathways into and out of streams.

Characteristic plants of freshwater wetlands include sedges *(Carex obnupta, Scirpus microcarpus)*, cattail *(Typha latifolia)*, soft rush *(Juncus effusus)*, spike rush *(Eleocharis spp.)*, skunk cabbage *(Lysichitum americanum)*, and reed canary grass *(Phalaris arundinacea)*, a species introduced as a pasture grass that can invade intertidal areas. Deeper marshes and ponds may contain duckweed *(Lemna minor)* and spatterdock *(Nuphas polysepalum)*. Species of *Darlingtonia* occur in a few remote freshwater bogs.

Salt marshes

Salt marshes support large populations of larval, juvenile and adult marine invertebrates, which are consumed by the shorebirds and waterfowl that frequent the estuary; they also play an important role in moderating the effects of flooding and chemical or oil pollution.

The Coos estuary contains less than 10 percent of its original salt marsh habitat as a result of decades of filling, dredging, and development. Significant portions of the salt marshes remaining in the Coos estuary are to be found in the South Slough. Marshes occur sporadically in the northern end of the slough, and become larger and more frequent towards its southern reaches. South Slough salt marshes may experience less tidal influence than salt marshes in the main Coos estuary due to the slough's north-south orientation.

South Slough salt marshes typically include tufted hairgrass *(Deschampsia caespitosa)*, saltgrass *(Distichlis spicata)*, pickleweed *(Salicornia virginica)*, and Lyngby's sedge *(Carex lyngbyei)*. A few small marshes support the less common salt-marsh bird's beak *(Cordylanthus maritimus)* and sea lavender *(Limonium californicum)*.

Emergent islands

In addition to Valino Island, the South Slough contains several small, low-lying islands of a few hundred square feet in all created from dredging deposits during the past century. These islands appear to provide habitat for invertebrates and some birds, but their biota, like the biota of spoil islands elsewhere in the Coos estuary, remain to be studied.

Tide flats and channels

The abundant sediments carried into the Coos estuary have created extensive tide flats. The flats are a rich feeding ground for shorebirds, herons, egrets, gulls, and belted kingfishers. Most flats are composed of soft, unconsolidated mud or muddy sand. The tide flats are often partially covered by mats of the green algae *Vaucheria*. They typically harbor cockles *(Clinocardium nuttalli)* and gaper *(Tresus capax),* bent-nose *(Macoma nasuta),* and littleneck *(Protothaca staminea)* clams. Ghost shrimp *(Neotrypaea californiensis),* mud shrimp *(Upogebia pugettensis),* and juvenile Dungeness crabs *(Metacarcinus magister)* also inhabit the tide flats.

Sand flats are rare in the South Slough, but a few are found adjacent to sandy bluffs and in the higher energy portions nearer to the ocean entrance. Within the Reserve itself, one sand flat area occurs off the northwest corner of Valino Island, and a second occurs along Long Island Point's western shore. A few coves and bluffs north of the Reserve also have sandy bottoms. Open channels with muddy bottoms provide benthic habitat even at lowest tides to provide access throughout the South Slough for fish.

Eelgrass

Beds of eelgrass, (both native *Zostera marina,* and non-native *Z. japonica*), cover a significant portion of the Coos estuary bottom. In late summer, up to 160 acres (64.74 ha.) of eelgrass may be found in the Reserve, with additional beds of unknown size in the northern part of the slough beyond the administrative boundary. The plants' height allows development of several vertical layers of structurally diverse and productive habitat. Blades of eelgrass offer attachment area for algae, planktonic larvae, juvenile Dungeness crabs, and snails.

Eelgrass beds, together with the deeper tidal channels, shelter fish and invertebrates including juvenile crabs, ling cod *(Ophiodon elongates),* coho salmon *(Oncorhynchus kisutch),* starry flounder *(Platichthys stellatus),* English sole *(Parophrys vetulus),* and others.

Tidal channels provide access throughout the estuary and habitat for larger fish, beaver, otters, and wading and secretive marsh birds. Brackish channels provide habitat for smolting coho.

Biotic conditions in the South Slough catchment, especially within the Reserve, are described in detail in *Ecology of the South Slough Estuary: Site Profile of the South Slough National Estuarine Research Reserve,* available online at www.nerrs.noaa.gov/Doc/PDF/Reserve/SOS_SiteProfile.pdf.

Benthic habitat

South Slough does not contain extensive sandy, rocky or cobbled bottom areas. Rocky bottoms are found at the northern end of the slough near the ocean entrance, below Coos Head. This small rocky patch is occupied by a community of hard bottom dwelling and boring invertebrates, including barnacles, mussels, sea anemones, snails, and rock-boring clams.

Additional information may be found in the *State of the South Slough and Coastal Frontal Watersheds,* available at www.partnershipforcoastalwatersheds.org/watersheds/.

Citations

Baptista, A.M. 1989. Salinity in Coos Bay, Oregon: review of historical data (1930-1989). Report 5E-89—001. U. S. Army Corps of Engineers, Portland, Ore. 40pp.

Dello, K.D., and P.W. Mote, (eds.). 2010. Oregon Climate Assessment Report Legislative Summary, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, Ore. Available at: www.occri.net/OCAR

Haagen, J.T. 1989. Soil Survey of Coos County, Oregon. National Cooperative Soil Survey. 269 pp.

Harris, D.W., W.G. McDougal, W.A. Patton, and N. Talebbeydokhpi. 1979. Hydrologic study for South Slough Estuarine Sanctuary, Coos Bay, Oregon. Water Resources Research Institute, Oregon State University, Corvallis, Ore. 23 pp.

Juza, H.K. 1995. Water quality model for South Slough, Coos Bay, Oregon. Master's thesis, Portland State University. 107 pp.

Kelsey, H.M., A.R. Nelson, E. Hemphill-Haley, R.C. Witter. 2005. Tsunami history of an Oregon coastal lake reveals a 4600 year record of great earthquakes on the Cascadia subduction zone. GSA Bulletin; July/August 2005; v 117; no. 7/8; pp. 1009-1032; doi: 10.1130/B25452.1. Data repository item 2005105.

Miller, R. 2010. Is the past present? Historical splash-dam mapping and stream disturbance detection in the Oregon Coastal Province. Master's thesis, Oregon State University, Corvallis, Ore.

Nellemen, C., E. Corcoran, C.M. Duarte, L. Valdés, C. De Young, L. Fonseca, and G. Grimsditch (eds.). 2009. Blue Carbon: The Role of Healthy Oceans in Binding Carbon. A Rapid Response Assessment. United Nations Environment Program.

Nelson, A.R., Y. Ota, M. Umitsu, K. Kashima, and Y. Marsushima. 1998. Seismic or hydrodynamic control of rapid late-Holocene sea-level rises in southern coastal Oregon, USA. The Holocene 8: 287-299.

Oregon Climate Change Research Institute, 2010. Oregon Climate Assessment Report, K.D. Dello and P.W. Mote (eds.). College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, Ore.

Peterson, C.D., and M.E. Darienzo, 1989. Episodic abrupt tectonic subsidence recorded in late Holocene deposits of the South Slough syncline—an on-land expression of shelf fold belt deformation from the southern Cascadia margin. Geological Society of America. Abstracts with Programs 21 (5): 129.

Robinson, J. 2009. Upper Watershed Restoration Action Plan. South Slough National Estuarine Research Reserve, Charleston, Ore.

Roegner, G.C., and A. Shanks. 2001. Input of coastally-derived chlorophyll a to South Slough, Oregon. Estuaries 24: 244-256.

Ruggiero, P., C.A. Brown, P.D. Komar, J.C. Allan, D.A. Reusser, and H. Lee, II, in Oregon Climate Change Research Institute (2010), Oregon Climate Assessment Report, K.D. Dello and P.W. Mote (eds.). College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, Oregon. Available at: www.occri.net/OCAR

Satake, K., K. Shimazaki, Y. Tsuji, and K. Useda. 1996. Time and size of a giant earthquake in Cascadia inferred from Japanese tsunami records of January, 1700. Nature 379: 246-249.

U.S. Army Corps of Engineers. 1993. Feasibility report on navigation improvement with Environmental Impact Statement. Vol. I. U.S. Army Corps of Engineers, Portland, Ore. 81pp.

United States Census Bureau. 2010. Accessed online July 28, 2014 at http://quickfacts.census.gov/qfd/states/41/4153000.html

Management authorities

The South Slough National Estuarine Research Reserve (Reserve) operates within a strategic framework of state and federal laws and policies. The day-to-day activities of staff and management are guided by core principles adopted by the South Slough Management Commission (Commission).

The Reserve is managed through a partnership between the National Oceanic and Atmospheric Administration (NOAA) and the Oregon Department of State Lands (State lands). As one of 28 reserves in the National Estuarine Research Reserve System (Reserve System), all the Reserve's programs and activities are responsive to NOAA's strategic goals, the Reserve System's program goals, Oregon law, and State lands' policies.

Oregon law complements and reinforces the federal regulations for the Reserve System by declaring that the maintenance of the Reserve as a "national sanctuary" is state policy. According to the statute *(Appendix C)*, the management policy of the Reserve is to:

> ***Maintain the integrity of the estuary.***
>
> ***Protect the estuary from uses and activities, both within and beyond boundaries, which may alter or affect the ecosystem and its natural dynamic processes.***
>
> ***Preserve the area for long-term scientific and educational uses.***
>
> *Oregon Revised Statutes 273.553*

Federal regulations and the Reserve System's program goals

Federal regulations (15 C.F.R 921.1(b)) provide five specific goals for the Reserve System:

- Ensure a stable environment for research through long-term protection of National Estuarine Research Reserve resources;
- Address coastal management issues identified as significant through coordi-

nated estuarine research within the System;

- Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
- Promote federal, state, public and private use of one or more Reserves within the System when such entities conduct estuarine research, and
- Conduct and coordinate estuarine research within the System, gathering and making available information necessary for improved understanding and management of estuarine areas.

Strategic guidance

The Reserve's research and education programs are guided by NOAA's Strategic Plan for 2010-2015 *(Appendix P)* and the Reserve System's Strategic Plan for 2011-2016 *(Appendix Q)*.

NOAA's strategic plan, 2010-2015

NOAA's vision of the future is of resilient ecosystems, communities and economies that can maintain and improve their health and vitality over time by anticipating, absorbing, and diffusing change.

The vision acknowledges the challenges posed by global warming and widespread climate change. It steers NOAA and its partners in a collective effort to reduce the immediate vulnerability of communities and ecological systems, while helping society avoid or adapt to long-term environmental, social, and economic changes (NOAA, 2010).

Four goals guide this vision:

Climate adaptation and mitigation: An informed society is anticipating and responding to climate and its impacts.

Weather-ready nation: Society is prepared for and responds to weather-related events.

Healthy oceans: Marine fisheries, habitats, and biodiversity are sustained within healthy and productive ecosystems.

Resilient coastal communities and economies: Coastal and Great Lakes communities are environmentally and economically sustainable.

The Reserve System's strategic plan, 2011-2016

The Reserve System's vision of resilient estuaries and coastal watersheds where human and natural communities thrive guides its mission to practice and promote stewardship of coasts and estuaries, through innovative research, education, and training, using a place-based system of protected areas. The Reserve System's Strategic Plan for 2010-2015 identifies three strategic areas of focus to guide work at the reserves:

Climate change

Climate change will have significant impacts on estuaries and coasts by exacerbating sea level change, inundation and flooding from storms, drought, and changes to freshwater flows. Additional undesirable effects, such as ocean acidification and species shifts, also will affect estuaries, varying regionally in their effects on coastal communities and economies.

NOAA believes the National Estuarine Research Reserves are well-positioned to monitor and study the impacts that climate change will have on estuaries and to work with communities to plan and adapt to the changes. Reserves can mitigate some of the effects by adapting the design and construction of facilities and through their land stewardship practices. Reserve training and education programs can help communities understand and adapt to anticipated climate change impacts.

Habitat protection

According to NOAA, coastal wetlands are being lost at a rate of approximately 60,000 acres per year, largely due to development and inundation. The biologically rich habitats of estuaries and coastal watersheds provide essential functions such as nurseries for many commercially important fish and shellfish as well as protection for human communities from storm surges, storm water run-off, and flooding. Climate change will amplify those stresses causing greater loss and alteration.

The research reserves are also well-suited to map, monitor, and investigate habitat changes and develop, test, and implement methods for habitat protection and restoration. Reserves also transfer these best management practices through coastal training and community education programs.

Water quality

In the most recent assessment of estuaries by NOAA, the Environmental Protection Agency and the U. S. Department of Agriculture, a majority of estuaries showed signs of eutrophication and algal blooms, which were strongly influenced by population growth and land use. Understanding and monitoring water quality trends provides critical information needed to improve ecosystem health and mitigate adverse impacts such as harmful algal blooms and hypoxia.

Of equal importance is promoting and implementing best management practices that address land-based sources of pollution.

The Reserve System's ability to couple long-term environmental monitoring data with management practices on reserve lands and in adjacent watersheds provides an opportunity to study the effectiveness of different management. Since they collect their data using consistent, system wide protocols, the reserves are also well-positioned to detect climate and environmental trends. Directly or indirectly, all of the work done at the Reserve addresses one or more of these areas.

State Lands' strategic plan

State lands is the administrative arm of the State Land Board. The board was established by the Oregon Constitution in 1859 to manage state-owned lands and assets of the common school fund. The board is composed of the governor, secretary of state, and state treasurer.

State lands' mission is to ensure a legacy for Oregonians and their public schools through sound stewardship of lands, wetlands, waterways, unclaimed property, estates and the common school fund. Goal 6 of the plan directs the agency to serve as state partner for the South Slough National Estuarine Research Reserve by providing leadership and administrative oversight.

The plan includes the following guidance for the Reserve:

- Advance scientific understanding of the ecological dynamics in the South Slough, Coos Bay and other Pacific northwest estuaries through assessment and monitoring.
- Provide technical assistance and advisory services for the effective management of estuaries in the lower Columbian biogeographic region.
- Use innovative programming and delivery to increase understanding of estuarine ecosystems for four targeted audiences: 1) school-aged children, 2) university students and researchers, 3) coastal decision makers, and 4) the public.
- Manage and restore the habitats and ecosystem processes within the Reserve and collaborate with local, regional, and national organizations on estuarine and coastal watershed projects.
- Maintain public access to the Reserve through exceptional facilities and trails, using innovative siting, design, and construction methods that minimize ecological impacts.

See *Appendix T—Department of State Lands' Strategic Plan*

South Slough's vision

South Slough's vision articulates the desired future condition that the Commission strives to attain. The vision translates into the goals and objectives of the Reserve's programs and operations. Staff are mindful of the vision as they prioritize research, education and training for direct problem-solving. Primary emphasis is on the Coos estuary and watershed, but the Reserve's science and education programs also reach out to assist estuarine dependent communities throughout the lower Columbian biogeographic region.

It is the vision of the South Slough Management Commission that the lower Columbian biogeographic region's estuaries and coastal communities are healthy and adaptable to environmental and socio-economic change.

The work of the Reserve supports the informed management of the Coos estuary and is a model for coastal management.

Mission

The Reserve's mission is to improve the understanding and stewardship of Pacific Northwest estuaries and coastal watersheds. All of the Reserve's programs and operations contribute to the accomplishment of the mission.

Core principles

The Commission has adopted five core principles to guide work at the Reserve. These principles reinforce the Reserve's mission, and are descriptive of values to which can be attributed the effectiveness of the Reserve's programs.

Strengthen the understanding of estuaries in the Pacific Northwest through increased knowledge about South Slough and the Coos estuary.

Coos Bay and the Coos estuary are the primary focus of the Reserve's research and education programs. By focusing on the Coos and South Slough watersheds, the Reserve develops information and expertise that can be used to better understand estuaries and coastal watershed issues throughout the region.

Solicit and incorporate the advice and partnership of others.

The Reserve sustains an atmosphere of cooperation, collaboration, and responsiveness. In the planning stages of a project, staff will request and consider

the advice from diverse sources—including those opposed to its proposals—to ensure the quality of the project and to improve the likelihood of success.

Prioritize stewardship of the South Slough estuary.

An intact and functioning estuarine ecosystem is necessary to support the Reserve's long-term research and education goals. All activities managed or endorsed by the Reserve will be compatible with the mission of the Reserve System and with the Reserve's stewardship program.

Develop projects to advance multiple Reserve goals.

The mission of the Reserve is best served by projects that are designed to address multiple Reserve goals. Staff will keep the manager and each other advised of proposed initiatives in order to identify opportunities to develop initiatives that meet the goals of more than one program and to avoid possible conflicts between programs.

Structure Reserve activities around key audiences and environmental themes.

Programs at the Reserve address common issues in different ways. Programmatic efforts will be coordinated around target audiences and relevant coastal issues in order to most effectively serve the Reserve's constituency.

Significant accomplishments, 2006-2014

Thanks to the professionalism, dedication and capabilities of staff and cooperative relationships with partners, the Reserve has accomplished many of the objectives set out in previous plan. The following achievements deserve special note:

- With funding provided by NOAA, renovated the Interpretive Center, Spruce Ranch guest house, the maintenance shop, and the environmental science laboratory to improve office spaces, installed photovoltaic power sources and energy efficient lighting in work spaces and exhibits, replaced or repaired deteriorating infrastructure, and expanded guest housing for visiting researchers or temporary staff.
- Worked with the Coos Watershed Association to establish the Partnership for Coastal Watersheds, a collaborative effort among public and private sectors in the Coos Bay community, to develop locally driven approaches for responsible development, and to help prepare for climate related changes on Oregon's south coast, with the assistance of the Science Collaborative.

- Initiated the Oregon Coast Education Program, an estuarine field study program for teachers, funded by NOAA's Bay Watershed Education and Training initiative, to increase the frequency and quality of outdoor education for Oregon students by providing funding and training in best teaching practices.
- Collaborated with the Coquille Indian Tribe, the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians, the Coos Watershed Association, and the University of Oregon to develop hydrodynamic circulation models for the Coos estuary.
- Worked with public and private organizations and sovereign tribal nations to convene the Pacific Marine and Estuarine Fish Habitat Partnership, chartered under the National Fish Habitat Partnership to restore habitat for native fish of Oregon, Washington, and California.
- In partnership with the Coquille Indian Tribe, hosted the Southern Oregon Lamprey Conference for seven northwestern sovereign tribal nations and federal natural resource agencies to review progress in the recovery of Pacific lamprey and other culturally important species.
- Established five, new, water-quality monitoring stations in the Coos estuary in collaboration with the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians, the Northwest Association of Networked Ocean Observing Systems, and the Coast Guard.
- Acquired Chmoosh, a 27-foot, eight passenger replica of a Native American sea canoe, with financial assistance from the Friends of South Slough. Chmoosh is very popular, and serves as the informal flagship of the Reserve's paddle powered interpretive fleet.
- Initiated an internship program and expanded opportunities for volunteers to contribute to education and interpretation, resulting in significant increases in the numbers of volunteers, programs delivered and public participants.
- With assistance from the Science Collaborative, completed a three-year project to explore the feasibility of restoring native Olympia oysters (Ostrea lurida) in Coos Bay and the South Slough.
- Established a network of high-precision benchmarks associated with the Reserve's network of water quality reporting stations.
- Established a series of summer science camps for youth, now aligned by grade level and expanded to increase capacity.
- Established high-speed internet service for all facilities and personnel.
- Developed an energy plan and an upland forest management plan.
- Added new trails, paddle launches, and exhibits.
- Created three, full-time staff positions.

Priority Management Issues

Priority management issues reflect new developments, new information, and new ideas and solutions. In addition to these priorities, staff recognize other management needs that must be addressed, including chronic issues as yet unresolved and newly-developing issues. With that qualification, for the coming planning period, staff and management have identified three management priorities for the South Slough National Estuarine Research Reserve (Reserve). The priorities are not ranked but equally important.

Addressing the priorities successfully will require additional staff and resources. Administrative staff will coordinate with State lands and NOAA to develop the Reserve's capacity, in terms of funding and personnel, to undertake the science and education program goals and objectives associated with the priorities, including:

Working with education and research coordinators to identify funding sources and staffing strategies (e.g., new permanent, limited duration, or temporary staff; partnerships, contractors) to ensure the tasks associated with the priorities are adequately staffed and funded.

Expanding the Reserve's capacity to engage effectively in climate science research and education by providing staff with appropriate tools and materials.

Augmenting the efforts of the research and education staff through the continued expansion of the Reserve's public involvement program.

Facilitating the development of strategies to secure funding from sources other than NOAA for work (e.g., proposing program option packages to expand capacity for consideration by the Oregon legislature); contributing to efforts led by non-profit organizations such as the Friends of South Slough, Inc., the National Estuarine Research Reserve Association, or other partnerships or collaborations, that encourage congressional support for estuaries through funding for NOAA's Sentinel Site Program, expanded system-wide monitoring capacity, public involvement, TOTE (Teachers on the Estuary), and other needs.

Priority 1

Characterize and communicate the current trends and likely future effects of climate change on Pacific Northwest coastal communities and estuarine ecosystems.

Goal 1: Provide timely and relevant information on the local effects of sea level rise to coastal communities, including to local government officials and natural resource managers, to aid in more fully informed land management and conservation planning decisions.

Objective 1: By 2020, determine whether sedimentation and vertical accretion rates in Coos estuary tidal wetlands are likely to keep pace with current and anticipated rates of local sea level rise.

Action 1: Use the Reserve's local geodetic control network to determine precise elevations of the water level sensors at all stations of the System-wide Monitoring Program (SWMP).

Action 2: Quantify changes in tidal inundation regimes at key tidal wetlands in the Coos estuary using long-term water level data from NOAA's tide station in Charleston, SWMP stations, and tribally managed water quality monitoring stations.

Action 3: Collect data at existing and newly established sediment dynamics sites to quantify tidal wetland sedimentation and vertical accretion rates in the Coos estuary, including at sentinel site stations in the South Slough.

Action 4: Coordinate the Reserve's development as a sentinel site with the Reserve System's efforts to synthesize information from multiple reserves.

Action 5: Assist the Pacific Northwest Coastal Blue Carbon Working Group to quantify carbon stocks, sequestration rates and greenhouse gas emissions in Pacific northwest tidal wetlands by: assisting with funding proposal development; providing local research sites; managing a blue carbon research database; and helping with fieldwork and associated logistics.

Action 6: Coordinate the actions taken under this objective with the work of the Pacific Northwest Coastal Blue Carbon Working Group.

Objective 2: By 2020, characterize the ongoing effects of sea level rise on the density and spatial distribution of emergent plant communities and eelgrass beds at the Reserve's sentinel site stations.

Action 1: Complete an implementation plan to qualify the Reserve as a fully

functional sentinel site within NOAA's Sentinel Site Program.

Action 2: Map the spatial distribution of emergent marshes and eelgrass beds at sentinel site stations.

Action 3: Collect percent cover, shoot density, and elevation data associated with emergent marsh plant communities and eelgrass beds at sentinel site stations.

Action 4: Establish groundwater wells and associated continuous water level data loggers at sentinel site stations to characterize tidal wetland groundwater level regimes and quantify changes.

Action 5: At sentinel site stations, analyze plant community and eelgrass bed data and use, elevation, groundwater level, sedimentation, and vertical accretion, and tide levels data to help interpret the results of those analyses.

Action 6: Coordinate the Reserve's implementation of NOAA's Sentinel Site Program with the work of the Pacific Northwest Coastal Blue Carbon Working Group.

Objective 3: By 2020, incorporate research pertaining to sea level trends, emergent plant communities, and eelgrass, into appropriate education programs and communication products.

Action 1: Provide teachers with training related to sentinel site program objectives and results through TOTE workshops.

Action 2: Facilitate delivery of research results associated with sea level trends, emergent plant communities, and eelgrass to K-12 students through NOAA's K-12 Estuary Education Program (KEEP).

Action 3: Incorporate local and regional climate change information into Coastal Training Program outreach to community members and other audiences as appropriate.

Action 4: Develop sea level rise and coastal storms information programs for public audiences using the Reserve's staff, volunteers and interns.

Objective 4: Through the Coastal Training Program, assess the needs of Coos Bay decision makers for information and training related to sea level rise and other likely climate change impacts.

Action 1: Confirm the selection of an appropriate group of decision makers to assist in determining needs.

Action 2: Conduct the assessment; compile the results..

Action 3: Provide training or technical assistance to address the identified

needs using available tools and resources as appropriate.

Goal 2: Increase communications about actual and potential climate change impacts to the reserve's stakeholders.

Objective 1: Using the Partnership for Coastal Watersheds' socio-economic and environmental inventory as the data foundation, facilitate the local community's development of a climate change vulnerability assessment for Coos Bay by 2020.

Action 1: Work with Partnership for Coastal Watersheds stakeholders to guide the development of the assessment.

Action 2: Work with University of Oregon and other scientists to incorporate the new Coos estuary hydrodynamic model into scenario-testing of various climate change issues raised by the local stakeholders.

Action 3: Evaluate the potential effects of changing pH, temperature, and sea level rise on local biota, including native fish and shellfish, especially species that are particularly sensitive to long-term changes in pH as juveniles (e.g., Olympia oysters, Dungeness crab).

Action 4: Evaluate the potential effects of changing pH, sea level rise, and other key environmental parameters on Coos Bay's socio-economic conditions, including impacts to economic development, infrastructure, quality of life, and exposure to hazards.

Action 5: Through the Coastal Training Program, assist the Pacific Northwest Coastal Blue Carbon Working Group to address the human dimensions of coastal blue carbon as a driver for habitat conservation and restoration.

Objective 2: By 2020, emphasize climate communication through education portals.

Action 1: Develop new exhibits and publications that incorporate climate science and emphasize its implications for the Reserve.

Action 2: Provide professional development workshops to help teachers incorporate climate change science in classrooms using new and existing curricula, activities and age-appropriate background materials.

Action 3: Incorporate climate science curricula with formal education using Estuaries 101 and similar NOAA education products.

Action 4: Through the Coastal Training Program, work with southern Oregon coastal communities to inform decision makers on impacts of climate change.

Objective 3: By 2018, improve staff's knowledge of climate science and current information on climate change.

Action 1: Encourage staff to participate in climate science workshops, webinars, and training.

Action 2: Conduct cross training among all staff to reach a better understanding of climate science.

Objective 4: By 2020, strengthen reserve staff skills in communicating about climate change.

Action 1: Partner with the National Network for Ocean and Climate Change Interpretation (NNOCCI) to provide staff training in climate interpretation.

Action 2: Incorporate climate interpretation with a variety of staff activities.

Action 3: The Reserve is expected to qualify for NOAA's Sentinel Site Program during the coming planning period. The Coastal Training Program will develop training or technical assistance to aid coastal managers in understanding, obtaining, applying, or adapting NOAA's sentinel site data for decision making.

Action 3: The Coastal Training Program will provide training and information to interested communities throughout the lower Columbia biogeographic region to expand the Reserve's sentinel site program to potentially support regional climate initiatives and decision making.

Objective 5: By 2020, incorporate climate change with interpretive programs.

Action 1: The Coastal Training Program will assess the needs of decision makers locally and throughout the lower Columbia biogeographic region for information, training or technical assistance related to sea level rise.

Action 2: Relay information about the Reserve's contributions to improved science and understanding of climate change to targeted audiences including students, teachers, decision makers and others.

Action 3: Highlight actions already undertaken by the Reserve to address climate change.

Action 4: Emphasize community level solutions at public outreach events.

Goal 3: Improve coastal communities' understanding of ocean acidification's potential effects on Pacific Northwest marine and estuarine ecosystem functions, including fish and shellfish.

Objective 1: By 2020, evaluate water column carbon dynamics of the South Slough.

Action 1: Establish and implement data collection protocols for high resolution partial pressure of carbon dioxide (pCO_2) and pH instruments deployed in the South Slough.

Action 2: Analyze, summarize and distribute data from high resolution pCO_2 and pH instruments deployed in the South Slough.

Action 3: Characterize ecosystem metabolism dynamics at pCO_2 and pH data collection sites.

Action 4: Use high resolution pCO_2 and pH data from two dedicated sensors (SAMI CO_2 and SeapHOX) to help interpret pH trends in the South Slough.

Action 5: Facilitate the collection of data to help characterize ocean acidification in southern Oregon offshore and nearshore waters.

Action 6: Facilitate comparisons between pCO_2 and pH trends in the South Slough and the nearshore ocean

Objective 2: Incorporate knowledge of ocean acidification impacts into education programs and communication products.

Action 1: In TOTE workshops, provide teachers with training on ocean acidification, using the Reserve's pCO_2 and pH data and results.

Action 2: Through the Coastal Training Program assess the needs of decision makers in southern Oregon communities for information or training related to ocean acidification, sea level rise, and other climate change effects.

Action 3: Develop ocean acidification interpretive materials.

Priority 2

Promote and apply comprehensive and adaptive approaches to maintaining and improving the long term resilience of coastal habitats in Pacific Northwest estuaries and coastal watersheds.

Goal 1: Improve scientists,' policymakers' and coastal communities' understanding of carbon-related ecosystem services (coastal blue carbon) associated with the restoration and conservation of tidal wetlands

Objective 1: By 2020, help biophysical researchers quantify carbon budgets for Pacific Northwest tidal wetland habitat classes in least disturbed, disturbed (e.g., diked or tide gated), and restored and recovering sites.

Action 1: Work with the biophysical technical team of the Pacific Northwest Coastal Blue Carbon Working Group to quantify carbon stocks, sequestration rates, greenhouse gas emissions and ecosystem drivers in Pacific northwest tidal wetlands by: assisting with funding proposal development; providing local research sites; contributing environmental monitoring data from SWMP and sentinel site stations, and helping with fieldwork and logistics.

Action 2: Coordinate the Reserve's implementation of NOAA's Sentinel Site Program with the work of the Pacific Northwest Coastal Blue Carbon Working Group.

Objective 2: By 2020, investigate the social and economic barriers, and potential incentives, for incorporating coastal blue carbon and other ecosystem services as factors in funding work and developing resilient land use policies, to support tidal wetland restoration and conservation.

Action 1: Work with the human dimensions technical team of the Pacific Northwest Coastal Blue Carbon Working Group to develop a socio-economic research framework that will help decision makers understand the impacts managing wetlands for carbon sequestration may have in coastal communities.

Goal 2: Assess and monitor terrestrial, intertidal, and subtidal habitats in the Coos estuary, and in the uplands of the South Slough catchment, in order to characterize baseline conditions and changes in habitat use and availability.

Objective 1: By 2020, create a baseline map for the distribution of terrestrial and intertidal habitats within Reserve-managed lands.

Action 1: Assess current maps and habitat data to determine gaps related to developing a habitat map.

Action 2: Work with partners (e.g., public and private forest land managers) to acquire information that informs the habitat map.

Action 3: Identify and obtain funding for additional staff and resources to meet the Reserve's habitat mapping needs; including a geographic information systems (GIS) data manager, data analysts' time, and supporting materials (e.g., work stations, software licenses, instruments, etc.).

Action 4: Engage interns to assist staff with mapping and ground-truthing as part of their job-training experience.

Action 5: Update and refine the Coastal and Marine Ecological Classification Standard (CMECS) maps for the Coos estuary by comparing each CMECS component with relevant spatial data and site visits, as needed.

Objective 2: By 2015, begin an annual monitoring program to track and evaluate the use of estuarine habitats by fish and invertebrate communities in the Coos estuary.

Action 1: Quantify levels of habitat use by juvenile estuarine-dependent species in at least six locations of the Coos estuary.

Action 2: Evaluate the nursery potential of eelgrass meadows, oyster beds, and tidal marshes for fish and invertebrate species at study sites.

Action 3: By 2018, start identifying the environmental requirements and adaptive potential for fish assemblages and invertebrate species.

Action 4: By 2018, begin to use program data to make habitat comparisons between study sites.

Action 4: The Coastal Training Program will identify funding sources to update the Winchester Tidelands Restoration Project case studies to include new work and project updates since publication of the original case studies.

Objective 3: To address needs already identified, the Coastal Training Program will organize and convene a conference to review latest science about the role of woody debris in estuaries and its use in habitat restoration and conservation, including living shoreline habitat projects.

Goal 3: Continue to build the comprehensive, ridgetop-to-estuary, habitat restoration program for all lands in the South Slough catchment managed by the Reserve.

Objective 1: By 2017, develop a restoration plan for the Wasson Creek Watershed Restoration Project.

Action 1: Work with partners and ecosystem specialists to determine appropriate and effective restoration prescriptions, including those that address the project's long term resilience to the local effects of climate change.

Action 2: Partner with Southwestern Oregon Community College to incorporate baseline monitoring and restoration planning for Wasson Creek with the community college's 2015-2017 natural resource program curricula.

Action 3: Secure partnerships and funding for Wasson Creek Watershed Restoration Project planning and work.

Action 4: Assess the potential and need for incorporating ridgetop-to-estuary restoration demonstrations into Reserve outreach programs.

Action 5: Through the Coastal Training Program, assess the needs of restoration scientists and decision makers for information or training related to

preserving or restoring ecological connectivity.

Action 6: Through the Coastal Training Program, and in coordination with Pacific Marine Estuarine Fish Habitat Partnership (PMEP), develop information and when appropriate, training related to habitat connectivity, including ridgetop-to-estuary, and freshwater-intertidal-subtidal-marine.

Objective 2: By 2020, develop a restoration and land use plan for the Indian Point parcels.

Action 1: Collaborate with partners and ecosystem specialists to determine appropriate and effective restoration prescriptions, with a special focus on managing populations on federal or state lists of threatened or endangered species and long term resilience to the local effects of climate change.

Action 2: Incorporate suitable research, educational and recreational policies or strategies that will be implemented with the assistance of community partners and natural resource specialists.

Action 3: Secure partnerships and funding for restoration, education, recreation planning and project work at Indian Point.

Action 4: Work with administration and facilities staff to coordinate restoration and land use planning support in contracting, equipment use, and design implementation.

Objective 3: By 2019, develop a comprehensive, long-term strategy to monitor the effectiveness of the Reserve's habitat restoration projects.

Action 1: Develop protocols and metrics to quantify the effectiveness of previous and ongoing restoration work.

Action 2: Implement effectiveness monitoring for restoration projects as they are developed and funded.

Goal 4: Seek opportunities for increasing awareness and use of water quality data to inform coastal managers and stakeholders of the Coos watershed's ecological connectivity with the ocean.

Objective 1: By 2017, develop a tool or service (e.g., an online service) to provide instantaneous water quality data to all interested stakeholders, decision-makers, and communities.

Action 1: Train teachers to understand and use water quality data in their classrooms.

Action 2: Distribute water quality data to users via the Partnership for Coast-

al Watersheds Project.

Action 3: Engage students and citizen scientists in water-quality monitoring.

Goal 5: Maintain the Reserve's ecological integrity through adaptive, collaborative approaches.

Objective 1: Maintain the current practice of cooperating with agencies and local landowners to monitor the land use activities in the South Slough watershed.

Action 1: Through agency permitting and public announcements, monitor land use activities in the South Slough watershed.

Action 2: Work with landowners to raise awareness of the Reserve's stewardship priorities to minimize or avoid land use practices that may affect the integrity of Reserve-managed lands and waterways.

Objective 2: By 2020, enhance public awareness of the Reserve's stewardship mission by developing best management practices for public events, managing habitat restoration projects adaptively (based on effectiveness monitoring) and increasing the public's awareness of practices used at the Reserve to improve stewardship.

Action 1: Develop a reference sheet of best practices that will reduce ecological impacts from special events and programs.

Action 2: Develop policies and work plans that address, and where possible, mitigate the local effects of climate change (e.g., including carbon sequestration among the goals and benefits of restoration planning, implementation and monitoring).

Action 3: Develop a schedule for conducting, adaptive management reviews of ongoing an completed habitat restoration projects.

Action 4: Communicate management decisions and processes through ongoing outreach activities, including the Partnership for Coastal Watersheds Project, exhibits, advisory groups, and with education programs where appropriate.

Action 5: Regularly review the condition of trails and the effectiveness of interpretive signs along trails to evaluate the impacts of trail use, increase public awareness of trail etiquette, and reduce erosion and trampling of plants.

Action 6: By 2016, implement and maintain a disaster resiliency and response plan with the participation of the community.

Priority 3

Monitor, research, manage, and communicate the impacts of existing and emerging invasive species within the Reserve and characterize potential threats from other locations.

Goal 1: Characterize and monitor the extent of aquatic and terrestrial non-native species in the Reserve.

Objective 1: Create an aquatic and terrestrial invasive species monitoring program within five years.

Action 1: Work with partners to identify existing and emerging invasive species of high priority to monitor.

Action 2: Identify existing invasive species data and maps, or data gaps, to inform strategy development.

Action 3: Identify and develop opportunities to engage the public, including interns and volunteers, in citizen science projects to monitor invasive species.

Action 4: Integrate an invasive species monitoring component with SWMP and sentinel site stations.

Action 5: At SWMP stations, implement a plankton monitoring program based on larval identification and molecular techniques.

Objective 2: Map the presence and extent of existing invasive species in the Reserve to establish a baseline by 2018.

Action 1: Use monitoring data to map presence of invasive species and prioritize eradication efforts within the Reserve.

Action 2: Compile and maintain a mapping resource for public use depicting the invasive species already existing the Reserve and in the Coos watershed to track future risks to the Reserve, based on remote sensing imagery and data collected by partners and Reserve staff.

Action 3: Provide training for volunteers, interns, and students to identify invasive species and to use mapping technology and eradication tools, as needed.

Goal 2: Measure and track the impacts of non-native species on biodiversity of estuarine and upland communities in the Reserve

Objective 1: Within one year of compiling baseline data, design and begin im-

PLEMENTING RESEARCH PROJECTS TO INVESTIGATE THE EFFECTS OF PRIORITY INVASIVE SPECIES ON NATIVE COMMUNITIES, SPECIES, AND HABITATS.

Action 1: Work with partners, such as the aquatic nuisance program at Portland State University, to identify existing and emerging invasive species of high priority for inclusion in research projects.

Action 2: Conduct laboratory and field experiments to determine the impacts of high priority invasive species on native species, and species interactions within ecological communities.

Goal 3: Reduce the impact of invasive species on native communities and biodiversity within the Reserve

OBJECTIVE 1: IDENTIFY AND IMPLEMENT APPROPRIATE METHODS FOR MINIMIZING THE EFFECTS OF AT LEAST 3 PRIORITY INVASIVE SPECIES IN THE RESERVE BY 2017.

Action 1: Work with partners to identify suitable and effective methods to reduce the impacts of high priority invasive species.

Action 2: Emphasize early detection and control measures to reduce risks and spread of emerging invasive species in the Reserve.

Action 3: Prioritize invasive species management areas and establish a strategy for removal and control of key species.

OBJECTIVE 2: CONDUCT AT LEAST SIX EVENTS ANNUALLY FOR PUBLIC INVOLVEMENT AND EDUCATION IN THE REMOVAL OF INVASIVE SPECIES AND THE RESTORATION OF NATIVE HABITAT.

Action 1: Provide internships and opportunities for public engagement to assist in the control efforts and effectiveness monitoring of invasive species projects based upon strategic priorities.

Action 2: Develop accessible on-line graphic database of native and non-native flora and fauna by habitat to support identification and training efforts.

Goal 4: Provide science-based information about the status of existing invasive species and potential impacts to improve coastal management.

OBJECTIVE: IDENTIFY AT LEAST THREE EFFECTIVE, NEEDS-BASED COMMUNICATION TOOLS INCORPORATING TEXT, GRAPHIC, AND DATA VISUALIZATIONS TO BE USED WITH VARIOUS AUDIENCES INCLUDING EDUCATORS AND STUDENTS.

Action 1: Work with relevant partners to determine available resources and materials for inclusion in the Reserve's education efforts.

Action 2: Create interactive on-line access to GIS maps of habitat types and

links to invasive and native species lists and to case studies.

Action 3: Identify key impacts of invasive species in the Coos estuary and watershed and, with the assistance of the Coastal Training Program, evaluate the cumulative effects of impacts and their relative concerns to decision makers.

Action 4: In concert with Action 3, assist the Oregon Coastal Management Program to develop case studies about the impacts and cumulative effects of invasive species to inform decision-making throughout the coastal zone.

Action 5: Develop an educational activity that incorporates the use of GIS and economic data to illustrate the harmful impacts of invasive species.

Action 6: Through the Coastal Training Program, present an eelgrass conference or workshop to explore and understand human impacts on eelgrass habitat, including impacts affecting the growth and sustenance of eelgrass, and interactions between native and non-native eelgrass species.

Threats, stressors, and other management issues

When the Reserve System was created, lands selected for reserves typically were chosen because they represented pristine or near-pristine estuarine systems. Reserve designation, however, does not stop time, eliminate stresses to the natural environment, or reduce the threats to the ecological services that estuaries provide.

Nor does the South Slough—located near a populated region and connected to a larger water body that exists almost entirely within a modified, urban environment—exist in a vacuum. In addition to concerns addressed in the priorities, other significant threats and stressors include those that threaten the integrity of the Reserve as a whole, but they are also intimately connected to the threats facing the communities of Coos Bay, the bay's larger ecosystem, and the biogeographic regoin.

Threats to the Reserve, the South Slough ecosystem and its environs include:

Water withdrawal from Winchester Creek

The North Bend Water Board supplies drinking water throughout Coos Bay from reservoirs on Pony Creek and Joe Ney Slough. The board's right to water from Winchester Creek is senior to the Reserve's right to keep water in the stream to protect fish (instream right).

In 2013 the board informed the Commission of its intention to seek additional sources of water to meet growing demand for fresh water for residential and commercial use. The board envisions acquiring additional water from another source; however, it may exercise its right to water from Winchester Creek if the other source

proves unfeasible. Water withdrawal from Winchester Creek potentially may affect coho salmon spawning and rearing, or alter the water quality and hydrologic characteristics of the South Slough waterway.

The Cascadia subduction zone

The Reserve and the Coos Bay region, its urban-rural community base, and vital highways, bridges, airports and railroads, sit astride the slow collision of tectonic plates that form the Cascadia subduction zone. This region is the source of frequent minor to larger earthquakes and occasional, powerful subduction earthquakes. It lies parallel to the coast of the lower Columbian biogeographic region roughly 150 to 400 miles offshore.

When plates meet at a subduction zone along a continental margin, the denser oceanic plate sinks beneath the continental plate and lifts it. Stress and friction between the two plates builds until a slip occurs somewhere along a portion of the subduction zone, and the plates suddenly shift. The release of energy results in a subduction earthquake which causes a rapid drop in the elevation of the coastal margin, and results in sudden and catastrophic inundation of coastal lands, and probably a tsunami.

Geologic evidence indicates that catastrophic earthquakes and tsunamis occur in the subduction zone at roughly 300 to 500 year intervals. Their occurrence can be traced over the last 10,000 years in the ancient sediments of lakes on the southern Oregon coast (Goldfinger *et al.*, 2012). The last catastrophic tsunami occurred on Jan. 26, 1700. It was documented in Japan, where it struck in a series of repeated waves (Kelsey *et al.,* 2005), and evidence of it can be seen at the Reserve in sediment core samples taken from the South Slough about 4.5 miles (7.20 km.) above Charleston.

Flooding

Flooding occurs as a result of many factors, from chronic increases in sea level that result from climate change or the slow subsidence of the coastal margin, or in the wake of torrential rains that can occur during a single winter storm. Some land use practices (e.g., shoreline armoring or paving) can reduce the landscape's capacity to mitigate flooding.

Sea level rise along the Oregon coast is influenced by local and global factors, including gravitational fluctuations that result from the melting of glaciers and ice sheets, increased storminess, changes in wind patterns, and ocean phenomena such as El Niño and the Pacific Decadal Oscillation, and the interplay of the movements of tectonic plates: all combine to determine whether and where along Oregon's coastal margin sea level is rising and where it is falling. (Nat'l. Acad. Sci., 2012.)

Locally, changing climate can affect prevailing wind patterns and the impact of wind fetch across large areas of open water such as Coos Bay. Fetch—wind-driven waves that propagate across shallow, exposed surface waters—can hasten incremental erosion and sedimentation along estuarine shores, exacerbate flooding, and damage property and shore-side infrastructure.

Wildfire

The Reserve's management philosophy embraces the ecological concept of ridge top to shoreline connectivity but the majority of attention has been devoted to the restoration of tidally-influenced bottom lands, while the upland forest has been more or less benignly neglected. After years of unmanaged growth, a wildfire originating in the Reserve's forest poses a risk to the overall health of the South Slough ecosystem, facilities, and neighboring lands.

The fire risk is in part the legacy of an early ruling of the Commission requiring its approval of any plans to cut trees within the Reserve, and in part that of the Reserve's creation on previously logged lands. The interpretive center is located on a graded ridgetop staging area where logs sawn from trees felled on the lower slopes were stacked and loaded onto trucks for hauling.

The legacy forest is consequently one of closely spaced undersized trees, with insufficient meadows, deadfalls, and snags to provide habitat for birds and small mammals. The combination of passive management, dense brush, dry, diseased thickets, and warming climate pose a higher-than-natural wildfire potential, especially where human activity occurs (Robinson, 2009). Fire originating in the South Slough catchment may spread up the slopes to neighboring public and private forest lands, especially if it occurs during the dry summer months when strong northerly winds typically prevail.

Climate change

Climate change is occurring in Oregon and affecting the coastal environment. Changes include warming air temperatures, increasing acidity in nearshore marine waters, increased storminess, and increasing water temperatures. Precipitation and atmospheric weather patterns are changing. Sea level is rising along portions of the Oregon coast. In some localities the change is either offset or exacerbated by uplift or subsidence of the coastal margin. The rising sea will eventually flood estuaries; in fact, Ruggiero *et al.,* reported in Dello and Mote (2010), found that the estimated long term rate of coastal wetland loss is greater for the Pacific coast than any other areas of the U. S.

Sea level rise is already threatening some north coast communities and residents with chronic flooding from increased storminess and extreme waves. Stormi-

ness, and the frequency of extreme waves, are increasing the erosion of shorelines and coastal bluffs. Along the southern Oregon coast uplift is occurring at a rate sufficient to offset sea level rise for now; by mid-century, the rate of sea level rise will outstrip the rate of uplift, and all of the Oregon coast will be at increased risk of inundation from rising seas. (Dello and Mote, 2010.)

Invasive species

Invasions by newly-arriving, exotic, non-native plant species, including terrestrial, freshwater, and marine species, and non-native animals, will continue to pose a threat to the Reserve for the foreseeable future. Species, especially marine plants and animals, are generally migrating from south to north along the Pacific coast, often as unseen passengers on motor vehicles, boats, boat trailers, and other human-mediated vectors. Presence of invasive species may go unnoticed for some time, depending on the extent and coverage of monitoring programs and efforts.

Carbon management

The fate of carbon in vegetated tidal wetlands and the marine environment is one of several emerging issues facing the Reserve. Recent science indicates that salt marshes and sea grasses (and mangroves elsewhere) sequester vast amounts of carbon referred to as coastal blue carbon (Nelleman *et al.,* 2009). These habitat types potentially mitigate from 300 to 900 metric tons of carbon dioxide equivalence annually. Sequestration occurs mostly in the soil, unlike in forests, where carbon storage occurs in standing wood.

It has been estimated that while the extent of vegetated coastal wetlands is only about one or two percent that of total global forest area, coastal wetlands sequester as much as one fifth of the annual emissions from global deforestation and forest degradation (Murray, Pendleton *et al.,* 2011).

Sequestration is an important natural benefit of estuaries to help mitigate climate change. Awareness of the potential benefit of coastal blue carbon provides incentive not only to restore vegetated tidal wetlands, but also to eliminate further diking, draining and conversion of tidal wetlands. When vegetated tidal wetlands are drained, the immense volumes of carbon sequestered in their soils are once more exposed and emitted to the atmosphere (Pendleton, Donato, *et al.,* 2012).

Citations

Dello, K.D. and P.W. Mote, eds. (2010), Legislative Summary, Oregon Climate Assessment Report, College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, Oregon. Available at: www.occri.net/OCAR

Goldfinger, C., C.H. Nelson, A.E. Morey, J.E. Johnson, J.R. Patton, E. Karabanov, J. Gutiérrez-Pastor, A.T. Eriksson, E. Gràcia, G. Dunhill, R.J. Enkin, A. Dallimore, and T. Vallier, 2012. Turbidite event history—Methods and implications for Holocene paleoseismicity of the Cascadia subduction zone: U.S. Geological Survey Professional Paper 1661–F, 170 p. (Available at http://pubs.usgs.gov/pp/pp1661f/).

Kelsey, H.M., A.R. Nelson, E Hemphill-Haley, R.C. Witter. 2005. Tsunami history of an Oregon coastal lake reveals a 4600 yr. record of great earthquakes on the Cascadia subduction zone. GSA Bulletin; July/August 2005; v 117; no. 7/8; p. 1009-1032; doi: 10.1130/B25452.1. Data repository item 2005105.

Nellemen, C., E. Corcoran, C.M. Duarte, L. Valdés, C. De Young, L. Fonseca, and G. Grimsditch (Eds). 2009. Blue Carbon: The Role of Healthy Oceans in Binding Carbon. A Rapid Response Assessment. United Nations Environment Program.

Murray, B.C., L. Pendleton, W.A. Jenkins, and S. Sifleet. 2011. Green Payments for Blue Carbon: Economic Incentives for Protecting Threatened Coastal Habitats. Nicholas Institute Report (Murray et al. 2009).

Oregon Population Growth and Trends. Excerpted in Oregon Coastal Management Program, 2012. Oregon's coastal zone. Accessed online at http://www.oregon.gov/LCD/OCMP/CstZone_Intro.shtml#top, July 28, 2014.

Pendleton L, D.C. Donato, B.C. Murray, S. Crooks, W.A. Jenkins, *et al.* (2012) Estimating Global ''Blue Carbon'' Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems. PLoS ONE 7(9): e43542. doi:10.1371/journal.pone.0043542.

Ruggiero, P., C.A. Brown, P.D. Komar, J.C. Allan, D.A. Reusser, and H. Lee, II, in Oregon Climate Change Research Institute (2010), Oregon Climate Assessment Report, K.D. Dello and P.W. Mote (eds). College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, Oregon. Available at: www.occri.net/OCAR

Sea-Level Rise for the Coasts of California, Oregon and Washington: Past, Present, and Future. 2012. Prepared by the Committee of Sea Level Rise in California, Oregon, and Washington. Board on Earth Sciences and Resources and Ocean Studies Board, Division on Earth and Life Studies. National Research Council, National Academies, Washington, D.C.

Chapter IV

Foundation Programs

Introduction

The South Slough National Estuarine Research Reserve (Reserve) typically addresses management priorities through a series of day-to-day interactions with residents—of both local communities and communities throughout Oregon's coastal zone—involving research and education staff.

Research staff includes scientists engaged in basic and applied research, and technical specialists engaged in various land stewardship and environmental monitoring activities.

Education staff include education program specialists working with elementary, secondary, and high school students; with college and post graduate students, with teachers; with coastal managers and decision makers, and with the public.

Part I—The Reserve System's research and monitoring program

The Reserve System's mission provides that reserves are protected and managed to afford opportunities for long-term research. Research at each reserve is designed to fulfill the Reserve System's goals as defined in the regulations (15 C.F.R Part 921(b)):

> ***Address coastal management issues identified as significant through coordinated estuarine research within the system;***
>
> ***Promote federal, state, public and private use of one or more reserves within the system when such entities conduct estuarine research;***
>
> ***Conduct and coordinate estuarine research within the system, gather and making available information necessary for improved understanding and management of estuarine areas.***

To sustain these system goals, the 2011-2016 Reserve System Strategic Plan outlines research objectives that support the focus areas of climate change, habitat protection, and water quality:

> ***Expand capacity to monitor changes in water quality and quantity, habitat, and biological indicators in response to land use and climate change drivers***

Improve understanding of the effects of climate change and coastal pollution on estuarine and coastal ecology, ecosystem processes, and habitat function.

Characterize coastal watersheds and estuary ecosystems and quantify ecosystem services to support ecosystem-based management of natural and built communities

Increase social science research and use of social information to foster coastal stewards that value and protect estuaries.

The Reserve System's research and monitoring programs provide the scientific basis for addressing coastal management challenges. Reserve research and monitoring activities provide valuable information about estuarine resources to increase understanding and awareness of their importance to a variety of audiences including scientists, resource managers, educators, and the general public.

Reserve System research program

Currently, there is one focused effort to fund estuarine research in the Reserve System. The Science Collaborative, a partnership between NOAA and the University of Michigan, is a program that focuses on integrating science into the management of coastal natural resources. Currently administered through the University of Michigan Water Center, the program integrates and applies the principles of collaborative research, information and technology transfer, graduate education, and adaptive management with the goal of developing and applying science-based tools to detect, prevent, and reverse the impacts of coastal pollution and habitat degradation in a time of climate change.

The program is designed to enhance the Reserve System's ability to support decisions related to coastal resources through collaborative approaches that engage the people who produce science and technology with those who need it. In so doing, the Science Collaborative seeks to make the process of linking science to coastal management decisions, practices, and policies more efficient, timely, and effective, and share best practices and examples for how this can be done.

Reserve System monitoring program

The System-wide Monitoring Program provides standardized data on national estuarine environmental trends while allowing the flexibility to assess coastal management issues of regional or local concern, and is guided by the System-wide Monitoring Program Plan. The principal mission of the monitoring program is to develop quantitative measurements of short-term variability and long-term changes in water

quality, biological systems, and land use and land cover characteristics of estuaries and estuarine ecosystems for the purposes of informing effective coastal zone management. The program is designed to enhance the value and vision of the reserves as a system of national references sites and focuses on three ecosystem characteristics:

Abiotic characteristics

Abiotic measurements are supported by standard protocols, parameters, and approaches that describe the physical environment including weather, water quality, hydrological, and sediment related parameters. The monitoring program currently provides data on water temperature, specific conductivity, percent saturation of dissolved oxygen, pressure, pH, turbidity, salinity, concentration of dissolved oxygen, and pressure corrected water depth.

Meteorological data include air temperature, relative humidity, barometric pressure, wind speed, wind direction, rainfall, and photosynthetically active radiation (PAR). In addition, the program collects monthly nutrient and chlorophyll a samples and monthly diel samples at one SWMP station. Data is Federal Geographical Data Committee compliant and available via the Reserve System Centralized Data Management Office.

Biotic characteristics

As funds are available, reserves are focusing on monitoring habitats and biodiversity.

Watershed and land use classifications

The Reserve System is examining the link between watershed land use and coastal habitat quality by tracking and evaluating changes in coastal habitats and watershed land use/cover. This element is guided by the Reserve System Habitat Mapping and Change Plan. Building on these foundational elements, the Reserve System is developing a network of sentinel sites and the capacity to assess the impact of sea level/lake level changes and inundation on the diverse set of coastal vegetative habitats represented in the system.

Reserves are implementing a suite of activities, as described in the 2012 Reserve System Sentinel Site Guidance Document, to assess the relationship between vegetative communities (marsh and submerged aquatic vegetation) and sea level. Reserves are adding surface elevation tables and monitoring pore water chemistry along vegetation monitoring transects and linking their system-wide monitoring program to a network of specialized spatial infrastructure to allow precise measure-

ment of local sea level and lake level changes and subsequent impacts to key habitats.

The Reserve System is working in partnership with NOAA's National Geodetic Survey and the Center for Operational Oceanographic Products and Services to support the development of sentinel sites.

Research, monitoring and stewardship at South Slough Reserve

The science program includes all research, monitoring and stewardship functions. Research and monitoring is overseen by a research coordinator; stewardship is carried out under the auspices of a stewardship coordinator. The science program staff includes a monitoring programs coordinator, an estuarine monitoring coordinator, a research assistant, GIS staff, and may include part-time or temporary employees as needed to carry out work related to specific, usually grant-funded, projects and tasks.

Science program scope and context

The geographic scope of the science program extends from the Reserve, the South Slough, and the Coos estuary, throughout the Pacific Northwest (e.g. blue carbon) and across the Reserve System (e.g. sentinel site synthesis).

The last management plan was approved in 2006. New information since then includes:

- Water quality analyses show a significant increasing trend in pH over the last 10 years at all SWMP stations, although over the last four years pH has been decreasing.
- Native oyster recruitment is low in South Slough compared to the Coos estuary.
- Research by University of Oregon students and NOAA graduate research fellows has improved the Reserve's understanding of native oyster reproduction, larval movement, recruitment, and feeding capacity in the Coos estuary.
- The Upper Watershed Restoration Action Plan provided new information about the uplands in the Reserve and a foundation for future restoration projects, particularly in the Wasson Creek drainage.
- Some Port Orford cedar trees sampled in the Reserve have shown increased genetic resistance to Port Orford cedar root rot *(P. lateralis)*, compared to trees sampled throughout their native range.
- Port Orford cedars planted in restoration sites show low mortality rates in their first two years of monitoring (2013-2014).

- Through its Coos Estuary Inventory, the Partnership for Coastal Watersheds identified large data gaps for:
  - Eelgrass and bathymetry,
  - Native clams, Dungeness crabs, lamprey, and sturgeon,
  - Sediment composition and contamination, and
  - Water quality (nutrients and pollutants).
- The Reserve has a better understanding of circulation in Coos estuary from the hydrodynamic model created by partners at the University of Oregon and Partnership for Coastal Watersheds.
- With the establishment of a high-precision vertical control network, improved elevation data is available for monitoring projects throughout the Reserve.
- With the assistance of Reserve staff and others, the Oregon Department of Land Conservation and Development drafted estuarine habitat classification maps for the Coos estuary using the Coastal Marine and Ecological Classification Standard (CMECS).
- Data is available on the distribution and density of two non-native snails *(Assiminea parasitologica* and *Myosotella myotis)* in the Coos estuary.
- Vegetation bio-monitoring baseline data is available for sentinel site stations.
- Two introduced species found in the South Slough estuary—the colonial sea squirt *Didemnum vexillum*, a relatively late arrival, and nutria *(Myocastor coypus)*, a long-established, exotic but endemic mammal—have taken on new significance as nuisance species within the Reserve.

Target audiences

Research results and monitoring data are presented and interpreted in various outreach products provided through the Partnership for Coastal Watersheds' Communities Lands and Waterways Data Resource, and the coastal training and education programs. The science program addresses the following audiences:

- Local decision makers, natural resource and land managers, academic research community,
- K-12 students, undergraduate and graduate college students, teachers,
- Sovereign domestic tribal nations in the Coos Bay region and on the Oregon coast,
- Conservation organizations,
- Watershed councils and associations,

- Development entities (e.g., International Port of Coos Bay, South Coast Development Corporation) and commercial firms, and
- Reserve staff, the Reserve System, and NOAA.

The local research community

The local research community consists of a broadly trained group of wetland, estuarine, marine, and forest biologists. Outside research partners may include natural resource managers for the Oregon Department of Fish and Wildlife and the U.S. Fish and Wildlife Service, academic researchers and students at OIMB, applied biological research and social scientists from the University of Oregon, Oregon State University, Oregon Sea Grant, Coos Watershed Association, the Forest Service, the Bureau of Land Management, and private firms and consultants.

Within the context of the priorities described in Chapter 3 are several pressing research questions that the Reserve will address over the next several years:

Climate change

Sentinel Site designation.

The Reserve's strategy to qualify as a Reserve System Sentinel Site pairs the long term water quality and water level data collected at SWMP stations with data quantifying other controlling factors, such as marsh elevation, plant community, vertical accretion, soil salinity, or groundwater level, to help interpret long term changes in marshes and eelgrass beds. This project, enhanced by the coastal blue carbon work planned for the South Slough and Coos estuary (proposal pending), will enable the Reserve to better understand how South Slough marshes will fare, given local forecasts for sea level rise.

Timeline—2015: Next bio-monitoring and sediment dynamics data collection (Hidden Creek marsh priority); **2016:** Digital surveys of water level sensors on SWMP data sondes.

Ridgetop to estuary forest restoration

Wasson Creek restoration. The Reserve manages approximately 4,000 acres of uplands, but no restoration projects have yet been implemented to improve upland habitat. The Reserve's ridgetop to estuary framework for habitat restoration will be applied in the Wasson Creek catchment with individual restoration projects being developed to answer specific questions, including:

- How does upland and riparian composition affect water quality and salmonid

habitat?

- Is it possible to accelerate late successional conditions (e.g., produce patches of large-diameter trees that provide habitat conditions similar to those of old-growth trees) in the upland forest? How can forest habitat be improved for endemic species?

Timeline—2015: restoration planning for Wasson Creek catchment; **2016-2020:** Ridgetop to estuary restoration implemented in Wasson.

Invasive species

Exotic, non-native species both aquatic and terrestrial have the potential to out-compete or otherwise negatively affect native species communities both within the Reserve and on Reserve-managed lands. Establishing an early detection and response system by monitoring and managing non-native species, within and outside of the Reserve, is important to minimize the impacts of invasive species within the Reserve.

Timeline—2016-2018: Implement monitoring protocols for high-priority species; **2018-2020:** Establish base line maps for prioritizing eradication in the Reserve.

Science program capacity

Permanent full-time staff positions include:

- Research Coordinator/Lead Scientist
- Coordinator of Monitoring Programs
- Coordinator of Estuarine Monitoring Programs
- Stewardship Coordinator
- Monitoring Technician

Material resources include:

- Science laboratory, fabrication shop
- Boats, trailers, motors, vehicles (available to all staff)

Oregon Institute of Marine Biology resources (library, boat house auditorium, etc.) are also available to staff. A memorandum of understanding (Appendix L) guides sharing of resources between the institute and the Reserve.

Partners

Science staff frequently work with the following partners and stakeholders to

accomplish mutual goals:

- The University of Oregon and Oregon Institute of Marine Biology, Oregon State University, Portland State University, Southwest Oregon Community College;
- Oregon Departments of Fish and Wildlife, Forestry, State Parks and Recreation, Environmental Quality, Transportation, and the Department of Land Conservation and Development and the Oregon Coastal Program;
- Coos County, Curry County, the Partnership for Coastal Watersheds, the Coquille Indian Tribe, the Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians; the Confederated Tribes of Siletz Indians;
- The Oregon Watershed Enhancement Board, Coos Watershed Association, Coquille Watershed Association; Gorse Action Group;
- Forest Service, U.S. Fish and Wildlife Service, Bureau of Land Management, U.S. Coast Guard, and
- Other NOAA offices, agencies and affiliates as needed.

System-wide initiatives

Science staff implement SWMP, the Science Collaborative, and NOAA's Climate Change Initiative. Two full-time staff positions are dedicated to implementing SWMP and funded through NOAA's Operations Award. Funding for equipment and supplies comes from non-federal sources such as the Northwest Association of Networked Ocean Observing Stations.

With funding from the Science Collaborative, and the assistance of the Partnership for Coastal Watersheds, the Coquille Indian Tribe, and the Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians, the Reserve expanded its water quality monitoring program by adding four stations to the upper reaches of the Coos estuary. The data collected at these sites will be made available through the Centralized Data Management Office website in 2016.

Habitat Mapping

Several projects to be implemented over the next five years will contribute information to a habitat map for the Reserve. For example, eelgrass mapping and bathymetry data will contribute to improved habitat classification for the Coos estuary. More information will be added to upland maps, including inventories of trees and species in the Reserve as data becomes available during restoration planning. Upcoming invasive species surveys (2015-2016) will inform mapping efforts as well.

Science Collaborative Support

Proposals have been submitted for two projects (one more will be submitted by March 26th). In cooperation with the Coos Estuary Inventory Project subcommittee of the Partnership for Coastal Watersheds, staff have developed two proposals to support the next phases in the growth of the partnership.

The first will facilitate the revision of Coos County's Coos Bay Estuary Management Plan by addressing specific data gaps, highlighted by the Coos Estuary Inventory, and needed to revise the estuary plan. The second will provide support for improving online access and usefulness of the inventory for local decision makers, and others, as well as the outreach needed to inform those audiences about the Inventory and its potential use in decision-making.

A third proposal was submitted by the Pacific Northwest Coastal Blue Carbon Working Group Feb 26, 2015, for a three-year investigation of carbon stocks, carbon sequestration rates, and greenhouse gas emissions in tidal marshes and former tidal marshes in the Coos estuary.

Additional funding proposals are likely to come from the working group's social and economic science researchers in Fall, 2015. The working group seeks to provide the quantitative basis for understanding the policy implications and opportunities associated with an improved understanding of coastal blue carbon in the context of the full range of ecosystem services (e.g., for climate change mitigation and adaptation strategies), the development of carbon financing mechanisms to help support coastal resource management, and the implications of carbon sequestration management for private landowners and state governments.

Climate Change Initiative

Staff collect bio-monitoring and sediment dynamics data at the primary sentinel site station (at Hidden Creek Marsh), biennially.

If funded, the blue carbon research described above will help implement additional monitoring at sentinel site stations for three years. (Long-term support for monitoring the Reserve's full complement of sentinel site stations remains uncertain.)

Regarding adaptation planning and ecological resilience, the Coos Estuary Inventory that was developed for the Partnership for Coastal Watersheds provides the data, status, and trends foundation for community-driven, climate change vulnerability assessments, adaptation planning and the development of greenhouse gas mitigation strategies.

Local, regional monitoring and research

The science program responds to the needs of the audiences it serves. Some audiences are oriented regionally, some locally, and others nationally.

The Reserve relies on partnerships as appropriate venues to explore specific research questions. Permanent staff are directly involved in implementing ongoing local monitoring projects (e.g. SeagrassNet, SWMP, Port Orford cedar resistance trials). Shorter-term research and monitoring projects are generally grant-funded and may involve the assistance of grant-funded temporary staff and interns, or volunteers.

Science staff work with partners to implement projects in the Reserve, throughout the Coos estuary, and regionally (e.g. through the Pacific Northwest Coastal Blue Carbon Working Group, the Pacific Marine-Estuarine Fish Habitat Partnership (PMEP), or the Gorse Action Group).

Finally, the Reserve pursues grant opportunities to support graduate and undergraduate student research projects.

The science team provides technical and training support to the Reserve's education and coastal training programs in several ways. Information gained through research, monitoring, and experimental habitat restoration is regularly integrated with education programs. Science staff often present to classes, advise students, and lead field trips. The results of research are the major source of information and guidance for decision-making recipients of coastal training and technical assistance.

For example, research into the habitat needs of fish and shellfish of the Coos estuary contributed to the development of a West Coast-wide juvenile habitat inventory by PMEP, a primary channel through which the coastal training program provides information and decision-making assistance to restoration scientists and practitioners throughout the lower Columbian biogeographic region.

Program integration

The research priorities outlined in this plan came from multi-sector discussions of important projects needed to meet the Reserve's research, education, and coastal training program needs. Staff regularly seek opportunities to integrate their activities to be mutually reinforcing (e.g., a proposal to fund curriculum development and teacher-training workshops using data about fish collected in Reserve-sponsored fish research projects). Education and coastal training staff, as well as other employees, help shape the science program's priorities by keeping science staff informed of education and training needs, and of new developments on the Reserve or in the local community that may affect management.

Performance and evaluation

The science program, like all of the Reserve's programs and operations, are reviewed periodically for consistency with NOAA's operating guidelines (Section 312 reviews). Staff receive annual performance reviews and evaluations. Staff report progress and news three time yearly to the Reserve Management Commission. Grant-based work is contingent on reports documenting successful outcomes of research proposals. Last, but not least, staff regularly evaluate new projects to determine whether they fit the Reserve's, the Reserve System's, and NOAA's priorities, and meet the test of the Reserve's core principles (see Chapter 3).

Major intended outcomes

During the next several years the science program hopes to achieve the following major milestones:

- Improved management of the Coos estuary though an updated Coos Bay Estuary Management Plan (funding proposal submitted to the Science Collaborative)
- Updated information on fish assemblages and habitat use in South Slough and Coos Bay, with emphasis on follow-up monitoring of fish use at restoration sites in the Reserve (proposal submitted to PMEP)
- Restoration of spawning habitat for coho salmon in Winchester Creek (proposal submitted to Oregon Watershed Enhancement Board)
- Implementation of a ridgetop to estuary restoration project for the Wasson Creek drainage (proposal submitted to OWEB)
- Better understanding of carbon sequestration rates in Coos estuary and South Slough and further development of the Pacific Northwest Blue Carbon Working Group (funding proposal submitted to Science Collaborative)
- Improved understanding of aquatic invasive species through the implementation of an early detection plankton monitoring technique (proposal submitted to Oregon Sea Grant)
- Better understanding of estuary circulation, including sediment transport, by further developing the Coos estuary hydrodynamic model, to provide information on the potential effects of various conservation, development, or land use planning proposals under consideration, as well as the potential local effects of climate change (funding proposal submitted Science Collaborative)
- Improved mapping, modeling, and control of invasive species, through partnerships
- Determine the sustainability of tidal wetlands in the Coos estuary in the face

of sea level rise.

- Continue to inform genetic research of Port Orford cedar resistance to P. lateralis via the planting trials in the Reserve (joint endeavor with the Forest Service's Dorena Genetic Resource Center).

To guide future work, the following needs and priorities have been identified by stakeholders

- Fill data gaps identified by Partnership for Coastal Watersheds
- Facilitate update of the Coos Bay Estuary Management Plan and estuary habitat classification maps (Coos County, Oregon Coastal Program)
- Early detection of invasive species (Partnership for Coastal Watersheds, Oregon Sea Grant, Oregon Department of Fish and Wildlife, Oregon Department of Agriculture, Portland State University)
- Continued monitoring of Port Orford cedar planting plots (Forest Service)
- Restoration and monitoring of coho spawning sites in Winchester Creek (Oregon Department of Fish and Wildlife, Coos County)
- Mapping and monitoring of invasive plant species (Gorse Action Group)
- Water quality of South Slough and Coos estuary (Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians, the Coquille Indian Tribe, NOAA, the Reserve System)
- Bio-monitoring at sentinel site stations (NOAA)
- Facilitate use of the Coos estuary hydrodynamic model to better understand:
  - potential effects of various conservation, development, or land use planning proposals under consideration;
  - potential local effects of climate change, help coastal decision makers develop policies and practices that support adaptive responses to climate change;
  - estimate the carbon benefits of preserving and restoring estuarine wetlands in the Pacific Northwest;
- coastal resource managers' needs for data to incorporate coastal blue carbon and other ecological services provided by estuaries with coastal resource management decisions
- standards for carbon finance mechanisms that support tidal wetland restoration and conservation,
- the sustainability of tidal wetlands in the Coos estuary in the face of sea level rise

Project capacity for many of these new projects will be determined largely by the success of funding proposals (currently pending). Expanded involvement of interns and student researchers will at times provide additional temporary capacity for science and monitoring, but grants will continue to be instrumental for funding longer term, multi-dimensional projects.

Barriers to developing the full capacity needed by the research agenda includelack of funding and staff for new project, and limited staff available to take on work related to existing, unfunded system-wide projects (e.g., sentinel site implementation, habitat mapping, and other stewardship needs).

To some extent those limitations can be offset through resources provided by partners, collaborative relationships with others, and working with education and training staff to identify cross-disciplinary funding opportunities that involve graduate and undergraduate student in both science and education.

Research-related Objectives and Actions

See Chapter 3 for objectives.

See Chapter 3 for actions.

Part II—Education program

The National Estuarine Research Reserve System's mission includes an emphasis on education, interpretation, and outreach. Education at each reserve is designed to fulfill the Reserve System goals as defined in the regulations (15 C.F.R Part 921(b)):

- Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
- Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.
- To sustain these system goals, the 2011-2016 Reserve System Strategic Plan outlines education objectives that support the focus areas of climate change, habitat protection and water quality:
- Enhance the capacity and skills of teachers and students to understand and use Reserve System data and information for inquiry-based learning; and
- Increase estuary literacy and promote active stewardship among public audiences through the development and delivery of tools and programs addressing climate change, habitat protection, and water quality.

The Reserve System provides a vehicle to increase understanding and awareness of estuarine systems and improve decision-making among key audiences to promote stewardship of the nation's coastal resources. Education and interpretation incorporate science-based content into a range of programs and methodologies that are systematically tailored to key audiences around priority coastal resource issues.

Reserves conduct formal and informal education activities, as well as outreach activities that target culturally diverse audiences of educators and students, environmental professionals, resource users and the general public. Education and public programs, interpretive exhibits and community outreach programs integrate elements of Reserve System science, research and monitoring activities and ensure a systematic, multi-faceted, and locally focused approach to fostering stewardship.

The reserves system is committed to preparing tomorrow's future leaders with the knowledge and understanding of our nation's oceans and coasts to be responsible stewards. To fulfill this commitment, the Reserve System has created the K-12 Estuarine Education Program (KEEP) to increase the estuary literacy of students, teachers and the general public. The KEEP Program helps students and teachers learn about essential coastal and estuarine concepts, develop data literacy skills and strengthen their critical thinking, team building, and problem solving skills. K-12 and professional development programs for teachers include the use of established coastal and estuarine science curricula aligned with state and national science education standards and frequently involves both on-site and in-school follow-up activity.

Community education and outreach is another priority for the Reserve System. Community education programs foster behavioral change to promote resource conservation. These programs work with audiences whose choices directly impact the integrity of our estuaries and their associated watersheds.

The education program staff includes an education coordinator, a coastal training coordinator, an education program specialist, a public involvement coordinator, and various temporary workers, interns, and volunteers. Education activities include formal and informal education, public involvement and volunteer coordination, public programs and events, and training and technical assistance for coastal managers and decision makers.

Part II addresses education in general. Part III addresses coastal training.

Education Program Context

Geographic scope

The education program draws participation from schools across Oregon and visitors from the West Coast, primarily, although tourists from throughout the U.S. include the Reserve on their itineraries. Specialized classes and make occasional, customized visits; for example, students of the Williams-Mystic Maritime Studies Program, in Mystic, Conn., annually make a field trip to the Coos estuary.

Nevertheless, the primary audience for the Reserve's educational efforts is within a six county area of southwestern Oregon, as was defined by the Oregon Coastal Education Market Analysis and Needs Assessment Study (Gaskill, 2012).

Larger cities included in this area are Coos Bay and North Bend, Eugene and Springfield, Medford and Ashland, Grants Pass, and Roseburg. Distance learning methodologies and partnerships have significantly extended the reach of the Reserve's education program, providing increased visibility and expanded opportunities to reach new audiences.

New information

Market Analysis and Needs Assessment

Completion of the Education Program Market Analysis and Needs Assessment, in 2012, provides the latest available guidance for program development and expansion. The analysis and assessment, which was conducted by Reserve staff with assistance from NOAA, the Bureau of Land Management in Coos Bay, and the Coos Watershed Association, advances staff's understanding of the full spectrum of coastal and estuarine education programs and courses offered by a range of providers (the market analysis) and the needs of audiences (the needs assessment).

During the fall of 2011 and the spring of 2012, South Slough National Estuarine Research Reserve worked in partnership with the US Bureau of Land Management, Coos Bay District and the Coos Watershed Association to conduct two studies in Oregon. The first study, a market analysis, was designed to better understand the landscape of coastal education providers in Oregon for K-12 audiences. The second study, a needs assessment of six coastal counties in southern Oregon and the southern Willamette valley, attempted to advance our knowledge of the curricular and professional development needs of K-12 educators in this region.

The term coastal education best describes the efforts of a number of key partners to adopt a holistic view of important concepts and principals involved in understanding various relationships between watersheds, estuaries, the ocean and

Earth's climate. Through this work, the Reserve acknowledges the importance of reaching beyond coastal communities to better understand and, in turn, reach the major population centers of the state with services and products supported by scientific research and best practices in the field of education.

Target audience

The education program serves a variety of audiences. The type of audience determines the nature of the content, methods, and location for instruction.

Audiences for professional development include teachers, both formal (e.g., K-12 professional and student teachers) and informal educators (e.g., volunteer instructors; interpretive aides) participating in various teacher-training and volunteer skill-building activities. The scope of recruitment for training involves teachers in the Oregon coastal zone, the Willamette Valley and Portland metropolitan area, southern Oregon and central Oregon. Through partnerships with institutions in these communities, including Portland State University, the High Desert Museum (Bend), the Hatfield Marine Science Center and the Oregon Coast Aquarium (Newport), the Reserve has been able to expand its professional development opportunities for educators.

Informal education is focused mostly on visitors and local residents, at festivals, in campgrounds, and at other community events such as the weekly Farmers' Market that occurs in Coos Bay during summers. Staff and volunteers make use of temporary exhibits and portable demonstrations to provide lessons about sustainable land use, water quality protection, and climate. These public venues also offer a means to increase public involvement by recruiting volunteers or interns.

The audience that benefits the most from public interpretation and informal learning activities is largely self-selecting, and local. Thus the primary driver of informal education and outreach is the geographic range of the audience, which is seasonal: Increasing during late spring and summer with the end of school and arrival of tourists, and declining in again in fall.

While the Reserve provides college-level instruction and continuing professional education, the primary emphasis for formal education is the Kindergarten-to-12th grade Estuary Education Program, known as KEEP. Its audience includes elementary and middle school students from Grades 3 through 12, and comprises roughly 70 percent of the 6,000 participants annually.

Once again, geographic proximity is a defining characteristic limiting participation in this program. The majority of students come from Coos County, most of the remaining are from the six county area of southwest Oregon noted in the market analysis.

Oregon State University and the Oregon Natural Resources Education Program

provide additional access to teacher professional development opportunities. In addition, partnerships with new learning centers, or hubs, focused on science, technology, engineering, and math education (STEM) have further advanced outreach to teachers in these areas of the state. The scope of audience for training, while broad, was identified through collaborative planning with a network of partner institutions identified as the Oregon Coast Education Program and supported through grant funding since 2009.

Public outreach efforts are primarily focused on visitors, at the interpretive center, and in the local community. Local festivals, campground presentations, and other events—such as the weekly Farmers' Market held spring and summer in Coos Bay—afford opportunities for staff and volunteers to erect temporary exhibits and science demonstrations as an information forum and market for interpretive and community education programming. These venues also serve to attract new volunteers and potential interns.

Priority education issues

The education program has capacity and strategies to address all three priority issues identified by Reserve staff. The Reserve incorporates the following key themes into education and training activities so that participants will gain an improved understanding of the research occurring at the Reserve and support improved stewardship of estuarine resources.

Impacts of global climate change, such as sea level rise and the spread of invasive species, or related phenomena such as ocean acidification, may pose significant threats to the stability and integrity of the Reserve's lands and waters. Through education and training, residents of coastal communities will be better able to increase the resilience of estuaries and shore lands to these and other climate-related effects.

Estuarine ecology encompasses a complex system of relationships between living and non-living elements connecting the watershed to the ocean through tidal marshes, channels, tide flats, and rocky shores. The role of water needs to be called out more explicitly.

Habitat protection and restoration within the watershed, estuary, and ocean help to support a sustainable estuarine ecosystem.

Study of land and water use, habitat change, and water quality support improved understanding of the estuarine ecosystem and the activities necessary to restore these functions. Controlling and monitoring invasive species is a part of habitat protection.

Education program capacity

The interpretive center is a base for workshops, field trips, lectures, classroom

and laboratory activities and distance learning. The Reserve partners with institutions locally and regionally to provide professional development and training using appropriate facilities, including Southwestern Oregon Community College, both in Coos Bay and Gold Beach (Curry County), and OIMB. The Reserve partners with a variety of institutions in the local community and around the state to provide professional development and training using appropriate facilities on a temporary basis, including Southwestern Oregon Community College campuses in Coos Bay and Gold Beach, and OIMB.

Partnerships

In implementing formal education programs for K-12 audiences, the Reserve works locally with schools and districts in Coos County primarily and, to a lesser degree, in Curry, Douglas, Lane, Jackson and Josephine counties. Partner institutions in this effort include OIMB, for shared facility use, and the locations of the schools in some cases.

More broadly, through partnerships with institutions in communities in this region, including Portland State University (Portland), the Oregon High Desert Museum (Bend), the Hatfield Marine Science Center and the Oregon Coast Aquarium (Newport), the Reserve has been able to expand the reach of professional development opportunities for teachers. This network provides access to facilities, personnel, and training resources in support of teacher professional development activities.

Collaboration with the Oregon Natural Resources Education Program at Oregon State University, provides staff with additional opportunities to offer professional development for teachers.

In addition, learning centers focused on science, technology, engineering and math (i.e., STEM hubs) offer additional opportunities to train teachers in regions of Oregon where they are established. While this audience is broadly defined, it was identified by the Oregon Coast Education Program and has been supported by grants since 2009.

South Slough's education program works with the Oregon Environmental Literacy Council to advance an environmental literacy plan adopted by the state in 2010. The education program coordinator is a member of the council, and the education specialist assists the council in work group tasks.

Education staff actively participate in, and are leaders of, the Northwest Aquatic and Marine Educators, a regional guild of the National Marine Education Association that includes education institutions and educators from Alaska, British Columbia, Washington, and Oregon. Participation and leadership in engagement with these networks, and other broader impact activities, increase the stature, visibility, and

effectiveness of the education program throughout the Pacific Northwest.

Program delivery

The education program uses information products developed by the Reserve System, such as SWMP data, to develop teaching materials for students and, more expansively, through teacher training activities, products and ideas modified by teachers to meet specific classroom needs. Estuaries 101 curriculum and activities are also used, to a lesser degree, in education programming, principally because a substitute curriculum, one that has been developed and used successfully to establish meaningful, local connections between students, the Coos estuary and the Reserve, is available.

In support of national products, elements of the local curricula are designed to work with products available through NOAA (e.g., the www.estuaries.noaa.gov website; the Estuary Live video library collection, the SWMP data graphing tool, and other resources).

Recent work with the Waquoit Bay Reserve, with funding provided by the Science Collaborative, developed the Bringing Wetlands to Market curriculum for teaching climate change, and offered a training workshop to focus on research related to carbon sequestration in coastal marshes. This type of workshop and follow up support of teachers and students, when sufficient funding support is available, provides the best opportunity to implement a national program such as the Teachers on the Estuary component of KEEP.

This example exemplifies the link to the Climate Change Initiative and provides a forum for discussing and sharing, in a meaningful way, information about the resiliency of coastal communities to the effects of climate change.

During the period covered by this plan, greater emphasis will be given to the use of national products, such as the Bringing Wetlands to Market curriculum, when relevant. The results of the education market analysis and needs assessment indicate a strong level of interest in grade level-appropriate content and curricula related to coastal science emerging from the Reserve System. The capacity to develop new curricula, or revise existing curricula to integrate new science and data, is limited.

Resources to advance the national dimension of education programs such as the Teachers on the Estuary have been fully supported by non-federal national and state grants. While the NOAA's B-WET (Bay Watershed Education and Training) program has played a substantial part in the advance of this work at South Slough, these funds are competitive year to year and do not provide a long-term, permanent footing for this successful program.

A stable, annual, dedicated source of funding within the Reserve System budget is necessary to sustain any meaningful effort to implement system-wide education

programs.

Teacher Professional Development

Establishment of a substantial, professional, teacher development program will be a major focus of this planning period.

Significant progress on the foundation for such a program has been accomplished through the work of the Oregon Coast Education Program in collaboration with the Oregon Natural Resources Education Program. Through Teachers on the Estuary, the Reserve will seek funding and continue to foster partnerships with institutions interested in providing coastal and climate change related education, and advancing key elements of the Oregon Environmental Literacy Plan. Additionally, an emphasis on STEM education in Oregon has afforded ample opportunity for partnerships to advance the mission and goals of the education program.

Methods for this effort will include teacher professional development workshops hosted at the reserve and at partner sites around the state, support of educators engaging students in best practices related to field and classroom-based study, and provision of access to relevant curriculum and scientific data, research, scientists, and technology.

Field study and curricula development- Field studies offered by the Reserve occur both at the interpretive center and along the shoreline of the estuary in Charleston. The acquisition of Indian Point by State Lands affords new opportunities to modify the education program's approach, and define new techniques and methods for providing meaningful experiences with estuary shorelands and habitat. Paddle access at Indian Point, and the potential to engage students more directly in stewardship (e.g., invasive plant removal) and learn about important habitat types, promise good potential for designing new interpretive programs and messages.

As a part of the overall education program's activities, curricula review is needed to establish consistency with NOAA's Next Generation science standards, and revise content. The curriculum currently used by the Reserve includes a collection of activities loosely designed to meet the needs of 3rd grade audiences; these activities have not been subjected to a comprehensive curriculum design process. Additionally, another curriculum developed by NOAA and used to some extent at the Reserve, Teaching Investigation and Discovery through Estuary Study (TIDES) needs to be updated and correlated with current science standards; so does the foundation Estuary Study Program including the In Search of the Treasures of South Slough curriculum.

Distance education

The Reserve continues to explores a variety of methods for providing education

at a distance. Classes and teachers have participated in various types of distance learning since the Reserve's initial involvement with the Estuary Live program in 2002. More recent efforts have included live web-based programs for K-12 classes; webinars for teachers, and streaming broadcasts of interpretive programs such as Creature Feature Live, which are recorded and made available through a streaming channel.

This type of program development is a valuable means of reaching a broad audience of students, educators, and other participants to provide introductory and advanced content related to estuaries and their watersheds. Advances in technology have brought costs per production to feasible levels.

Continued development in this area will depend upon the provision of improved high-speed Internet access at the interpretive center. While this is not the only constraint, the opportunities afforded by advancements in broadband access will substantially expand the potential audience for Internet-based learning.

Education Program Management System

The methods used to manage the data and program registration information, payments, and other education program data are outdated and confusing. On-line access to this information ranges from limited to non-existent, and does not facilitate efficient preparation of performance reports and success stories.

The Reserve will develop an education program management system that will include a comprehensive framework of program descriptions and designs, registration forms and evaluation tools, integrated with on-line access. Preliminary steps have already been taken to develop the system, based on models of systems in place at other reserves.

Cross-sector integration

Education staff and volunteers, and the activities they typically lead, are the primary tools for sharing the Reserve's science with students, teachers, and other program participants. Additionally science, training, and education staff join forces to represent the Reserve at community festivals and other public events. Volunteers at the Reserve provide a substantial service by helping to interpret or demonstrate the results of the Reserve's science projects. Finally, education staff participate, when needed, in assisting science staff with research and monitoring activities.

In turn, science staff working directly on research, monitoring, and stewardship activities occasionally teach classes, present at workshops or lead field trips for students, teachers, community members or decision makers. Science, education and training staff also collaborative to develop funding proposals that include both scientific and educational objectives. During the coming planning period, this approach

to joint proposal development will become standard practice.

Delivering results

The capacity to meet the Reserve's commitments to formal education, informal learning, interpretation and training depends on the having sufficient staff, funding, and materials to meet the needs of the target audiences, including providing learning facilities and operational support sufficient to maintain the current level of productivity and outcomes at levels consistent with past planning periods. The education program will seek opportunities to build capacity through recruitment of volunteers, efficient operation of fund-based programming, and solicitation of additional grant funding to enhance delivery.

Education program results are shared frequently with local, state, and regional audiences through professional conferences and directly upon request with partners. Presentations highlight tools, curriculum, resources, and pedagogy. Professional sharing is facilitated by the various networks that the reserve works with including the Northwest Association of Marine Educators, the Oregon Education Literacy Plan, and the Oregon Coast Education Plan.

Results are regularly documented for the governing South Slough Management Commission in thrice-annual reports including periodic data summaries and narrative describing education program activities. Occasional presentations are provided to the commission detailing specific aspects of the education program including status updates on special projects, documentation of changes over time in education techniques, and review of planning studies such as needs assessment and market analysis results.

Further documentation of results is included in periodic grant related reports for specific projects funded through external sources. The level of documentation of results for projects such as the Oregon Coast Education Program provides substantial benefit to the overall management of South Slough's education program and has been used by partner institutions to inform their own program development. This is a desirable outcome and resources to provide this level of documentation will be sought for future projects.

Performance evaluation

The Reserve has offered a diverse menu of education programs for a wide variety of audiences since 1984. Current evaluation methods for education are limited. Measures of audience impacts are varied and lack cohesiveness. Without appropriate evaluation tools and a strategy to employ these tools and assess the results, the impact of the various elements of the education program are not well documented.

Currently evaluation includes documentation of basic performance indicators

including number of participants, duration of programs, duration of preparatory effort, content defined by learning objectives, and post program anecdotal evidence provided by instructors. A limited number of post program evaluation surveys are provided for specific types of programs.

The most comprehensively evaluated aspect of education programming is the teacher training associated with the Oregon Coast Education Program. These activities are evaluated by design with tools and techniques informed by a professional, independent evaluator. Evidence and substantial documentation of outcome achievement is available through summary reports, provided over the course of the project's evolution, from 2009 to present.

The Reserve needs to develop a comprehensive education evaluation strategy, including identifying of appropriate evaluation tools, incorporated with an overall strategy for measuring effectiveness. Specifically, staff needs to understand the impact of two elements of the education program: the formal K-12 student program (KEEP) and public interpretation. Multiple challenges exist in building or selecting an appropriate set of evaluation tools that will consistently yield meaningful results. The value of the wide variety of education programming that is available from the Reserve is lessened, to the degree that that programming lacks consistency in meaningful objectives.

A significant body of quantitative data is available for this task. Program designs, including specific learning objectives, exist for most programs. However, current staff lacks capacity to review and synthesize this data in a comprehensive data base that can be used to inform the development of an evaluation strategy. Support for this work has been sought through the NOAA Hollings Scholar program. While the funding for this scholarship has been awarded, and qualified applicants have been sought for several years, the Reserve has failed to attract a qualified candidate.

During the next five years, the Reserve will reconsider its strategy for accomplishing this work, perhaps using funding provided through one of Oregon's universities.

Major impacts or outcomes

The impacts or outcomes of education activities typically relate to the particular audience and method of interaction (e.g., training), where the introduction of content and teaching materials is serves a specific purpose, that is, to inform educational practice. The following outcomes reflect the broad dichotomy of formal and informal audiences and are labeled to assist with clarity of purpose.

- Formal: Coastal and estuary education experiences guided by South Slough's key education themes and issues are integrated with teaching in schools reflecting best practices in field-based education.

- Formal: Teachers have access to and use the tools, support, training and resources necessary to incorporate watershed and coastal education experiences into their curriculum to meet educational goals.
- Formal and informal: The frequency and quality of coastal and estuary education for teachers, students, and program participants is increased within the focal area in southwestern Oregon and is informed by NERRS science, data products, curriculum, and tools.

Behavior change may also be specifically characterized by the particular program, method, or activity conducted and therefore measurement of the change depends upon the specific outcome and the anticipated actions. In this case however, formal and informal audience distinctions are less important since the context of estuary and coastal educational experiences is the primary defining feature. In other words, the understanding, valuation, and actions of protecting, restoring and maintaining estuaries and their habitats is intrinsically important regardless of the specific background or setting within which the educational activities take place and the characterization of the audience. With this perspective, the following changes in behavior have been identified as desirable potential achievements that may be measured through pre and post program assessments or other similar means of evaluation.

Education program participants exhibit greater understanding and appreciation for estuaries and coastal environments and the values these natural systems provide.

Education program participants participate in actions to protect, restore, and maintain estuaries and coastal environments.

Future Needs and Opportunities

Needs identified via assessment or by local stakeholders

The most substantial efforts to assess stakeholder needs are encompassed by the market analysis and needs assessment. This research provided a snapshot of the estuary education offered by providers throughout the state, and the needs of k-12 educators within a six-county area of southwestern Oregon.

Primary providers of estuary and coastal education in Oregon are limited to a fairly small number of informal science education institutions; most are affiliated in some way with a university, non-profit organization, or government. Within this group, the topics of estuarine biology and ecology, climate change and sea level rise, conservation and restoration, human interaction with nature, sustainable practices, and careers in science, were all identified as needing more

attention in terms of educational programs offered.

Stewardship, coastal cultural heritage, invasive species, water quality, and marine/freshwater pollution were also ranked highly. These topics represent a great deal of potential for the Reserve to capitalize on existing and new partnerships in the practice of estuarine and coastal education.

Within the k-12 teaching community in the six-county focus area, the analysis identified key needs including age-appropriate curriculum development and background materials, teacher professional development, access to sampling equipment, and funding to support field experiences. The need to increase awareness of the Reserve's education program and resources offered by the Reserve System was also clearly expressed.

Demographics of the respondents conveyed some valuable information as well; nearly 50 percent were located in the most heavily populated part of the focus area, which did not include the communities typically served by the Reserve's education program. Additionally, the majority of the respondents have been teaching for more than a decade, thereby representing the potential to inform a skilled and seasoned workforce with new information, techniques, and tools addressing expressed needs.

See Appendix S: The Oregon Coastal Education Market Analysis and Needs Assessment Study (December 2012).

Program needs and projected capacity

The capacity of the education program—beyond the support provided by NOAA for operations, and limited funding from State Lands—is largely determined by supplemental grant funding, success with volunteer recruitment and training, and assistance of partner institutions with missions and goals similar to the Reserve's. The demand for education continues to grow as the staff seeks to build awareness of the Reserve throughout the state and the biogeographic region. In particular, seasonal program demand during spring, summer, and fall regularly outstrips the capacity of the Reserve to meet all program requests.

In order to address the expressed needs of teachers, emphasis has been placed on providing teachers with professional development activities. This work is undertaken primarily through partnerships and through the leadership of staff in developing successful funding proposals and managing projects. While the direct consequence of this approach is an increase in the number of formal educators using the educational resources provided, these activities also contribute to an increase in demand for staff and volunteers to lead field trips and learning experiences for students as well.

The Reserve will continue to emphasize teacher training and alignment with the TOTE and KEEP to broaden the impact of educational resources and address the opportunities identified in the needs assessment. In particular, the Reserve will target recruitment efforts for teacher training workshops within the six counties of southwestern Oregon.

Projected capacity to meet this demand is dependent on available budget. The success of raising non-federal funds through grants, fees for teacher training, and collaboration with partner institutions is a critical determining factor in the continued success of this shift in program focus.

Regarding informal education, successful recruitment and training of volunteers is the most likely method of enhancing capacity to do work. Development of programs supported by fees and administered by the Friends of South Slough, Inc., has proven an effective means of establishing programs such as the South Slough Summer Science Camps. This pathway also affords opportunities to augment education staff with seasonal, temporary positions.

Limitations and opportunities

The geographic distance from major metropolitan areas has been a challenge for the education program. Schools and potential program participants must make a substantial commitment of time and resources to visit the Reserve. This barrier has been exacerbated in recent years due to poor economic conditions in the state and the nation which have negatively impacted school budgets and affected travel trends.

The resulting declines in school and program participation have been offset somewhat by a shift in approach that focuses more heavily on partnerships with other coastal education providers and training on the use of other estuaries in Oregon as teaching locations. This opportunity to regionalize the understanding of estuaries and their watersheds of the Pacific Northwest is consistent with the Reserve's mission, and reduces the emphasis on classroom visits to the Reserve.

The limitation of staff capacity is not insignificant, as the demand for programs increases, and the opportunities to advance the Reserve's mission—through meaningful, high quality, first hand experiences with estuaries—is bounded by available personnel and resources. Opportunities to further expand the education staff through partnership with programs such as AmeriCorps, internships, and trained volunteers must be considered as only a temporary means of advancing the overall effort.

Grant funded opportunities are another temporary means of advancing the program's goals, while providing an important test bed for ideas, techniques, and

development of new approaches and partnerships. However, a more realistic long-term approach will involve securing permanent financial resources to fund staff positions dedicated to areas with growth potential, such as teacher professional development, and service in support of formal education field and classroom experiences for students.

Education Related Objectives and Actions

See Chapter 3 for objectives.

See Chapter 3 for actions.

Part III—Coastal training program

The National Estuarine Research Reserve System's mission includes an emphasis on education and interpretation. The Reserve System recognizes it has a responsibility to educate coastal decision makers and supports the Reserve System goals, as defined in the regulations (15 C.F.R Part 921(b)), through the Coastal Training Program:

Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;

Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.

To sustain these System goals, the 2011-2016 Reserve System Strategic Plan outlines coastal training objectives that support the focus areas of climate change, habitat protection and water quality:

- Increase estuary literacy and promote active stewardship among public audiences through the development and delivery of tools and programs addressing climate change, habitat protection, and water quality.
- Improve the capacity and skills of coastal decision makers to use and apply science-based information in decisions that affect estuaries and coastal watersheds.

The Coastal Training Program provides up-to-date scientific information and skill-building opportunities to coastal decision-makers responsible for making decisions affecting coastal resources. Through this program, reserves ensure that coast-

al decision makers have the knowledge and tools they need to address local critical resource management issues.

Coastal decision makers are defined as individuals whose duties include making decisions that affect the coast and its resources. The target decision maker groups vary according to reserve priorities, but generally include groups such as local elected or appointed officials, managers of both public and private lands, natural resource managers, coastal and community planners, and coastal business owners and operators. They may also include groups such as farmers, watershed councils, professional associations, recreation enthusiasts, researchers, and more.

Reserves are uniquely positioned to deliver of pertinent information to local and regional decision-makers given their place-based nature. Coastal Training Program coordinators know the local people, places, and science are able to skillfully convene training participants and experts to address coastal management issues. Coastal Training Programs are built upon solid and strategic program documents, including an analysis of the training market and assessment of audience needs. Coordinators then work with the results to identify how their program can best address local and Reserve System priority issues.

Partnerships are integral to the success of the program. Reserves work closely with state coastal management programs, Sea Grant Programs, NOAA Coastal Services Center and a host of local partners in determining key coastal resource issues, target audiences, and expertise to deliver relevant and accessible programs.

Coastal training at South Slough

Training audience

The audience for coastal training includes restoration scientists and organizations, partnerships, associations, and agencies that plan, support, implement or monitor habitat restoration projects, including: planners and floodplain managers; sovereign domestic tribal nations, watershed councils and associations, communities and collaborative partnerships engaged in such work.

The geographic scope of coastal training encompasses the Coos Bay area and the lower Columbian biogeographic region; the coastal zones of Washington, Oregon, and California served by the Pacific Marine-Estuarine Fish Habitat Partnership or the Pacific Northwest Coastal Blue Carbon Working Group. Coastal training's geographic scope extends, in collaboration with other research reserves, throughout the U.S. to address topics of national and regional importance for coastal management.

New issues and information

Staff have identified several new issues that will be addressed in coastal training:

Estuary master planning

Oregon's coastal counties are being encouraged to revise their locally-adopted estuary management plans, which have been in place since the late 1970s or early 1980s. These plans were approved at a time when decision-makers were forecasting long-term growth in shore-based commerce; they formulated plans that prioritized much shoreline property for development. Forty years later, reality does not reflect the vision: In most cases the expected growth did not occur. In the case of Coos Bay commercial shipping significantly declined.

Estuary master planning

Some coastal communities—including Coos Bay and Gold Beach—are considering new priorities, such as conserving more natural shore lands or restoring tidal flow to formerly tidal lands. As needs and opportunities coincide, the training coordinator will work with communities, county governments, and the Oregon Coastal Program to provide training and technical assistance to facilitate estuary master planning.

Coastal blue carbon

Carbon sequestration by vegetated tidal wetlands, and carbon stores created by the long-term burial of carbon-rich sediment beneath salt marshes, is now recognized as an important mitigation factor in reducing greenhouse gas accumulation in the atmosphere. The process of sequestration is referred to as coastal blue carbon. Pending the availability of funding the Reserve will initiate a three-year, $750,000 project to begin quantifying the coastal blue carbon content of estuaries in the Pacific Northwest. To facilitate this effort the Reserve and its partners have formed the Pacific Northwest Coastal Blue Carbon Working Group, with links to state, national, and international blue carbon working groups. The working group includes both biophysical and social scientists.

Ridgetop to estuary connectivity

The Reserve is initiating its restoration plans for the uplands of the South Slough Reserve. The strategy will focus on maintaining or restoring hydrologic connectivity from the uplands to the estuarine shorelines. Ridgetop to estuary restoration emphasizes the importance of preserving the ecologic and hydrologic connections between various discrete habitat types such as forests meadows

and freshwater marshes, streams, intertidal marshes, subtidal channels, and the marine environment.

The Reserve's strategy for ridgetop-to-estuary restoration coincides neatly with the mission of the Pacific Marine and Estuarine Fish Habitat Partnership (fish partnership). The fish partnership develops science and information to inform habitat restoration priorities, and provides funding to restoration projects that emphasize protecting, restoring, and enhancing

- juvenile fish habitat in nearshore marine and estuary habitats;
- tidal wetland-intertidal-subtidal-nearshore connectivity; and
- water quality and quantity in estuaries and nearshore marine environments.

Program Alignment and Delivery

Coastal training historically has addressed six training priorities: habitat restoration, water quality, invasive species, human dimensions of protected area management; climate, coastal hazards and energy, and nearshore ocean processes. The training priorities nest nicely within the Reserve System's priorities for habitat restoration, water quality and climate change, and provide the Reserve flexibility to address a wide array of coastal management issues that affect habitat restoration

The priorities are periodically reviewed for their relevance and consistency with those of State Lands, the Reserve System, and NOAA. The Reserve's alignment with partnerships and working groups focused on habitat restoration, climate, water quality, and coastal resiliency, ensures that NOAA's system-wide goals and objectives are included, as appropriate, in coastal training and technical assistance.

Over the next five years, coastal training staff will:

- Work with education staff to engage Coos Bay decision makers and community leaders in the development of living shoreline restoration projects as part of a broader effort to improve shoreline management by creating resilient shores.
- As funding develops, plan and present a science conference on the role of woody debris in estuaries and its use in estuarine habitat restoration projects, including living shorelines.
- Assist the Pacific Northwest Coastal Blue Carbon Working Group as necessary to plan and implement human dimensions research to incorporate carbon sequestration among a suite of ecosystem benefits that derive from ecological habitat restoration.

- Provide leadership to the Pacific Marine-Estuarine Fish Habitat Partnership in its support of estuary habitat restoration; identify and describe training needs related to the partnership's priorities especially within the lower Columbian biogeographic region; develop or coordinate training for restoration scientists and practitioners to facilitate the partnership's goals and objectives.
- Assist stewardship staff to provide information and training related to implementation of the Reserve's ridgetop to estuary concept for habitat restoration.
- Pending the approval of funding from the Science Collaborative or other sources, assist the Pacific Northwest Coastal Blue Carbon Working Group to identify social, economic and other human dimensions of coastal blue carbon management to assist coastal communities understand the various economic and ecological benefits of restoring estuarine habitat to sequester carbon.

Methodologies

All services, both training and technical assistance, are custom-developed specifically to meet the needs of target audiences.

Strategy update

NOAA requires reserve to update their coastal training strategies every five years from the program's inception. Thus the training strategies tend to be developed separately from reserves' management plans. The Reserve's current strategy is in effect until 2017. The Reserve will continue to update the strategy as per NOAA requirements, but will work with NOAA to incorporate coastal training strategy updates into the ordinary management planning cycle. In the event that management planning is delayed beyond the five year cycle, the coastal training program coordinator will nevertheless update the training strategy to meet NOAA's requirements.

The Reserve is taking the opportunity to update the training strategy in order to ensure it remains aligned with the revised management plan. It coincides with the emergence of new needs and issues resulting from developments in coastal management, climate awareness, estuary management, and evolving research, monitoring, stewardship and education efforts at the Reserve. These considerations include:

Cross-sector integration

The coastal training coordinator participates in regularly scheduled full-staff and science-staff meetings to identify links, overlaps, and points of intersection for training or technical assistance. All of the Reserve's staff maintain close communications to ensure that various disciplines (science, education, training, administration) are

aware of opportunities and needs to engage in joint action.

The education team holds regular monthly meetings to manage time and resources. The coastal training and education coordinators meet regularly to prioritize needs and opportunities for training or technical assistance. The training coordinator networks with colleagues throughout the Oregon coastal zone, coastal management community, the Reserve System, and other NOAA offices as needed.

Generally, the desired change in behavior expected by the Reserve's coastal training program is that participating decision makers will give considerable weight to the information, skills, and methods they have gained as a result of coastal training in their decision making.

For training, the Reserve expects that participants in coastal training workshops or courses will apply the lessons they have learned in their day to day work. Post-event evaluations generally demonstrate that participants have increased their knowledge and understanding of the material presented, and affirm their intent to apply the lessons learned. The majority of coastal training events are one-time occurrences, and there rarely is a chance to repeat a workshop or schedule a course that builds upon what has gone before. Training participants often attend events on different topics, and the coordinator takes advantage of these reunions to gain insights on the outcome or application of previous training.

The information gained is anecdotal, and while it helps the coordinator adjust procedures and methods, or identify new training needs or opportunities, there is little need to continually adapt individual courses or field studies for repeated use.

Current and Anticipated Partnerships

Partnerships offer opportunities to extend and apply the findings of research conducted or supported by the Reserve. Coastal training partners include: Oregon's Coastal Management Program and Oregon Sea Grant, as required by NOAA.

Additional partners and stakeholders, including the Pacific Northwest Coastal Blue Carbon Working Group, Pacific Marine-Estuarine Fish Habitat Partnership, Lower Rogue Watershed Council, Coquille Indian Tribe and Confederated Tribes of the Coos, Lower Umpqua and Siuslaw Indians, and the Oregon Climate Research Institute, extend and leverage the Reserve's capacity to identify, evaluate, prioritize, and address a range of coastal management issues that respond to the Reserve System's priorities.

The Reserve will explore partnership opportunities with the Northwest Regional Floodplain Management Association to identify training and outreach needs related to floodplain inundation and tide gate management.

Partnership with Oregon's Coastal Management Program, besides being required by NOAA, is among the Reserve's most valuable partnerships for extending training to coastal management audiences, especially on short notice. The Reserve's rela-

tionship with the coastal program staff, besides being required by NOAA, is among the Reserve's most valuable partnerships for extending training to coastal management audiences, especially on short notice. The program is networked, which means that significant coastal management program elements are implemented by several state agencies and Oregon's coastal cities and counties.

Under this plan, the Reserve will develop closer working arrangements with managers and staff in the OCMP and Oregon Sea Grant to (1) develop training materials as necessary, and (2) coordinate and provide training and technical assistance for coastal decision-makers.

Since the implementation of the Coastal Training Program in 2002, and particularly during the period of the 2006 management plan, the value of the coastal training program has increased as a provider of training and technical assistance for decision makers, in part through its partnership with the OCMP. Moreover, the OCMP has long relied on the Reserve as a de facto adjunct research arm by providing management recommendations and science about Oregon's estuaries.

Closer working ties with these partners would enable the Reserve to strategically meet the needs of target audiences while addressing the Reserve System's priorities. Development of a successful relationship would undoubtedly benefit from NOAA's encouragement and support.

Monitoring and Evaluation

The coastal training program developed a logic model during the last strategy revision and confirmed the relevancy of that model for this revision. We evaluate the success of the program in three ways: through post-event evaluations that are reported to the Reserve System's performance monitoring database, and by word-of-mouth and networking relationships with training partners and target audience members, and in response to NOAA's periodic Section 312 reviews of the Reserve's operations and programs.

A fourth element of program monitoring occurs in during NOAA's five-year review and renewal of the Reserve's coastal training strategy. Although the Reserve was not required to revise the strategy for this planning purpose, we elected to do so in order to:

- Ensure that the training strategy was responsive to new staff, new ideas, new management needs, and evolving priorities for addressing them, and
- Bring the five year strategy review cycle in line with the five-year cycle for management plan revisions.

As was briefly discussed among coastal training coordinators at the Reserve System's 2014 annual meeting in Shepherdstown, WV, NOAA's rationale for requiring a separate approval process for coastal training strategies may benefit from modification, at least for programs that are well-established (although newly-established

training programs will almost always benefit from closer oversight and review by NOAA during the formative stage). The Reserve will work with NOAA to coordinate coastal training strategy updates with the management planning process; in the event that a management plan revision is delayed, the Reserve will work with NOAA to revise or extend the strategy, as necessary, to ensure it remains responsive to the management plan.

Training results

In addition to reporting and evaluation opportunities provided by NOAA, the Reserve communicates coastal training impacts and results as appropriate through email list serves that target training partners and stakeholders, including the Reserve System's sector email lists, as appropriate, Oregon's Watershed Enhancement Board, working groups and partnerships, and staff. Coastal training activities are also reported through periodic management commission meetings, and when appropriate, the Friends of South Slough Newsletter and the Reserve's Facebook page.

The behavior change that the coastal training coordinator would like to see is that people value estuaries for their intrinsic worth and recognize that other values that are based on natural resources, including economic, conservation, social, spiritual, and psychological values, derive from holistically functioning estuaries that are ecologically connected to the surrounding lands and seas. This might be demonstrated by the degree of support, both regionally and locally, for policies that encourage and support habitat restoration in estuaries to attain ecologically-based, community supported goals and outcomes.

Program Needs and Gaps

The major needs of coastal training during the next five years will include a coastal training assistant and funding to support that position. The assistant would be tasked with day to day tasks associated with planning and delivering training. The training coordinator will work with other education staff to identify additional needs for personnel with the goal of establishing at least one permanent, full-time position to assume both coastal training and general education duties.

Future needs and opportunities

In general, the needs identified by stakeholders, locally and throughout the lower Columbian biogeographic region, would be best served by improved Internet communications systems (e.g., webinars and distant communication). Coastal training staff will work with education staff to identify and describe appropriate duties for a coastal training and education assistant.

This position, when created, will also assist in the arena of community education which is jointly addressed by all facets of the Reserve's education program

The chief limitation is budget and staff. Opportunities arise when as they do, and

the Reserve will approach opportunities to expand or enhance its coastal training program as they occur.

Coastal training objectives and actions for 2015-2020

See Chapter 3 for objectives.

See Chapter 3 for actions.

Administration

Administrative staff at the South Slough National Estuarine Research Reserve (Reserve) monitor grants, reconcile fiscal accounts with the Oregon Department of State Lands (State lands), and provide guidance to staff for general operations and processes. Administrative staff oversee maintenance and safe operation of all the Reserve's facilities and equipment and provide other support for staff as needed to achieve the Reserve's research and education goals and objectives.

Organizational framework

The National Oceanic and Atmospheric Administration (NOAA) provides funding for the Reserve, national guidance, and technical assistance. A cooperative agreement between NOAA and State lands on behalf of the Reserve outlines both agencies' responsibilities in their management of the Reserve. (See Appendix J.)

The Reserve applies annually for funds from NOAA to support the research, education, coastal training programs and SWMP. Funds may also be requested of NOAA for special projects, construction and land acquisition. NOAA guidelines require a 30 percent non-federal cost share for operations and construction awards and a 50 percent cost share for acquisition.

In addition, the Reserve strategically seeks grants and contracts from a variety of sources to support many projects.

Role and responsibility of NOAA

NOAA administers the National Estuarine Research Reserve System (Reserve System), provides financial support and technical assistance for the reserves, oversees the expenditure of federal funds, and conducts periodic reviews of the reserves' programs and activities. NOAA coordinates the implementation of SWMP, and provides guidance for the development of the Reserve System's policies.

As required by federal regulations (15 C.F.R. Part 921.40), NOAA periodically evaluates the Reserve's compliance with federal requirements to ensure that it is operating according to its federally-approved management plan.

Reserve management commission

The Reserve Management Commission (Commission) is responsible for the day-to-day operation and management of the Reserve (O.R.S. 273.554).

The Commission establishes operating policies and administrative rules. As per state statute, the nine members of the Commission are appointed by the Governor and represent academic institutions, agencies, tribes and other constituencies. The director of State lands (or a designee) serves as permanent chair of the Commission. The authority of the Commission must remain consistent with the policies formulated by the State Land Board as well as state and federal laws.

The Commission is empowered by statute to appoint a manager and other staff to accomplish work. The Commission may apply for, receive, and expend federal, state, and other funds for the Reserve's purposes. Commissioners review the Reserve's activities and business at public meetings triennially. Commissioners are appointed by Governor to the following positions for four-year terms:

- Pos. 1 Education
- Pos. 2 Public
- Pos. 3 Oregon International Port of Coos Bay
- Pos. 4 Director of State lands (commission chair)
- Pos. 5 National Oceanic and Atmospheric Administration (non-voting)
- Pos. 6 University of Oregon Institute of Marine Biology
- Pos. 7 Oregon State University
- Pos. 8 Coos County Commission
- Pos. 9 Oregon Sovereign Tribal Nations

Role and responsibility of State lands

State lands manages land acquisition and related transactions on behalf of the Reserve (O.R.S. 273.553(2)) and provides administrative support to the Commission (O.R.S. 273.554(1)(a)). The department also provides fiscal oversight, recordkeeping, technological support, and human resource assistance. Full-time staff are State lands employees. Funding for the Reserve, whether from NOAA or other sources, is administered by State lands.

State and federal legal bases

The Reserve is managed in accordance with federal regulations (15 C.F.R. 921 et seq.), Oregon Revised Statutes (O.R.S. part 273.553) and Oregon Administrative Rules (O.A.R. 142-10-005 et seq.) The federal regulations govern the administration of the Reserve's programs, grants, and funding (see Appendix A.) Oregon revised

statutes (Appendix C) and administrative rules (Appendix D) support the objectives of the Reserve System by establishing policy for its operation and public use. These regulations and rules are used in combination with the Reserve's stewardship policies to manage lands and protect the integrity of the Reserve's resources.

Staff

There are 16 permanent, full-time staff positions. The work force fluctuates seasonally with the addition of temporary workers assigned to specific projects and supported by competitive grants, interagency cooperative agreements, or other agencies.

New staff positions are identified and developed in a number of ways. In developing work proposals for competitive grants, staff advises management of the need for temporary part-time or full-time workers. New, permanent part-time or full-time positions are created based largely on the Reserve's ongoing responsibilities to partners and funding agencies, work load, and budget.

Some positions are identified by NOAA as prerequisites for participation in certain programs (Coastal Training Program; SWMP). The funding available for these programs supports the program operations and associated staff. The Reserve must apply for these funds and agree to conduct the programming according to NOAA's guidance. NOAA may also determine additional staffing needs via periodic (CZMA Section 312) evaluations.

Staff support and professional development

The Reserve depends on a variety of sources to fund the staff necessary for programs and operations. Regardless of source, funding is administered through State lands and the Reserve must seek and obtain position authority from the state before it can hire staff. Staff participate in training and professional development, State lands, and other agencies or providers, including geographic information systems (GIS), grants writing, marketing, boating and marine safety, workplace safety and security. Staff are eligible, with agency approval, to participate in agency job rotations or to attend college or professional development courses during working hours, at their own expense.

Staff benefit from training provided by NOAA in several ways. Staff may be eligible to participate in coastal training workshops based on the definition and need of the target audience. Staff may participate in training provided at annual Reserve System business meetings, and are encouraged to participate in professional development webinars sponsored by NOAA or its training partners. Environmental monitoring staff participate in annual SWMP technical training in Georgetown, S.C.

Strategic partnerships

Partnerships enhance the ability of all the partners to work efficiently, effectively, and productively. The Reserve relies on several strategic partnerships to provide broad support for projects and ensure successful outcomes, including NOAA. The partnership with NOAA ensures financial support for daily operations, and contingent funds for acquiring land and constructing facilities. Other strategic partnerships are memorialized through formal agreements or charters:

The Friends of South Slough, Inc.

The Friends of South Slough, Inc., (FOSS) is a 501(c) 3 non-profit corporation that assists the Reserve in many ways. FOSS manages a bookstore and gift shop at the interpretive center, accepts and raises money on behalf of the Reserve, and sponsors public events. Each year individual members collectively contribute hundreds of hours to the Reserve. Membership is about 2,000. A memorandum of agreement between the entities describing their working relationship was signed March 22, 2012. It remains in effect through August, 2017. (See Appendix O.)

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

A memorandum of agreement between the Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians and State lands on behalf of the Reserve allows the entities to share data, laboratories and equipment, develop joint proposals, co-administer grants, and otherwise cooperate to achieve mutual objectives. It was signed April 15, 2013, and remains in effect until December 31, 2021. (See Appendix N.)

Oregon Institute of Marine Biology

A memorandum of understanding between the University of Oregon, on behalf of OIMB, and State lands on behalf of the Reserve, allows the entities to share administrative resources and laboratories. The agreement was signed in 2004 and renewed in 2009. (See Appendix L.)

Coos Watershed Association

The Coos Watershed Association is a 501(c)3 non-profit corporation representing a variety of land management interests in Coos Bay. The association has initiated many innovative practices in watershed management and conservation. The Reserve is a founding member of the association and coordinates with it on many projects. Watershed association staff solicit and administer grants to sup-

port work that engages both organizations. The Reserve manager is a standing member of the Coos Watershed Association Board of Directors.

Land acquisition strategy

From time to time the Reserve acquires real property to ensure its ability to carry out its management policy. Land acquisition is guided by the Core Recommendations of the Cooperative Plan for Watershed Conservation (approved by the Commission in 1999; revised 2003 and 2015).

The goals for land acquisition are to 1) protect the integrity of the lands within the current administrative boundary; 2) enhance the Reserve's ability to more fully meet its research, stewardship and education objectives, and 3) address specific projects and opportunities.

When land acquisition is anticipated, the Reserve will form an acquisition team consisting of the Reserve manager, stewardship coordinator and other staff or state personnel as needed (e.g., contract negotiation; legal services).

At present the Reserve has no specific plans for land acquisition. As opportunities arise in alignment with project needs, plans may be developed. As a general rule, an acquisition should include landscape characteristics that align with the Reserve's mission. Examples include, but are not limited to:

- Coastal cliffs, shrublands or grasslands, intertidal beaches, or sub-tidal hard bottoms
- Headwaters of South Slough drainages
- Tidal shore lands in the South Slough estuary
- Uplands
- Developed shoreline (e.g., a site that could be used for public interpretation along lower Cape Arago Highway)
- Areas that ensure conservation of aesthetically and culturally important sites, views, and sounds
- Areas that contain biologically and archaeologically important resources
- Areas that include fish and shellfish habitat

The Reserve acquires land only on a willing buyer, willing seller basis.

Habitat restoration strategy

The Reserve's first management plan (1984) envisioned that habitat restoration work would begin in tidal wetlands but progress eventually to the upland forest. Beginning in the mid-1990s, staff began a series of experimental wetland restorations,

collectively known as the Winchester Tidelands Restoration Project, to improve the understanding of tidal wetland restoration in the Pacific Northwest. The projects addressed restoring salt marshes, streams, and hydrologic connectivity, and creating new tidal channels.

The Upper Watershed Restoration Action Plan (Appendix V) provides the basis for active forest stewardship to protect or restore hydrologic connectivity from the ridgetops of the Reserve to the estuary. It provides specific guidance for ecologically distinct sites and recommends various methods, ranging from thinning and commercial harvest to brush removal or doing nothing. This comprehensive ridgetop-to-estuary approach to habitat restoration includes uplands, freshwater streams, riparian zones, tidal wetlands and eelgrass in applicable projects.

For more information see Chapter 3 (priority management issues) and Chapter 4 (Foundational programs—science and monitoring).

Resource protection strategy

Oregon law specifies that state policy for the Reserve is to maintain the integrity of the estuary; protect the estuary from uses and activities, both within and beyond boundaries, which may alter or affect the ecosystem and its natural dynamic processes, and preserve the area for long-term scientific and educational uses (O.R.S. 273.553.1).

The Reserve's resource protection goal is to protect first staff and visitors, secondly buildings and facilities, and thirdly lands, from damage or harm due to criminal harm and illegal activity, neglect, or wildfire.

Most public programs, activities, and amenities (e.g., trailheads and visitors' services) are anchored at the interpretive center, which also provides office space for education and interpretive staff. Most public activities occur at the interpretive center or along trails originating from the center. Trails are open every day from sunrise to sunset.

In general, allowable uses include most daily activities such as research, education, and non-motorized recreation including trail-walking, paddling, and boating. Bicycles, motorized vehicles, and horses are not allowed on hiking trails. Off-road or all-terrain vehicles may not be operated in the Reserve. Motorized boat traffic is allowed within the Reserve's boundaries in specified areas. Within the administrative boundary, South Slough is a no-wake zone.

Horses or pack animals in watercourses, commercial harvesting of any products, including mushrooms, trees or parts of trees, plants, fibers, roots, etc., minerals), overnight camping, and open fires, are prohibited.

Prohibited activities (O.A.R 142-010-0021)

The following activities are prohibited, as determined by the Commission, by authority of ORS 273 .553(3):

- Commercial bait gathering
- Commercial timber harvest
- Commercial mineral removal
- Discharge of firearms for pleasure shooting or target practice
- Picking of forest greenery and cascara bark gathering for commercial purposes.

Stat. Auth.: ORS 273 Stats. Implemented: ORS 273 Hist.: SSES 2-1982, f. & ef. 3-2-82; SSNER 1-1998, f. & cert. ef. 7-15-98

Public Health, Safety, and Welfare (O.A.R 142-010-0025)

The Manager is authorized to take actions necessary for maintaining public health, safety, and welfare. The Manager's actions under such authority shall be consistent with the primary objectives of the Reserve.

Stat. Auth.: ORS 273 Stats. Implemented: ORS 273 Hist.: SSES 2-1980, f. & ef. 12-23-80; SSES 2-1982, f. & ef. 3-2-82; SSNER 1-1998, f. & cert. ef. 7-15-98

Surveillance and enforcement

Protection during non-business hours includes active security alarms at the maintenance shop, Spruce Ranch and interpretive center; 24-hour remote monitoring video at selected buildings and remote locations; periodic patrols of remote areas by maintenance staff, and occasional patrols by law enforcement agencies.

The Oregon Institute of Marine Biology engages security services for campus, including the Reserve's science laboratory and offices.

Natural disaster response and resiliency

The Reserve is developing a natural disaster response and resiliency plan with assistance from NOAA.

Hunting and fishing

Hunting and fishing are allowed within the Reserve in accordance with Oregon

Fish and Wildlife hunting and fishing regulations. No hunting is allowed south of Hinch Lane and west of Winchester Creek. Hunting with limitations (no center-fire firearms, muzzle loaders, or shotguns using rifled slugs) is allowed in the area bounded by Hinch Lane, Seven Devils Road, Winchester Creek and Salal Lane.

Resource protection challenges

Hinch Lane, a county-owned road, provides access to the south end of the Reserve including the Winchester Marsh-Wasson Creek Trail, the paddle launch, and areas used largely for research and environmental monitoring. Service trails provide access for staff but are not marked, signed, or recommended for public use. Some cross tidal channels on makeshift plank bridges, or extend into areas where access can be cut off by high tides.

Due to their remoteness, the south and east sides of the Reserve faces several resource protection challenges:

Fredrickson house

This former homestead repeatedly has been vandalized and is in a state of extreme disrepair. The house is of a common style and construction and lacks historical or unique features. A nearby outbuilding is architecturally distinct and of cultural value to members of sovereign domestic tribal nations. It will be managed to limit further decay. The area surrounding the house is the site of occasional, prohibited overnight camping, vandalism, dumping, illegal harvest of forest products, and other illegal activity.

Valino Island

The island at the northern boundary of the Reserve is a popular stopover for paddlers. It lacks sanitary facilities or services. Overnight camping and littering are also management concerns.

Eastside lands

The lands drained by Talbot, Elliott, and John B creeks and the Sengstacken arm are remote and largely inaccessible by land, although some areas may be accessed using off-road vehicles from industrial forest lands east of the Reserve. Although this activity is known to occur, the Reserve lacks capacity to fully monitor and enforce the boundary in this region, except to respond to a specific activity or event.

Wildfire

Forest fire monitoring and response is provided by the Coos Forest Protective Association, which would respond to a wildfire inside the Reserve's boundary.

Other lands managed by the Reserve

State lands acquired several parcels of land adjacent to the Reserve southwest (the Wasson Creek headwaters) and northwest (along Salal Lane). A third parcel, located north of the Reserve on the easter side of South Slough, known as Indian Point, was also acquired by State lands.

These lands were purchased with the intent that they be managed under Oregon Administrative Rules for the Reserve; thus their protection extends the Commission's concern about chronic trespass and vandalism. The Reserve will work with State lands and interested neighbors to develop management plans for these areas, particularly Indian Point, which presents outstanding opportunities for conservation, research and interpretation.

Public Access and Visitor Use

Oregon Administrative Rules require the Reserve to provide maximum public access to lands and waters as is allowable and consistent with the Reserve's management policy. The Reserve's lands and waters are available to scientists, students and the general public for research, education, and permissible recreational uses (O.A.R. 142-010-0005).

Access is consistent with the need to protect lands and water, publicly-owned buildings, vehicles, vessels and equipment from damage and reduce impacts from public use. To that end, most public use is concentrated at the interpretive center and network of trails originating there. Access largely depends on safe, well-maintained, clearly-signed trails and water trails.

Trails are essential to education and interpretive activities. Trails are planned and designed to meet the aesthetic needs of visitors seeking solitude and quiet contemplation, as well as for groups and classes.

Trails include:

- Ten-Minute Trail—(0.20 mi.) This loop trail begins and ends at the interpretive center. It provides access to the North Creek Trail and the Middle Creek Trail.
- North Creek Trail—(1.50 mi.) Departs from a junction with the Ten-Minute Trail to descend through forest habitat, crossing many small streams, through an alluvial valley and across a forested bench, to terminate at Rhodes Dike. A bridge connects the North Creek Trail with the Tunnel and Railroad trails.
- Winchester Marsh (0.50 mi.) and Wasson Creek Trail—(0.50 mi.) Access is from Fredrickson Road via Hinch Lane. The trailhead is located across from a small parking area at the locked gate. Private vehicles are not permitted

beyond the gate. Not wheelchair accessible.

- Estuary Study Trail System—The Estuary Study Trail system originates at either the interpretive center by way of the Ten-Minute Trail or the Hidden Creek trailhead parking lot, located at the end of a spur road about a quarter mile southeast of the interpretive center. The trails lead to the marsh observation deck, lower parking lot, the Sloughside Pilings, and the sloughside study area where much of formal K-12 education occurs, and to the North Creek Bridge.

Segments include:

- Hidden Creek Trail—(0.75 mi.) Accessible from the interpretive center via the Ten-Minute and the Middle Creek trails, or from the Hidden Creek trailhead parking area. The descent to the estuary shoreline is relatively steep (a five percent grade).
- Middle Creek Trail—(0.50 mi.) Connects the Ten Minute Trail to Hidden Creek Trail.
- Skunk Cabbage Boardwalk and Marsh Observation Deck—A boardwalk begins at the foot of the Hidden Creek Trail and winds through skunk cabbage and marshes to a 1,300 square-foot marsh observation deck.
- Big Cedar Trail—(0.25 mi.) Is accessible from the lower parking area. Leads to the marsh observation deck and the skunk cabbage boardwalk.
- Tunnel Trail—(0.40 mi.) Is accessible from the marsh observation deck. Leads to a bluff above the Sloughside Pilings and the North Creek bridge.
- Railroad Trail—(0.40 mi.) Is accessible from the lower parking area. Leads by way of an old railway grade to the Sloughside Pilings and the North Creek Trail bridge.

Water trails

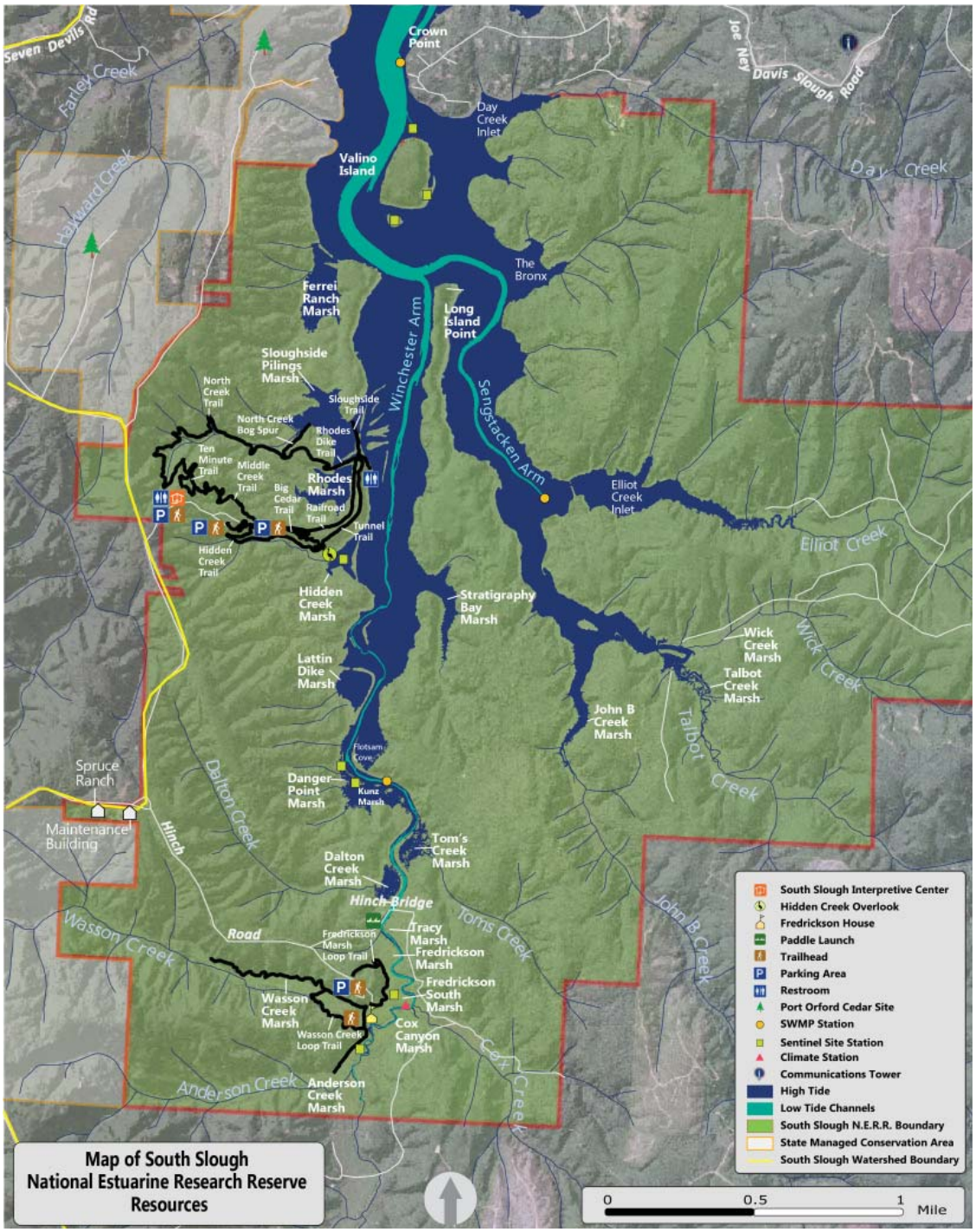
A public launch for canoes, kayaks and other paddle craft is located in the Reserve at Hinch Bridge. Some parking is available. A second public launch is located at the distant water fleet facility in Charleston.

Roads and parking

The Reserve provides roads and parking for public access. To reduce the pollution associated with compacted soils, storm water runoff, and erosion, the Reserve's policy is to construct and maintain roads and trails only to the extent necessary to do work.

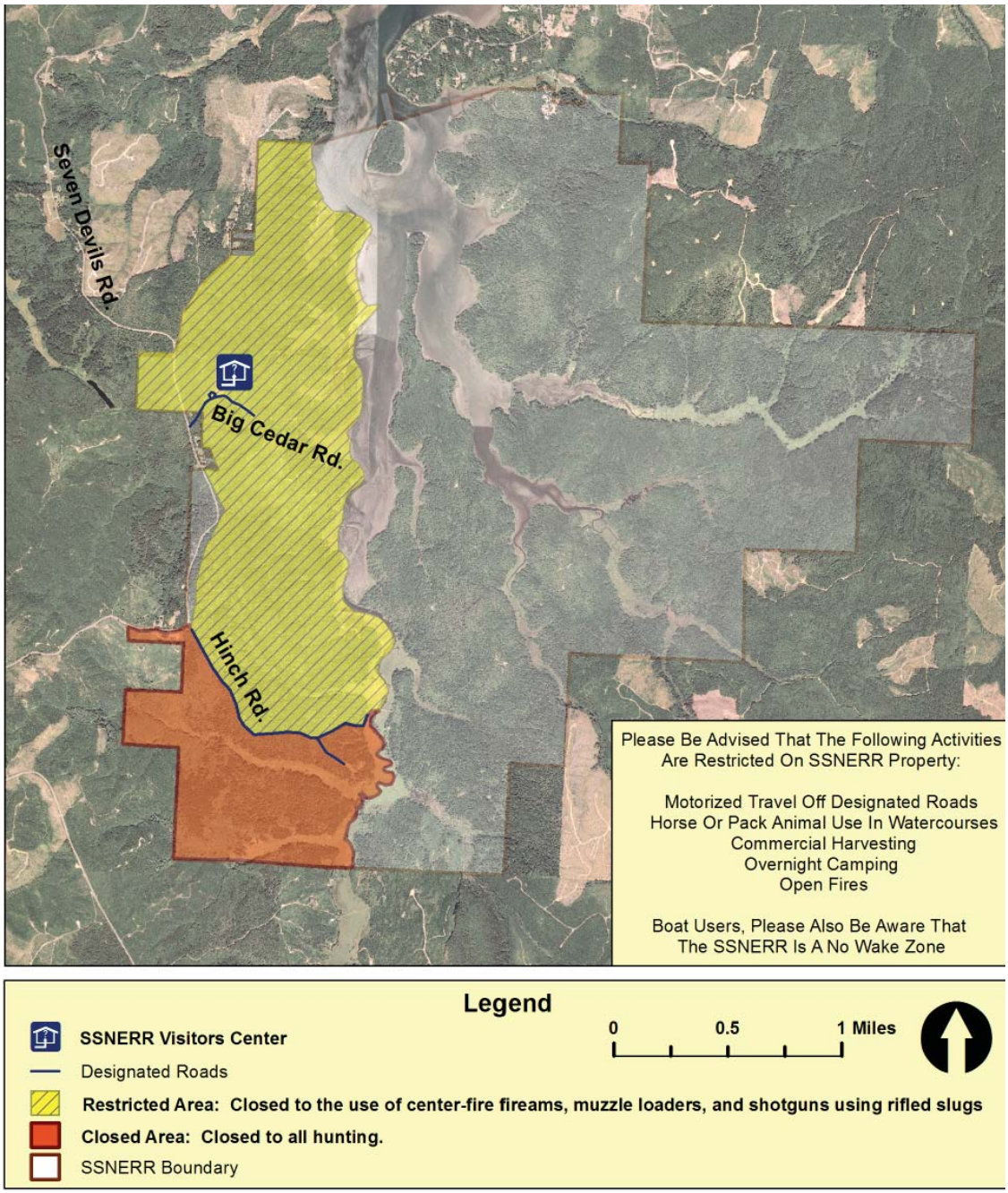
Permanent roads include:

- Entrance road—Paved. Provides access from Seven Devils Road to the interpretive center parking area. The parking lot provides space for 16 vehicles, including one space reserved for persons with disabilities. Parking is available for buses and recreational vehicles.
- Trailhead access road—Paved. Leads from the interpretive center to the Hidden Creek trailhead parking area, and, via a locked gate, to the lower parking lot.
- Hinch Lane—Crushed rock. Povides access to Winchester Road and the paddle launch at Hinch Bridge.
- Winchester Road—Crushed rock. Provides access to the Winchester Marsh-Wasson Creek trailhead parking area, the Fredrickson house, utility lines, fish trap, and research sites.



Map credit: Collen Burch Johnson

Fig. 5—Trails, facilities, research areas and waterways of the South Slough Reserve



Map credit: Collen Burch Johnson

Fig. 6—Hunting zones of the South Slough National Estuarine Research Reserve

Facilities Development and Improvement

The South Slough National Estuarine Research Reserve (Reserve) maintains various facilities and provides public access to them as necessary to support its mission and goals. They include buildings and other structures, a paddle launch, trails, vehicles and vessels. Facilities are located beyond the administrative boundary as necessary to support the Reserve's mission, including the environmental science laboratory and offices located on the campus of Oregon Institute of Marine Biology in Charleston. Communications relay towers located east and south of the Reserve support internet and network needs. All facilities are directly or indirectly required to accomplish day to day work.

In 1991 the Reserve Management Commission approved a Facilities Master Plan to guide construction. Needs for facilities are, at present, fully addressed, and the Reserve has no immediate plans to construct new facilities. (Although staff are considering structural modifications that will be needed at the environmental sciences laboratory and offices to meet changing work needs.)

The 1991 plan remains a valuable archive of historic information about former homes, roads, dikes and other structures that previously existed on lands now occupied by the Reserve.

Buildings include:

Interpretive center—(6,755 sq. ft.)

Built in the mid-1980s; remodeled in 2002; located four miles south of Charleston on Seven Devils Road. Includes exhibits, a reception area, and a bookstore and gift shop occupying about 1,700 square feet of floor space. A 1,500 square-foot auditorium accommodates up to 60 people. There are 13 work stations, a secure internet server station; a common room, copy room, kitchen, bathroom, utility room, classroom, storage area, and a deck.

Improvements since 2006 include installing new exhibits; resurfacing the auditorium floor; installing energy-efficient lights in exhibits and work areas; replacing the failing cedar shake roof with a metal roof; installing a photovoltaic

energy generating system; constructing a new drinking water pumping and storage system, including a new pump house, twin 1,000 gallon water tanks, and a solar-powered pump; replacing worn heat pumps, electrical wires, structural beams, doors and outdoor security lights, and interior and exterior painting. An energy-efficient, wood burning insert was installed in the fireplace.

Environmental science lab—(3,000 sq. ft.)

Built in 1999; located on OIMB campus. A cooperative agreement with the University of Oregon guides the use, operation, and maintenance of the offices and space (Appendix L). There are seven offices, 10 work stations, a wet/dry laboratory, seawater table room, staging and storage areas, a shower, and a garage. Improvements since 2006 include expansion of offices and reorganizing work stations for greater efficiency and comfort.

Maintenance shop—(3,888 sq. ft.)

Built in 1997; located on Seven Devils Road a mile south of the interpretive center. The shop provides shelter for vehicles and paddle craft, storage for office furniture and equipment, and work space. A pole barn provides protection from weather for additional equipment. The shop, barn, and yard are protected by a security fence, alarm system, and remotely-operated gate.

Spruce Ranch—(1,680 sq. ft.)

Purchased in 1997; remodeled in 2002 to accommodate guests or temporary workers, and located adjacent to the maintenance shop. Two 24-foot diameter yurts erected in 2004 provide additional temporary housing. The roof is scheduled for replacement.

Education shed—(120 sq. ft.)

Built in 1997 at the lower end of the Estuary Study Trail to provide storage for education props.

Trail restrooms

Restrooms are located at the Interpretive Center trailhead and at the lower end of Estuary Study Trail. There are no other restroom facilities located in the Reserve.

Other facilities include:

Vessels

Smoker Craft 18 foot boat, outboard motor and trailer

Alumiweld 16' boat and trailer

"Chmoosh," – a 24 ft. Native American-styled 9-passenger canoe

Six kayaks

Vehicles

2000 Dodge Grand Caravan

2008 Chevrolet 4x2 pickup truck

2004 Ford (flatbed) truck

2006 Toyota Prius

Facility planning and upgrades

All facilities comply with the requirements of the Americans with Disabilities Act.

When new buildings are needed, construction will be planned so as to have minimal visual impact and not obstruct views, either within or beyond the Reserve's boundary.

Building exteriors will be finished using rough-textured, natural or natural-appearing materials with neutral, natural colors. Where practical, preference may be given to artificial, sustainably-produced building materials that mimic natural materials.

To the greatest extent possible, new buildings will be designed and located to support multiple Reserve goals. In locating buildings, the Reserve will consider the potential impact of increased human activity on natural areas and resources. Construction methods will be chosen to have minimal environmental impact, with particular attention paid to reducing the impacts of runoff, pollution, and soil compaction.

Where applicable, construction will occur in dry seasons to minimize adverse impacts to fish. Runoff from roads and parking lots will be directed whenever possible through vegetative filters prior to entering any water body. Non-motorized conveyances will be used whenever feasible to transport construction materials to and from sensitive sites.

For new facilities, the Reserve will plan for energy efficiency and use sustainably-produced and designed materials for construction. All construction will be con-

sistent with the Reserve's stewardship policies and Oregon's statewide land use planning goals. Only native plants already found within the Reserve will be used as decorative plantings around buildings and facilities.

Facility maintenance

Facilities are maintained principally by the maintenance supervisor, with help from the maintenance assistant, and occasional help from other staff, contractors, temporary workers, and volunteers. Trail development is guided by the 1990 Watershed Walkway Plan. Trail maintenance is a primary responsibility of the maintenance assistant.

Public trails are planned to avoid crossing tidally-influenced areas and wetlands as much as possible. Trails are designed to discourage shortcuts or off-trail excursions. Trail are predominantly earthen but may be surfaced with wood chips or gravel for safety or to minimize erosion. In sensitive areas exposed soil is protected from compaction, erosion, or colonization by exotic invasive plants. In areas where boardwalks can become slippery the planks have been surfaced with wire mesh to provide traction.

Maintenance and upkeep needs

The following maintenance and upgrade needs have been identified for trails, boardwalks, foot bridges, and trail-related structures:

Hidden Creek Trail

Bank erosion; water-crossing maintenance, limited accessibility due to the steep grade (five percent)

Marsh boardwalk and observation deck

Minimizing damage to the boardwalk from wildlife; replacing weathered and deteriorating boards, reducing slip hazards, structural integrity (observation deck)

Railroad Trail

Protection of carnivorous plant bog(s); brush management and disposal

North Creek Trail

Stream crossing maintenance

Winchester Marsh and Wasson Creek trails

Delayed maintenance pending the outcome of forest and floodplain habitat restoration planned for Wasson Creek; visitor safety in the Fredrickson house area; implementing "arrested decline" management of the Fredrickson shed.

Roads and parking

The Reserve maintains roads and parking to provide public access and facilitate the Reserve's programs and operations. All of the Reserve's roads are legacies of the age of logging. Many have been modified to improve drainage and reduce erosion. Roads and parking areas are associated with compacted soils, storm water runoff, and erosion, and may disrupt animal habitat and visitors' trail experiences.

Entrance Road

A 0.20 mile paved driveway provides access to the Interpretive Center and parking area from Seven Devils Road. Space for 19 vehicles, including one space reserved for persons with disabilities. Parking for buses and recreational vehicles. A spur road leads to the Hidden Creek trailhead parking area and, via a locked gate, to a parking lot at the lower end of the Estuary Study Trail. The road was paved in 2004 to control erosion.

Winchester Road

Beginning at a junction with HinchLane, a 1,000 foot single-lane crushed rock road connecting Hinch Lane with the parking area at the Wasson Creek trailhead that also provides access to utility lines, a fish trap, and research sites.

Hinch Lane

Located within the Reserve, Hinch Lane (1.25 miles in length) is county-owned and maintained. It provides access from Seven Devils Road to the southern end of the Reserve, including Winchester Road and the Hinch paddle launch. Hinch Bridge is the only bridge across Winchester Creek south of Charleston.

Public motorized travel is prohibited except on the above-named roads. The Reserve's policy is to construct and maintain roads and trails only to the extent necessary to do work. If needed, temporary roads may be constructed to provide access for work crews. Staff do not maintain the many miles of abandoned logging roads that remain within the Reserve's boundaries. These roads—despite being covered by forest duff and grown over by small trees—remain usable. Some are likely to be

re-activated as the Reserve begins to implement habitat restoration in the upper watershed.

Structure demolition and removal

Staff will remove several deteriorating or unsafe residential structures or out-buildings on property adjacent to the Reserve and recently acquired by State lands. Planning has not yet begun for demolition and clean up; however, depending on the need, the Reserve may seek funding from NOAA for demolition and clean up.

Appendices

Appendices include legal authorities, strategic guidance, management guidance, interagency agreements, and new information.

A Biogeographic Regions of the National Estuarine Research Reserve System

B Code of Federal Regulations

C Oregon Revised Statutes

D Oregon Administrative Rules

F Coos Estuary Management Plan

H South Slough Stewardship Units

I Land Acquisitions Strategy

J MOA—NOAA, State Lands, and the South Slough National Estuarine Research Reserve

L MOU—University of Oregon, Oregon Institute of Marine Biology, and South Slough National Estuarine Research Reserve

N MOA—State Lands and Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians

O MOA—South Slough National Estuarine Research Reserve and the Friends of South Slough, Inc.

P NOAA Next Generation Strategic Plan

Q National Estuarine Research Reserve System Strategic Plan

S Oregon Coastal Education Market Analysis and Needs Assessment Study

T Oregon Department of State Lands Strategic Plan

U A Brief History of Coos Bay