Coos County

Estuarine Resilience Action Plan

South Jetty Road, Bandon, 2020

2023

Prepared for the communities and residents of Coos County
with support from South Slough National Estuarine Research Reserve
and the UO Institute for Policy Research and Engagement

OREGON
Coastal Management Program
DEPARTMENT OF LAND CONSERVATION & DEVELOPMENT

Coos County

Estuarine Resilience Action Plan

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Cover photo: South Jetty Road in Bandon during a king tide event, 2020. Courtesy of Rick Poecker.

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Wild Rivers Land Trust

Sawmill, Coquille River estuary, 2016. Photo courtesy of Jens Andersen.

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Acronyms

ADA – Americans with Disabilities Act
BDA – Beaver Dam Analog
BIL – Bipartisan Infrastructure Law
BRIC – (FEMA) Building Resilience Infrastructure and Communities grant
CBEMP – Coos Bay Estuary Management Plan
CIT – Coquille Indian Tribe
CMECS – Coastal and Marine Ecological Classification Standard
CO_2 – Carbon Dioxide
CoosWA – Coos Watershed Association
CoqWA – Coquille Watershed Assocation
CQWG – Coquille Working Group
CREP – (NRCS) Conservation Reserve Enhancement Program
CSZ – Cascadia Subduction Zone
CTCLUSI – Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians
CUSP – Continually Updated Shoreline Product
CVA – Climate Vulnerability Assessment
CZM – Coastal Zone Management
DLCD – (Oregon) Department of Land Conservation and Development
DO – Dissolved Oxygen
DOGAMI – (Oregon) Department of Geological and Mineral Industries
DSL – (Oregon) Department of State Lands
EMP – Estuary Management Plan (DLCD)
ENSO – El Niño Southern Oscillation
EPA – (United States) Environmental Protection Agency
EQIP – (USDA NRCS) Environmental Quality Incentives Program
ERAP – Estuarine Resilience Action Plan (this document)
ESA – Endangered Species Act
FEMA – Federal Emergency Management Agency
FIP – Focused Investment Partnership
FOSS – Friends of South Slough
IAE – Institute for Applied Ecology
ICLEI - International Council for Local Environmental Initiatives
IPRE – (University of Oregon) Institute for Policy Research and Engagement
IRA – Inflation Reduction Act
LWCF – (OPRD) Land and Water Conservation Fund
MTR – Muted Tidal Regulator
NBS – Nature Based Solutions
NCRF – (NFWF) National Coastal Resilience Fund
NERR – National Estuarine Research Reserve
NFWF – National Fish and Wildlife Foundation
NHD – National Hydrography Dataset

NHMP – Natural Hazard Mitigation Plan
NMFS – (NOAA) National Marine Fisheries Service
NOAA – National Ocean and Atmospheric Administration
NRC – National Research Council
NRCS – (USDA) Natural Resources Conservation Service
NSF – National Science Foundation
OA – Ocean Acidification
OCMP – Oregon Coastal Management Program
OCRF – (ODFW) Oregon Conservation and Recreation Fund
ODA – Oregon Department of Agriculture
OODEQ – Oregon Department of Environmental Quality
ODFW – Oregon Department of Fish and Wildlife
ODOT – Oregon Department of Transportation
OEM – (Oregon) Office of Emergency Management
OOST – Oregon Ocean Science Trust
OPRD – Oregon Department of Parks and Recreation
OSG – Oregon Sea Grant
OSU – Oregon State University
OWEB – Oregon Watershed Enhancement Board
PAC – Procurement, Acquisition and Construction
PCW – Partnership for Coastal Watersheds
PLO – Private Landowner(s)
PMEP – Pacific Marine and Estuaries Fish Habitat Partnership
RCPP – (USDA NRCS) Regional Conservation Partnership Program
RFP – Request For Proposals
RM – River Mile
SAP – Strategic Action Plan
SLR – Sea Level Rise
SSNERR – South Slough National Estuarine Research Reserve
SWCD – Soil and Water Conservation District
TNC – The Nature Conservancy
USACE – United States Army Corps of Engineers
USDA – United States Department of Agriculture
USDOT – United States Department of Transportation
USFS – United States Forest Service
USFWS – United States Fish and Wildlife Service
USGS – United States Geological Survey
VA – Vulnerability Assessment
WRCA – Wild Rivers Coast Alliance
WRLT – Wild Rivers Land Trust

I. Introduction

Oregon's coastal population is largely situated around its estuaries. These communities are positioned to be disproportionately impacted by the threat of storms, floods, climate change, sea level rise, and other natural hazards, yet also stand to benefit the most from efforts to strengthen and restore natural systems. As the number of coastal residents and visitors continues to increase, this balance between vulnerability and buffering capacity will only be tipped by strong and deliberate efforts in coastal resilience planning and management.

Oregon has long been an innovator in estuarine planning and management, and leveraging these efforts enables coastal communities to capitalize on and expand local capacity for coastal resilience planning and implementation. Fortunately, many of these efforts have already begun in several coastal counties but vary in nature, focus, and scope. Unifying coastal resilience coordination and planning will bolster current planning efforts underway by local organizations and governments, as well as strengthen organizational and staff partnerships for future coastal planning and management. This action plan utilizes a novel process for estuarine resilience planning that attempts to identify and fill gaps in planning and capacity, leverage current efforts and existing resources, and unify goals and priorities to formalize resilience actions to build local capacity and facilitate future work.

Background and Purpose

In November 2020, the Oregon Department of Land Conservation and Development (DLCD) received funding from the National Fish and Wildlife Foundation's (NFWF) National Coastal Resilience Fund (NCRF[1]) to work with communities and local organizations to develop an Estuarine Resilience Action Plan (ERAP) for Coos County estuaries. This process focuses on actions to restore and strengthen natural systems to protect coastal communities from the impacts of storms, floods, and other natural hazards, improve recovery, and enhance fish and wildlife habitats by implementing nature-based solutions that focus on natural (green) infrastructure to increase resilience.

The Coos County ERAP (this document) attempts to assess local resilience vulnerabilities and identify and evaluate potential resilience actions. ERAP development is a bottom-up, locally-driven process in partnership with stakeholders representing the county, cities, state and federal agencies, watershed councils, and other organizations with relevant interest in estuarine resilience. Coastal Tribal Nations have also been invited and participated in the process. The resilience actions identified in this plan have been shaped by stakeholder engagement and feedback, representing local needs and concerns. These results aim to enable participating coastal jurisdictions to understand the scope, impacts, costs, and benefits of

[1] https://www.nfwf.org/programs/national-coastal-resilience-fund

potential adaptation actions, prioritize them based on a variety of planning contingencies, and help resilience and natural infrastructure projects advance towards or reach completion.

Estuary Planning Context

Most of Oregon's Estuary Management Plans (EMPs) have seen little update or revision since originally developed more than thirty years ago (DLCD 2014a). Despite the general success and durability of these plans, a number of current and anticipated developments indicate the need for modernization. In particular, current drivers for various conservation and restoration initiatives (e.g., salmonid recovery) and the potential impacts from climate change and coastal hazards are largely unanticipated by current plans. The needs and impacts on estuarine planning efforts has already been investigated (DLCD 2014b), and recent studies provide significant information related to wetland and estuary migration (Brophy & Ewald 2017), sea level rise impacts on infrastructure (DLCD 2017), and climate change impacts to natural resources and ecosystem services.

A plethora of datasets and mapping tools are available to all Oregon estuary planners and managers, and provide fundamental resource inventory tools for all estuary planning efforts. Examples of these include the Oregon Coastal Management Program's (OCMP) Oregon Coastal Atlas[2] and the Estuary Planning Tool[3]. In the nearly three decades since most of Oregon's EMPs were developed, the widespread public and agency engagement that characterized the original process has waned, reducing their effectiveness as foundational decision-making tools. In some instances, the incorporation of highly detailed developmental decisions into plans has proven problematic. Changing markets and other forces have resulted in the need to update these highly detailed plans at a scale and frequency beyond the capacity of local governments.

The fact that Oregon incorporated estuary plans into comprehensive growth management plans in the early 1980s remains innovative at the national level today. The desire to further enhance their applicability and incorporate coastal hazards associated with climate change, will provide a holistic approach to understanding and responding to the challenges of the 21st century. The lessons learned from this project will apply within the state, region, and nation as virtually all estuaries in the country will face parallel challenges associated with sea level rise and flooding impacts to infrastructure and natural resources. Oregon's planning-based approach to estuary management has provided a strong foundation for estuarine resource conservation and development decisions. In particular, the management framework's emphasis on advanced decision-making based on spatial planning concepts has proven effective in providing a system-wide approach to management. Likewise, the locally focused nature of the estuary planning process has produced plans with broad-based support and increased awareness of the relationships between traditional community development planning and aquatic resource management.

[2] https://www.coastalatlas.net/
[3] https://www.coastalatlas.net/estuarymaps/

Development on vulnerable low-lying shorelands is common in Oregon's estuaries. The extent of planning for hazards that threaten these developments (such as sea level rise) varies along the Oregon Coast, with many communities yet to initiate these efforts. In response to this data gap, an exposure inventory was developed to serve as a statewide resource for sea level rise planning in and around estuaries (DLCD 2017). As sea level rises, Oregon's estuary floodplains will increase in extent (Brophy & Ewald 2017). Land currently in the floodplain will be flooded more frequently, and land outside of the floodplain may become a part of the floodplain. The exposure inventory determined the assets and geographies most likely to be affected by a sea level rise-driven increase in flooding of 21 of Oregon's 22 major estuaries, and prioritized areas to focus future resources and warrants further study.

Study Area

The geographic scope of this work centers on the Coos and Coquille estuaries, and the areas that interact directly with the estuarine waterways, habitats, and wildlife. This includes the historic tidal floodplain and communities situated adjacent to the estuaries. The two estuaries are both classified as development management units under Oregon Statewide Land Use Planning Goal 16[4], which allows for construction and maintenance of jetties, dredging and channelization, and water-dependent commercial activities. Coos Bay is maintained as a deep draft development estuary (>22 ft. channel depth), one of only three in Oregon, while the Coquille River is a shallow draft development estuary.

Tidal mud flats across from downtown North Bend, Coos Bay. Image source: Oregon ShoreZone[5].

[4] https://www.oregon.gov/lcd/OP/Pages/Goal-16.aspx
[5] https://www.oregonshorezone.info/

Figure 1. The Coos Bay estuarine area.

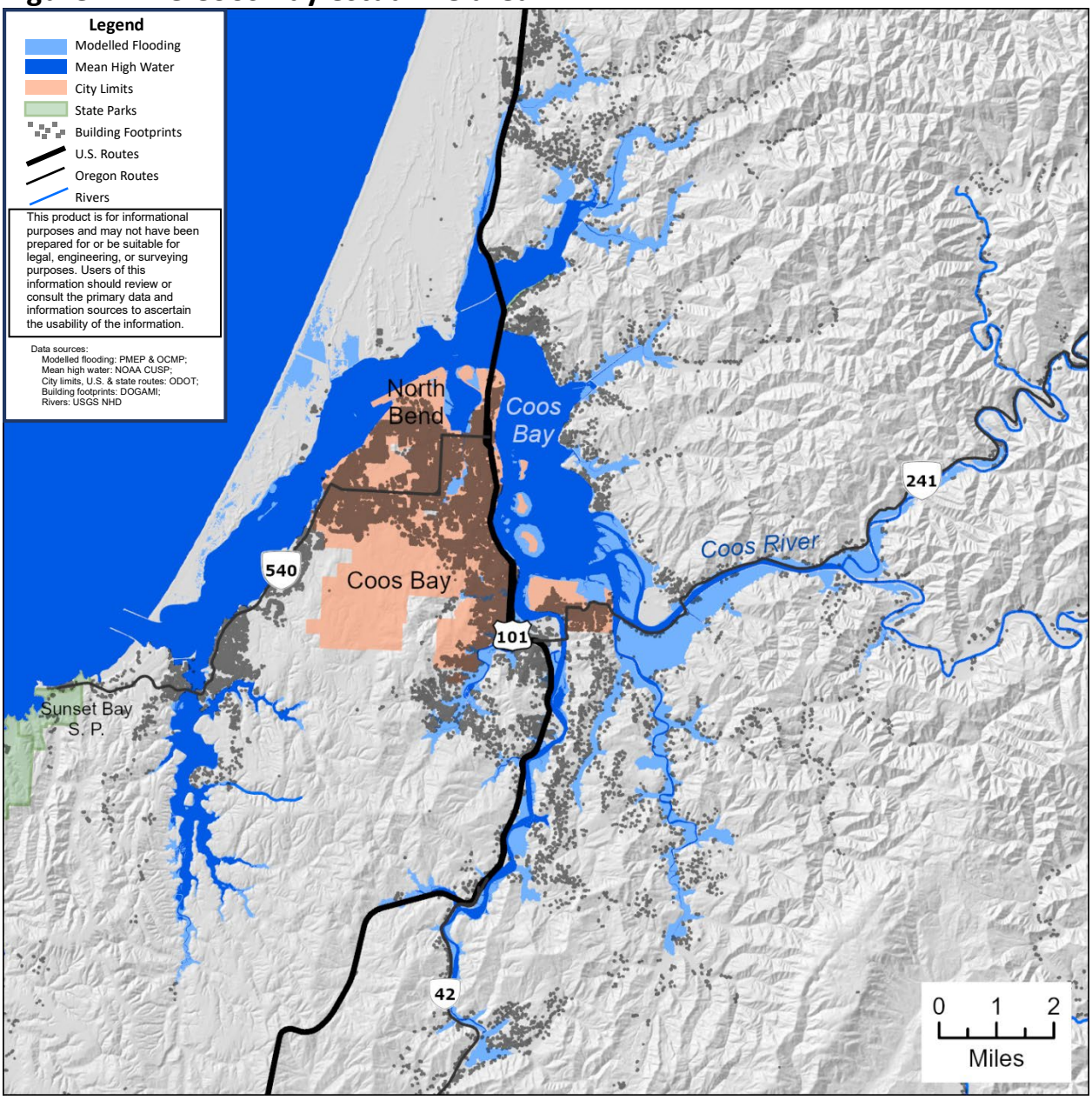
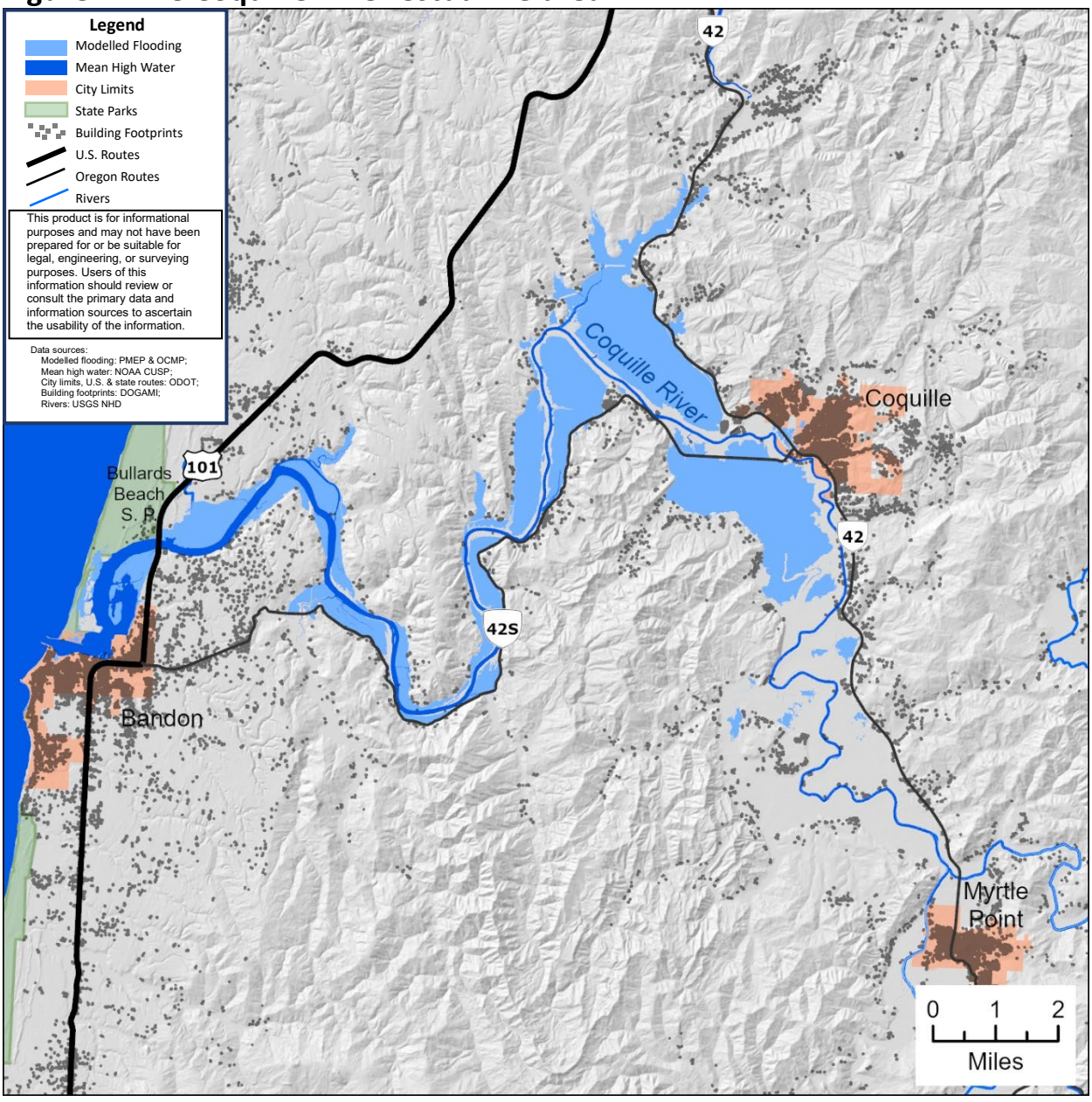


Figure 2. The Coquille River estuarine area.



II. Methods

Coos County Context for Resilience

The Coos Bay estuary is the largest estuary fully within Oregon and the sixth largest on the US West Coast. It is rich in natural resources and has abundant economic opportunities as one of the only estuaries in Oregon that allows deep-draft development. Adjacent to the estuary are two cities and nearly a dozen unincorporated communities. The Coquille River estuary is the longest estuary fully within Oregon, extending its marine influence 41 miles upriver. Its seasonally drowned river valley is bound by the steep slopes of the Oregon Coast Range, with three cities, and half a dozen unincorporated communities. Prior to Euro-American settlement the vast majority of the Coquille River valley consisted of scrub/shrub wetlands intermixed with spruce. Since the mid-19th century with the settlement of the valley, nearly 90% of wetlands have been diked and drained through canal systems, streams and rivers straightened, and establishment of expansive agricultural lands, largely utilized for cattle grazing.

Because of its coastal setting, the natural and cultural resources and dependent industries of these estuaries are vulnerable to both episodic and chronic natural hazards. For example, the geology underlying the area includes complex tectonic interactions between plates and oceanic ridges. This tectonically active area known as the Cascadia Subduction Zone has resulted in the region experiencing repeated significant (magnitude >8) earthquakes and ensuing tsunamis over the past millennia (Kelsey et al. 2002; Witter et al. 2003). These types of episodic hazards have been well-studied and some statewide and local planning has occurred around them (e.g., seismic design and construction requirements).

The impacts to Oregon estuaries from many hazards related to climate change are also well studied. These include sea level rise (SLR) (Sweet et al. 2017), ocean acidification (OA) (Gruber et al. 2012), changes to weather patterns (Fleischman 2023); and more frequent and intense marine heat waves (Frölicher 2018), among others. Systems that are vulnerable to these climate-related hazards are numerous yet have been assessed to a much lesser degree. Those studied include tidal wetlands loss due to SLR (Brophy & Ewald 2017), Dungeness crab population impacts from OA (Bednaršek 2020), increased mortality of commercial oysters from marine heat waves (Green et al. 2019) and impacts to statewide transit systems from SLR (ODOT 2012), among others. However, many vulnerable sites, systems, resources, and populations have not been assessed collectively and not at a local scale.

Planning and Partnership

While ERAP development is a novel process, concurrent and existing work were leveraged to avoid duplication of efforts and add value to the planning landscape. This effort was conducted

alongside the University of Oregon's Institute for Policy Research and Engagement[6] (IPRE) Coos Bay vulnerability assessment effort, under a FEMA Cooperating Technical Partnership grant. Work in Coos Bay was overseen by the Partnership for Coastal Watersheds[7] (PCW), a public-private partnership of land use and natural resource interests, which seeks to provide local guidance for development and conservation planning. Work for the Coquille estuary effort was guided by a working group (CQWG) composed of local stakeholders such as county and city planners, state and federal agencies, conservation interests, the Coquille Indian Tribe, and other natural resource managers.

The Oregon Coastal Management Program has worked over the last five years with Coos County, the cities of North Bend and Coos Bay, South Slough National Estuarine Research Reserve (SSNERR), and other members of the PCW to update the Coos Bay Estuary Management Plan. This included the Coos Estuary Land Use Analysis[8] (Schmitt et al. 2019) and a conceptual evaluation for the update of the Coos Bay Estuary Management Plan (CBEMP). The final report and recommendations for land use analysis were published in January 2019[9]. An adoption framework and proposed plan policy and implementing regulation amendments were developed for this project, based on the Coos Estuary Land Use Analysis recommendations. Additionally, hearing ready drafts for the CBEMP inventory update and CBEMP implementing zoning district updates were developed. Efforts from this process helped to inform the vulnerability assessment work to ensure success.

Other planning efforts were relied on to guide and constrain the scope and development of the ERAP process. The Coquille Indian Tribe prepared the Coquille River Subbasin Plan[10] (CIT 2007) for the NOAA National Fisheries Service, which evaluated the viability of local coho salmon populations and other native fish species and identified potential actions needed to conserve them. The highest priority actions focused on restoration of coldwater refugia, and improvements to management and monitoring. The Coquille Estuary Climate Change Vulnerability Assessment[11] (Mielbrecht et al. 2014) evaluated the vulnerability of seven key habitats and six key species to future effects of climate change, with a scope focused primarily on the lower Coquille River watershed. The report assesses climate exposure, sensitivity, and adaptive capacity of the most vulnerable species and habitats important to local resource management. While highly informative, this report does not evaluate built or social vulnerabilities of local communities, providing an opportunity for the Coos ERAP to fill a gap in understanding.

Broader, county-level planning also contributed to development of this document. The Natural Hazard Risk Report for Coos County, Oregon[12] (Williams et al. 2018), a FEMA-funded report

[6] https://ipre.uoregon.edu/
[7] https://partnershipforcoastalwatersheds.org/
[8] https://oe.oregonexplorer.info/externalcontent/partnershipforcoastalwatersheds/COOS-Estuary-Land-Use-Analysis-10-19.pdf
[9] https://www.co.coos.or.us/community-dev/page/am-22-005-coos-bay-estuary-management-plan
[10] https://www.coquillewatershed.org/wp-content/uploads/2017/01/CoquilleRiversub-basinplan.pdf
[11] https://ecoadapt.org/data/documents/Coquille_Estuary_Climate_Change_Vulnerability_Assessment_FINAL_1April14.pdf
[12] https://www.oregongeology.org/pubs/ofr/O-21-04/Coos%20County%20Natural%20Hazard%20Risk%20Report.pdf

produced by the Oregon Department of Geology and Mineral Industries (DOGAMI), details the methods used to understand natural hazard risk for Coos County communities. The findings allow cross-comparison of multiple hazards to facilitate action prioritization to help reduce hazard risk, and has helped develop specific mitigation actions for this document. Finally, the Coos County Multi-Jurisdictional Natural Hazard Mitigation Plan[13] (NHMP), which recently completed its five-year update, also contributed to understanding of vulnerability and risk in Coos County. Like other NHMPs, it includes a detailed risk assessment for major natural hazards and profiles mitigation actions for many Coos County communities.

Vulnerability Assessment

Figure 3. Factors of hazard vulnerability defined.

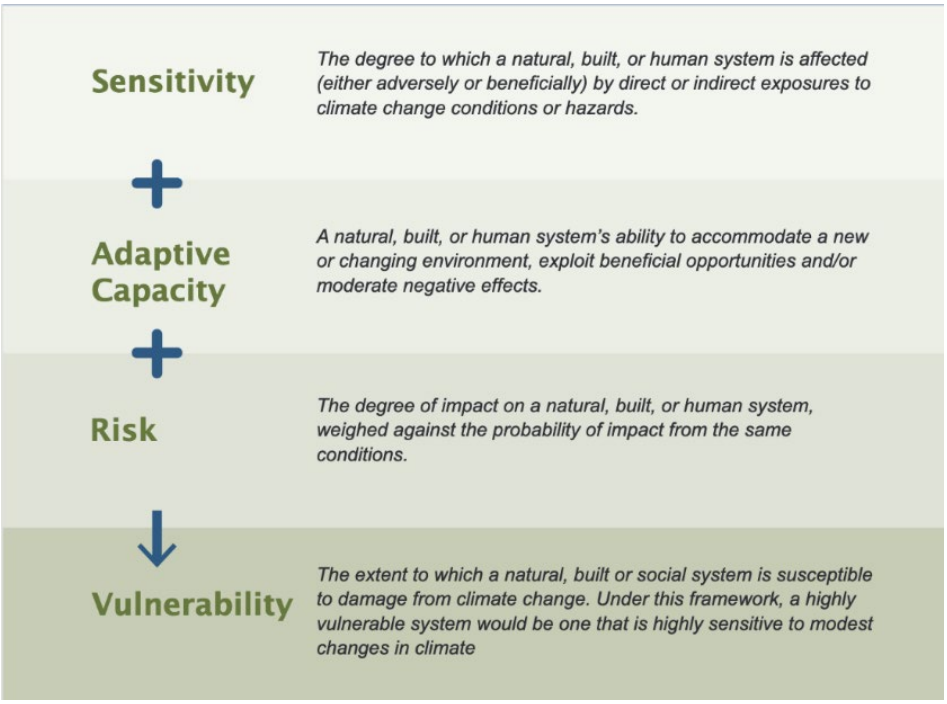


Image source: IPRE

The vulnerabilities and needs on the Oregon Coast are unique to each community; broad stakeholder outreach and engagement efforts were conducted in 2020-2022 to better understand local needs and concerns, and identify vulnerable assets, resources, and populations. The PCW and CQWG identified local stakeholders for a survey effort followed by a series of community listening sessions. Individual interviews were also conducted with many stakeholders for more detailed vulnerability context and information. Feedback collected through these efforts was used to help characterize vulnerability within the communities and habitats associated with each estuarine area.

[13] https://www.co.coos.or.us/sheriff/page/natural-hazards-mitigation-plan

Vulnerability assessment work in the Coos Bay estuary was led by IPRE and established the roadmap for assessing vulnerabilities within the broader ERAP effort. These results were leveraged for the Coos Bay estuary portion of the ERAP process and replicated and adapted for the Coquille River and Tillamook County estuary communities. The full Coos Bay vulnerability assessment and adaptation strategy is available in the Coos Bay Climate Hazards Adaptation Plan[14] (2022).

The components of the vulnerability assessment evaluate adaptive capacity, sensitivity, and risk (Figure 3) to determine vulnerability to a particular hazard. Adaptive capacity and sensitivities were largely determined directly from stakeholder interactions. Extant planning literature, such as state and local NHMPs, the Oregon Climate Assessment, and others listed in the previous section provided data, models, and future projections used to derive risk and additional vulnerability information. Data gathered from the survey effort and listening session were evaluated following a scoring method adapted from the IPRE, and used to determine quantitative scores and qualitative rankings for the various aspects of vulnerability. Vulnerability information was then used to characterize risk and identify and prioritize potential adaptation actions to increase local hazard resilience within the estuaries. While this effort is focused on areas that interact directly with the estuaries (either currently or historically), participants represented interests throughout Coos County, including those beyond the areas of direct estuarine influence. Consequently, some areas and concerns outside of the geographic scope of interest (areas of estuarine influence) may also be discussed at times in the summaries. This process largely focused on understanding impacts to human communities and the built environment and is intended to complement other planning efforts. For a full summary of vulnerability assessment methods, see Appendix A: Vulnerability Assessment Methods.

Due to the COVID-19 pandemic, community listening sessions and other interactions were conducted remotely. Pandemic conditions severely impacted participant availability in some communities and consequently the scope of results may reflect this limitation, and additional work may be needed to fill gaps in understanding.

Bandon waterfront, Coquille River estuary, 2018. Photo courtesy of Rick Poecker.

[14] https://partnershipforcoastalwatersheds.org/coastal-hazards/

III. Coos Bay Estuary Vulnerability Summary

The following section provides a summary of the findings adapted from the Coos Bay vulnerability assessment effort and resulting Coos Bay Climate Hazards Adaptation Plan. This effort, led by PCW and IPRE and supported by a FEMA Cooperating Technical Partnership grant, was leveraged for the Coos Bay estuary vulnerabilities portion of this ERAP due to considerable overlap of scope and goals. The purpose of the Plan is to identify climate-related and other natural hazard vulnerabilities in the Coos Bay estuary and surrounding communities, and outline adaptation strategies to address them. Its findings are also intended to support the ongoing Coos Bay Estuary Management Plan revision to help local communities and stakeholders better understand how to address resiliency through that process. While the ERAP process focuses on nature-based solutions, the scope of the IPRE process was broader, and this is reflected in the vulnerability assessment results below.

Key Takeaways

Focal Hazard of Concern	Sea Level Rise / Flooding

What are local stakeholders concerned about? The focal hazard for the Coos Bay estuary was the category of **sea level rise/flooding**, a composite hazard derived from a myriad of highly ranked flood threat sources such as heavy rains, tidal flooding, saltwater intrusion, and others. Stakeholders expressed the greatest concern for the anticipated Cascadia Subduction Zone (CSZ) earthquake and tsunami. However, because climate-related hazards were prioritized for this effort, this hazard was not evaluated. Other hazards of high concern include decreased summer precipitation (drought), heavier winter storms, and wildfire. Persistent drought conditions are likely to increase fire potential, and this relationship may elevate these threats in the future.

Why are local stakeholders concerned about it? Like much of the Oregon Coast, the Coos Bay region has a long rainy season, with regular flooding occurring during the November-February winter storm season. Rising winter temperatures may lead to increases in precipitation in upland watersheds, threatening to exacerbate flood potential. The annual rate of sea level rise in the estuary is increasing, with total rise expected to be 1.5-2.0 feet by 2050 (Board & NRC 2012, Sweet et al. 2017). Combined with tidal flooding (e.g., king tides), storm surge, and changes in precipitation, the flood threat looms large. Many businesses, structures, and low-lying high value lands are situated along the Coos Bay waterfront and its tributary rivers, particularly in the cities of North Bend and Coos Bay. Any increase in flood potential will significantly impact these communities, and the region as a whole.

What do local stakeholders want to do about it? Adaptation actions to address this hazard focus on updating infrastructure and local planning, increased restoration and natural resource management efforts, economic development, protecting cultural and historic resources, and public education. Stakeholders seek to adapt and protect existing infrastructure to future flood conditions, or relocate (as appropriate) critical systems such as sewer lines and wastewater treatment facilities. To reduce flood potential, protecting and facilitating landward migration zones for wetlands and other aquatic habitat are prioritized. This includes on-the-ground habitat restoration work, removal, or upgrades of water control infrastructure (e.g., levees and tide gates), and engagement in strategic planning to identify additional opportunities. Coordination with local business to support adaptation of business processes will help strengthen community resilience, along with broader outreach and awareness efforts.

Vulnerability

The vulnerability assessment effort in the Coos Bay estuary study area engaged stakeholders in five key sectors: Natural World, Built Environment, Economy, Public Health and Social Systems, and Cultural Heritage. The key vulnerabilities derived from each sector are outlined as focal areas, and were evaluated for adaptive capacity and sensitivity to natural hazards. Because the scope of this work includes resilience of built infrastructure, economic and social assets, and natural resilience, it reflects broader concerns than what may be addressed more strictly through nature-based solutions in the estuarine area. The section below summarizes the primary vulnerability findings from the Coos Bay vulnerability assessment effort.

Natural World

Six focal areas were identified:

Salt marsh: This habitat has been greatly impacted by human land use with nearly two-thirds of the habitat lost in Coos Bay. What remains is threatened by sea level rise and lack of landward migration space.

Tidal fresh wetlands: Similar to salt marsh, 96% of historic tidal fresh wetlands have been lost to land use changes in the Coos estuary. While more adaptable to landward migration, it is threatened by saltwater intrusion in coastal areas, as well as changing environmental conditions. Forested tidal wetlands are most vulnerable.

Native oysters, shellfish, and tidal flats: Many shellfish species are vulnerable to impacts of OA both in the estuaries and nearshore, particularly during juvenile life history stages. Oysters will be impacted by increasing precipitation, which will increase sedimentation rates and reduce salinity to potentially lethal concentrations. Tidal flat habitats are likely to migrate with sea level rise, but it is unclear what the long-term consequences may be.

Eelgrass: Thermal stress related to marine heat waves has led to large-scale die-offs of Common eelgrass (*Zostera marina*) on the Oregon Coast, reducing distribution and density. Human

activities and changes to regional dynamics in the California Current Large Marine Ecosystem are also contributing to eelgrass reductions.

Salmonids: Salmonid species will be impacted at every level of coastal watersheds. Rising stream temperatures in the upper watershed at times already exceed lethal levels for coho and Chinook salmon. Rearing and feeding habitats are being degraded and lost throughout the watershed and estuary, while sea level rise, marine heatwaves, and OA also threaten survival.

Upland forests: The estuary is bounded by dense temperate rainforest, which will be increasingly affected by changes to temperature and precipitation regimes. Warmer, drier summers combined with prolonged droughts and extreme heat waves are likely to indefinitely alter forest composition.

Built Environment

Building exposure: The metropolitan population situated around the Coos Bay estuary is the largest on the Oregon Coast. Consequently, Coos Bay has the greatest amount of infrastructure threatened by flooding, with 5% of buildings likely to be inundated by 2050, and 8% by 2100, given expected sea level rise plus 1% chance flood scenario. The highest number of buildings exposed are in the communities of Charleston, with 31% of buildings exposed to the 2100 scenario, followed by Bunker Hill (12%) and Libby (10%). In Central Coos Bay and Englewood neighborhoods of Coos Bay, 33% and 24% of buildings are exposed, respectively. The City of North Bend is at slightly lower flood risk with 5% of buildings exposed in the 2100 scenario. Additionally, 22% of buildings in the study area are at risk in the largest (XXL) Cascadia Subduction Zone tsunami scenario.

Community lifelines: Following the FEMA community lifelines scheme[15], local facilities were identified for the lifeline categories of “safety and security”, “food, water, and shelter”, “health and medical”, “energy”, “communications”, “transportation”, and “hazardous materials”. Of the 169 community lifelines identified in the study area, 82% are exposed to the 2050 SLR + 1% chance scenario, and 100% are exposed to the 2100 SLR + 1% chance scenario.

Transportation infrastructure: Vulnerability in this sector is high, and risk is exacerbated by deferred maintenance of many roads and bridges. Major routes that connect communities, such as US Hwy 101 and OR 540, are of critical importance, along with Southwest Oregon Regional Airport in North Bend.

Roads: US Hwy 101 may see more than 10 miles of road inundated by 2100, along with a total of nearly 94 miles of all roads impacted, including railways (especially through North Bend and Coos Bay). Hwy 101 connects the region to other areas of the coast, Oregon, and California beyond. Regional isolation already challenges access to facilities and services for many residents, and long-term disruptions to Hwy 101 and other arterial routes could have

[15] https://www.fema.gov/emergency-managers/practitioners/lifelines

catastrophic consequences. Flooding concerns for other critical routes include portions of OR 241, Coos-Sumner Lane, central Coos Bay, and Virginia Ave/Pony Slough area.

Bridges: 44 of the 80 bridges (55%) in the study area are exposed under the 2100 SLR + 1% chance scenario, with the McCullough Memorial Bridge (Hwy 101 over Coos Bay to North Bend) and the Isthmus Slough Bridge (connecting downtown Coos Bay to the Eastside District), identified as most critical. Of those 44, only 9 are expected to remain in relatively good structural condition under that same scenario. The bridges over Pony Slough (Virginia Ave), Coos River (County Rd 26), and Joe Ney Slough (County Rd 43), are currently in critically vulnerable scour condition.

Southwest OR Regional Airport: Another vital community lifeline serving the greater Coos Bay region, the airport facilities are located on a low elevation site adjacent to the estuary in North Bend. A significant portion of the runways are already within the 100-year floodplain, and the majority of the airport property is projected to be inundated in the 2100 SLR + 1% chance scenario. Other concerns include a 30,000-gallon fuel tank, and additional onsite buildings within the flood zone.

Utility infrastructure: The combination of potential sea level rise, flooding, tidal inundation, and storm surge, threaten to overwhelm water control infrastructure and systems in the Coos Bay estuary.

Stormwater: Levees, tide gates, outfalls, and other infrastructure are already impacted during extreme high tides. Many levees are overtopped during extreme events, and need to be built taller. Tide gates protect the drainage system from seawater infiltration on most outfalls, but some are missing while others are non-functional. Increasing green infrastructure options such as retention basins would help mitigate future increases in flooding. Top priorities include the Coal Bank slough levees in Englewood, and flooding issues in downtown Coos Bay and Blossom Gulch neighborhood.

Wastewater: High groundwater inflow and infiltration in the area threatens septic systems that may also be exacerbated by aging systems. The wastewater treatment plants in both Coos Bay and North Bend may be at risk under future sea level rise scenarios. Other top priorities include the Pony Creek pump station and private septic systems throughout the county.

Drinking water: There is limited capacity in the region for water retention during the drier summer months. This is expected to worsen with future climate change, and will ultimately impact drinking water systems that largely rely on local sources that fluctuate seasonally.

Electrical: Although generally resilient to future flood scenarios, future increases in climate change-driven demand may overstress current capacity. Electrical substations at Lockhart (Coos Bay) and Jordan Point are most critical to protect.

Economy

Coos Bay is an important economic center for the south coast region that is highly dependent on industry and natural resource extraction sectors (agriculture, forestry, fishing). There is a significant low-wage workforce presence (25%) and high levels of poverty (16%). Local economic diversity is relatively low compared to the rest of Oregon, and with two-thirds of residents employed in just five sectors: local government (20%), education & health services (14%), retail services (13%), leisure & hospitality (12%), and professional & business services (10%); given this, the local economy is highly vulnerable to disruption. Many businesses are situated on the waterfront, particularly in the downtown Coos Bay, where sea level rise and flooding threaten to disrupt the local economy. Industries such as tourism, fisheries, ports, retail, and leisure & hospitality, are all boosted by coastal tourism, and could all be significantly impacted by natural hazards. Five vulnerable areas of concern have been identified: Southwest Oregon Regional Airport, Pony Village Mall, Mill Casino, downtown Coos Bay, and the Charleston Marina/Barview area. Other concerns focus on impacts to habitats, fish, and wildlife, particularly with respect to healthy harvests of shellfish and salmonids, which support natural resources jobs and make important contributions to the regional economy.

Public Health and Social Systems

Social vulnerability in Coos County is overall highest on the Oregon Coast due to numerous interacting factors including disability rates and socioeconomic conditions. A few key demographics are disproportionately vulnerable, including the elderly, residents with disabilities, low-income, or living in poor-quality or mobile/manufactured housing, those lacking reliable transportation, and Indigenous, Hispanic, or non-native English-speaking people. The neighborhoods identified as having the highest social vulnerability are Empire, Empire Lakes, and Radar Hill-Ocean Blvd. Neighborhoods with the highest flood exposure (by 2100 or earlier) include Bunker Hill-Bay Park, Central Coos Bay, Charleson-Cape Arago, Englewood-Libby, Green Acres, Hauser, Millington, Sherman Heights-Pony Creek, and Sumner. Green Acres and Sumner also have the highest wildfire burn probability. More work needs to be done to identify highest priority sites and facilities.

Cultural Heritage

Sites and infrastructure of cultural significance were identified by local stakeholders, Tribal Nations, and through evaluation of the National Register of Historic Places[16]. The vast majority (96%) of the 314 sites exposed to the SLR + 1% scenarios are located in the City of Coos Bay. Of those, 52% are exposed to the 2050 scenario, and 64% to the 2100 scenario. The assessment does not include additional sites not on the Register that may be of significant importance to local cultural heritage, nor does it include Tribal Nations heritage sites. Tribal Nations heritage sites include some buildings and archaeological sites such as shell middens, sites for gathering of traditional foods and plants (e.g., tulle, sedge, camas), villages, cemeteries, and other sites

[16] https://www.nps.gov/subjects/nationalregister/index.htm

important for gathering and ceremonial uses. It is likely there are additional sites yet to be identified, particularly located outside the City of Coos Bay, which may be exposed to one or both flood scenarios. Efforts to identify additional sites and consult with local Tribal Nations should be integrated into planning processes. Updates to Goal 5 inventories and related processes may contribute additional sites and information.

King tides at Coos-Sumner Lane, Coos Bay, 2021. Photo courtesy of John Bragg.

IV. Coquille River Vulnerability Summary

The following section outlines the adaptive capacity and vulnerabilities identified by local stakeholders for the Coquille River estuary and surrounding communities. While this effort is focused on areas within the estuary, or that interact directly with the estuary (either currently or historically), stakeholder participants represented interests throughout the Coquille River basin, including those beyond areas of direct estuarine influence. Consequently, some areas and concerns outside of the geographic areas of interest (areas of estuarine influence) may also be discussed at times in the summary.

Key Takeaways

Focal Hazard of Concern	Water Quality Threats*

**e.g., changes to water chemistry, temperature, or turbidity*

What are local stakeholders concerned about? Stakeholders expressed the greatest concern for the hazard of impacts to **water quality**, manifested primarily as increases in temperature, turbidity, sedimentation, runoff, or other changes in water quality or chemistry. This also includes potential impacts related to ocean acidification and hypoxia, which may increasingly threaten species in the lower estuary in the near future. Degraded water quality is already impacting sensitive fish and other aquatic species throughout the Coquille River basin such as salmonids, which are highly valued culturally and ecologically. Proliferation of invasive gorse (*Ulex europaeus*) is also a major concern, as it is difficult to control its spread and greatly increases the threat of wildfire throughout the region.

Why are local stakeholders concerned about it? The flat basin that follows the Coquille River estuary upriver is composed almost entirely of historic tidal floodplain that has been diked and channelized for agricultural use. A vast array of outdated and failing water control structures (e.g., tide gates, levees) directionally limit tidal and floodplain connectivity and function, highlighting the need for improvements for both ecological and agricultural purposes. Vegetated riparian buffers are absent or greatly degraded along many channels and streams, increasing water temperatures, and limiting the intercept of runoff, leading to poor water quality for many species in the river. Drinking water sources are also threatened by siltation and other water quality issues, as well as decreasing availability with persistent seasonal drought conditions.

What do local stakeholders want to do about it? Adaptation actions to address this hazard focus on restoration of riparian habitat and waterway connectivity to improve ecological and hydrological function, and subsequently water quality. This includes replanting and restoring

riparian corridors and reducing agricultural impacts on the mainstem and tributaries where possible. Necessary repairs, upgrades, replacement, or removal of water control structures such as tide gates and levees, as well as construction or reestablishment of tidal channels, must also accompany habitat improvements. These efforts will increase coldwater refugia and reduce stream temperatures throughout the system, improving conditions for temperature sensitive species such as salmon. Restoration efforts will also reduce agricultural runoff and sedimentation, improve habitat quality and availability, and restore drinking water quality.

Table 1. Coquille River Vulnerability Summary

Critical Interdependencies	Critical Vulnerabilities
The systems, resources, assets, infrastructure, and populations that this community depends on to properly function include: • Tide gates, culverts, and other water control structures • Sensitive estuarine habitats (e.g., cold water refugia, eelgrass beds) • Private landowners in the basin	**The resources, assets, and populations identified as particularly vulnerable to the assessed hazard include:** • Chinook and coho salmon populations • Waterway connectivity and ecological function • Drinking water sources in Bandon, Coquille, and Myrtle Point • Invasive gorse threat (wildfire hazard)
Hazards of Greatest Risk	**Hazards of Greatest Concern**
Subjective ranking of the perceived risk imposed by current or projected natural hazards based on probability and consequence of occurrence: • Changes to water temperature, quality, or chemistry • Sea level rise and saltwater intrusion • Changes to climate regime (climate change)	**The most critical natural hazards of concern that may be chronic or episodic in nature:** • Water quality/table issues • Wildfire • Climate Change • Invasive species

Vulnerability Rankings

Adaptive Capacity†	VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH

Primary Hazard Assessed: Changes to water temperature, quality, or chemistry

Sensitivity	Impact	Hazard Vulnerability
HIGH	MEDIUM	HIGH

†*Note:* Adaptive capacity is ranked in the *opposite* direction of the other factors (i.e., low adaptive capacity is bad, whereas low vulnerability is good), and is evaluated independent of a given hazard.

The colored table above summarizes the major findings from the stakeholder outreach and engagement effort. The qualitative vulnerability rankings shown were assessed relative to the water quality impacts hazard. Adaptive capacity, however, is evaluated separately from hazard-specific risk, and assesses the system's ability to adapt to changing conditions. The more a system is able to adapt to a given hazard, the higher that system's resilience.

Overall, the hazard vulnerability ranking relative to the water quality hazard for the Coquille River estuary is **HIGH**. Sensitivity is also ranked **HIGH**, and impact is ranked **MEDIUM**, owing in part to the expansive protected wetlands in the lower estuary and numerous efforts in recent years to protect and restore ecological function. However, the sensitivity of estuarine fish species, compounded with other external stressors on the system (e.g., climate change, sea level rise, land use impacts, etc.), and challenges of local engagement with action result in generally **LOW** adaptive capacity ranking of the system.

Area Description

Figure 4. Coquille River estuary FEMA flood zones and estuarine levees.

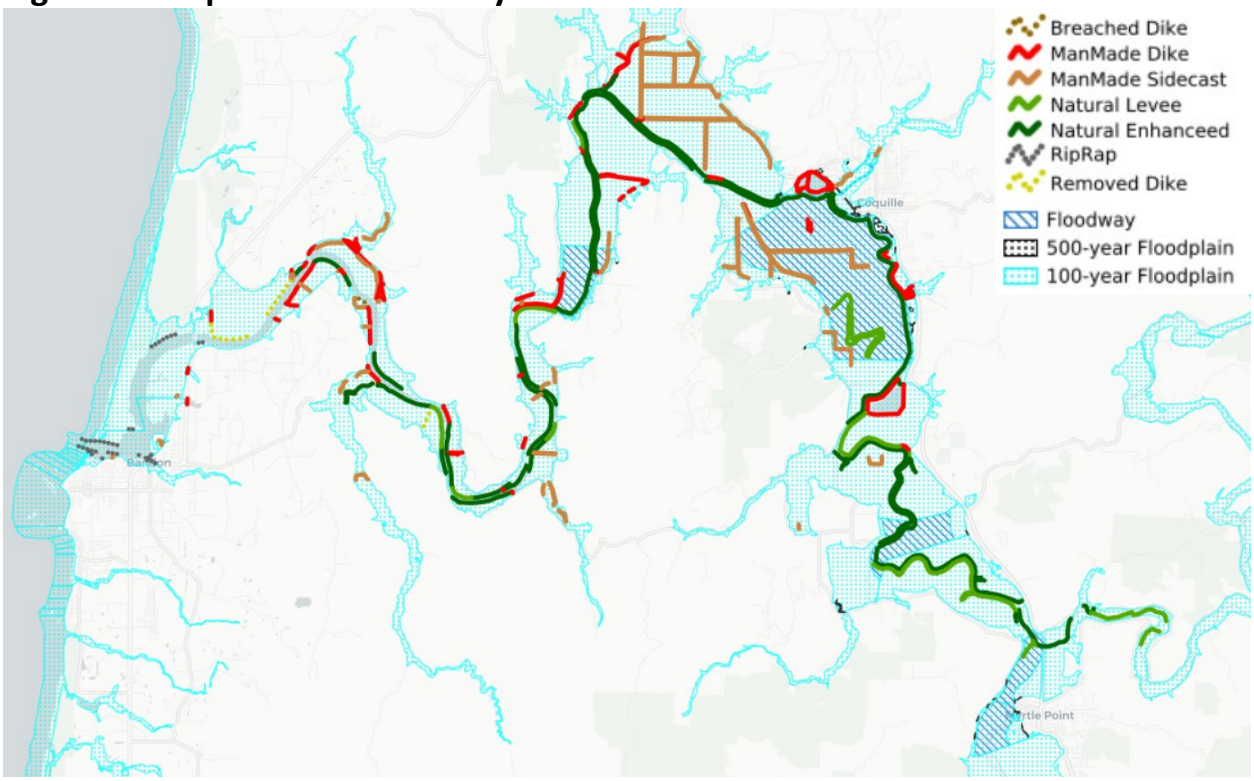


Image source: Oregon Estuary Data Viewer[17]

The Coquille River watershed lies south of the Coos Bay watershed, and is the fourth largest watershed in Oregon at 1,059 square miles. The river mouth lies next to the City of Bandon, and extends its estuarine influence at least 12 river miles upstream, with tidal influence extending

[17] https://www.coastalatlas.net/estuarymaps/

41 river miles to the City of Myrtle Point. Since Euro-American colonization, land use in the basin has been dominated by timber and agricultural operations. The low, flat basin floor has been diked, drained and/or channelized, and irrigated for over 150 years to facilitate extensive cattle grazing. Nearly all of the basin floor is within the 100-year floodplain, with significant portions directly in the regulatory floodway (Figure 4). The lower estuary contains extensive tidal wetlands, particularly the Bandon Marsh National Wildlife Refuge, which has undergone considerable restoration in recent years. In the upper estuary, near the City of Coquille, is the Winter Lake basin (Figure 5). This nearly 2000-acre lowland is grazed by cattle in the summer, and inundated in the winter to create off-channel wetland habitat for juvenile salmonids and many other species. Numerous other streams and side channels interact with the main channel along the estuary, though many have been channelized, diked, or regulated with hard infrastructure such as tide gates, altering the natural historic function of the estuary.

Figure 5. LiDAR elevation observation of the Coquille River basin.

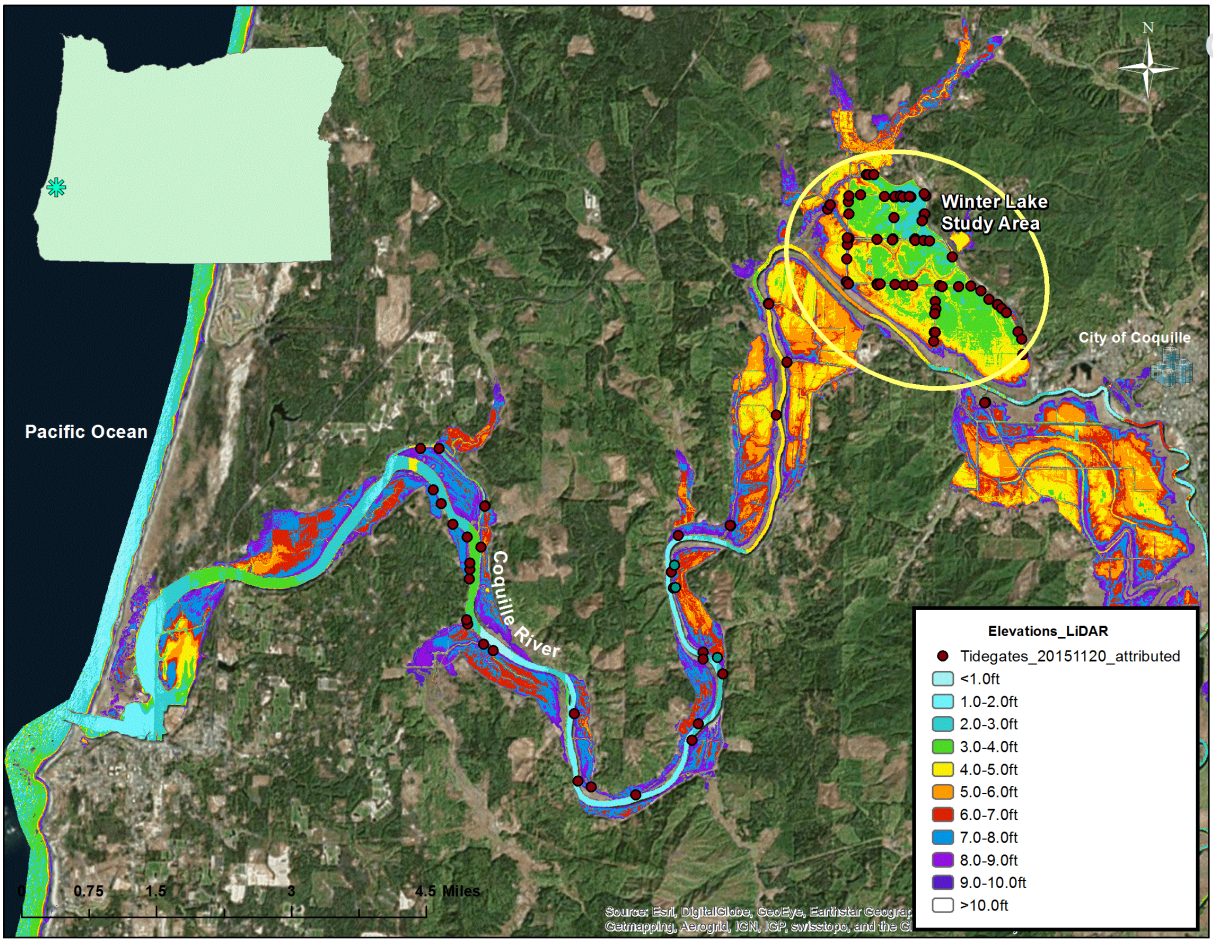


Image source: Huff & Claire 2019

Participating Stakeholder Organizations

The following organizations participated in the vulnerability assessment effort:

- City of Bandon
- City of Coquille
- City of Myrtle Point
- Coos County
- Coos Watershed Association
- Coquille Indian Tribe
- Coquille Watershed Association
- Oregon Department of Fish and Wildlife
- Oregon Department of State Lands
- Oregon Parks and Recreation Department
- Oregon Shores Conservation Coalition
- Partnership for Coastal Watersheds
- Port of Bandon
- Shoreline Education for Awareness
- South Slough National Estuarine Research Reserve
- US Fish and Wildlife Service
- Wild Rivers Coast Alliance
- Wild Rivers Land Trust

Water Quality Issues

Stakeholders throughout the Coquille River basin consistently expressed concern over the hazard of impacts to water quality, manifested primarily as increases in temperature, turbidity, sedimentation, runoff, or other changes in water quality or chemistry. In the Coquille River, exceedance of water quality standards often occurs seasonally, particularly in damaged and denuded channels and tributaries, several of which are no longer contributing coldwater to the mainstem. Numerous point and non-point sources are impairing water quality including development, failing septic systems, runoff (urban and rural), agricultural activities (e.g., livestock management), and wastewater treatment plant discharges in Bandon, Coquille, and Myrtle Point (DLCD 2014b). The considerable amount of agricultural activity in the basin may be contributing to the higher fecal coliform concentrations in the river, which fluctuates with runoff (DLCD 2014b, OODEQ 2011). Aggregate impacts from these stressors are affecting fish and wildlife in the estuary, particularly salmonid spawning and rearing, anadromous fish passage, shellfish, and other resident fishes and aquatic species. Despite this, eutrophication likely remains a low to moderate threat in most of Oregon's estuaries, including the Coquille, due to significant tidal flushing (DLCD 2014b).

Table 2 contains a list of Impaired Waters[18] in the Coquille River basin with their affected water quality parameters. 12 of the 19 listed streams are temperature impaired, with all but one impaired year-round (unnamed tributary to Hatchet Slough). This represents a significant portion of the basin. The most sensitive beneficial use for the water temperature criterion is coldwater aquatic communities and ecosystems. Sensitivity varies based on species, life history stage, and time of year, but salmonids and amphibians are generally regarded as most sensitive. Salmon migrate to the upper mainstem of the Coquille River and its main tributaries for spawning where the temperature criterion is 17.8 or 18°C.

Table 2. Water Quality Limited Streams with Affected Parameters

		Parameter					
Name	Description	DO	T	FC	EC	Fe	Turb
Bear Creek	Coquille R to Little Bear Cr	X+	X^				
Beaver Slough	RM 1 to headwaters	X+	X^				
Bill Creek	Mouth to headwaters						
Calloway Creek	Mouth to headwaters				X		
Catching Creek	Coal Cr to S Fork Coquille		X^		X		
Coquille River	Mouth to Fahys Creek			X			
Coquille River	Fahys Cr to China Creek	X+	X^		X		
Coquille River	China Cr to N/S Fork confluence	X	X^	X			
Cunningham Creek	Mouth to headwaters	X+		X	X		
Fat Elk Creek	Mouth to headwaters		X^				
Ferry Creek	Mouth to headwaters						
Fishtrap Creek	Coquille R to Little Fishtrap Cr					X	
Gross Creek	Mouth to headwaters						
Hall Creek	Mouth to headwaters	X+	X^		X		
Hatchet Slough	Mouth to headwaters		X^				
Lampa Creek	Mouth to headwaters		X^				
N F Coquille River	Coquille mainstem to E F Coquille R	X	X^			X	X
Sevenmile Creek	Mouth to headwaters						
S F Coquille River	Coquille mainstem to M F Coquille R	X+	X^				
Unnamed trib to Hatchet Slough	Mouth to headwaters		X				

Data Source: OODEQ 2022 Integrated Report
DO = Dissolved Oxygen – Salmonid Spawning: October – April
+ = Dissolved Oxygen: Annual
T = Temperature: Summer
^ = Temperature: Annual
FC = Fecal Coliform: Fall – Spring
EC = E. coli
Fe = Iron
Turb = Turbidity

[18] Clean Water Act §303(d) listing

Temperature

While estuarine waters tend to keep the lower Coquille River mainstem cooler (Ruggiero et al. 2010), the upper mainstem has been temperature impaired since at least 2010 (Mayer 2012). This effect is attributable to a combination of factors, including stream channel modifications, removal of riparian vegetation (often via livestock grazing), diking, draining, or filling of wetlands, construction of reservoirs and other water diversion techniques, and upland timber harvest or other land clearing activities. From the 1850s through 1990s, these activities were not conducted with preservation of stream temperature in mind, but collaborative efforts (e.g., state and federal agencies, conservation organizations, and private landowners) for best management practices in the Coquille basin have begun to directly address this issue in recent years. The warming trend from 1903-2010 was approximately 0.1°C per decade on average for Coos County, and is projected to climb to 1.4°C (cumulative) by the 2040s, and to 1.8°C by the 2060s (Sharp et al., 2012). Similarly, Mayer (2012) found that the 7-day summer stream temperature averages at the mouths of the three major tributaries (South, North, and Middle Forks) were 22.0-24.6°C, far exceeding the expected 16°C. These averages are expected to increase approximately 0.7°C by the 2040s, and 0.9°C by the 2060s (*ibid*).

Dissolved Oxygen

Warming trends are also likely to impact dissolved oxygen (DO) concentrations in the Coquille River basin. Increasing temperatures decrease the ability of water to dissolve atmospheric gasses, including oxygen. 8 of the 19 Impaired Waters are listed for DO, with 6 impaired year-round (Table 2). Most of the DO-impaired reaches are higher up in the Coquille River system, but impacts from low concentrations can become cumulative further downstream and worsen in combination with runoff and heavy organic loading at the head of tide (CIT 2007). DO is also impacted by effluent from municipal sewage treatment plants in the Cities of Coquille and Myrtle Point, with the latter often discharging partially treated sewage during heavy rainfall events (*ibid*).

Other Water Quality Factors

Other water quality concerns in the Coquille River estuary include OA, sediment deposition and turbidity, nutrient loading, and other changes in hydrology. Increases in OA are expected to impact numerous marine and freshwater species, particularly shell-building and other calcareous organisms, or species which rely on them (such as salmonids). The Pacific Ocean has already seen a greater than 16% decrease in aragonite and calcite saturation states in the last 250 years (Feely et al. 2012), with an acceleration of this trend in recent years. Sedimentation and turbidity also decrease DO and increase stream temperature, among numerous other threats to aquatic life including covering salmon spawning gravel, blocking upstream migration, reducing prey availability, altering stream morphology, and gill abrasion. Nutrient loading is common in Oregon's estuaries, and can result in eutrophication, decreased DO concentrations, and may contaminate sediments (DLCD 2014b). Hydrology is likely to change in the future as well, impacting water quality. Higher mean flows are expected in the fall season by 2065 (Steele

et al. 2012), but with reductions in summer flows due to higher summer temperatures and decreased precipitation (Sharp 2012, Steele et al. 2012). Lack of significant groundwater input into the Coquille River, which can help regulate summer stream temperatures, may also contribute to these issues (Mayer 2012).

Improved understanding of water quality in Oregon's estuaries is currently challenged by a relative paucity of data (DLCD 2014b). Nonetheless, climate change and other natural hazard impacts in the Coquille River basin and estuary can be better understood in the context of broader, regional changes. Most of Oregon's river-dominated estuaries are well-flushed by their large tidal prisms and have low to moderate susceptibility to eutrophication (NOAA 1998), which may help to limit the extent of anticipated climate change impacts on water quality.

Vulnerability

Participants indicated their hazards of greatest concern to be wildfire, climate change, and water quality/table issues. However, changes to water quality, temperature, or chemistry rose to the top when asked to rate the hazard of greatest risk, followed closely by sea level rise & saltwater intrusion. Vulnerabilities were assessed primarily based on impacts to water quality in mind, which includes factors such as runoff, turbidity, sedimentation, temperature increases, low dissolved oxygen, nutrient limitations, acidification, and other changes to water chemistry. Wildfires were also identified as a persistent parallel theme throughout the process with respect to invasive gorse (*Ulex europaeus*). If climate change increasingly favors wildfire conditions, this threat will become even more important.

Some of the notable assets or resources (e.g., infrastructure, natural resources, habitat, vulnerable populations, cultural resources, equipment/supplies, structures, etc.) identified as most vulnerable to the hazard(s) of concern are as follows:

- Coldwater fish species (esp. Chinook and coho salmon, lamprey, white sturgeon) and associated harvests
- Failing, aging, outdated, or nonfunctional water control structures (e.g., tide gates, levees, culverts)
- Old Town/downtown Bandon buildings and infrastructure (saltwater intrusion)
- Bandon drinking water source quality and availability (e.g., Ferry Creek watershed)
- Safe access and egress to/from coastal and estuarine sites (esp. for emergencies)
- Wastewater treatment facilities (Bandon Wastewater Treatment Plant, Coquille Sewage Treatment Plant, Myrtle Point Sewer Treatment)
- Campgrounds and other recreational facilities (e.g., gorse threat at Bullards Beach State Park)
- Sensitive estuarine habitats (e.g., eelgrass beds, marshes, tidal swamps, mudflats exposed at low tide)
- Other vulnerable, sensitive, or threatened aquatic species present throughout the basin

- Ecosystem health of forests, streams, and wetlands that interact with the estuarine basin

While these are the primary vulnerabilities identified in this effort, its representation is limited to the perspectives of the participating stakeholders. It is not comprehensive of all potential natural hazard vulnerabilities throughout the Coquille River estuarine area. Vulnerability assessment results should be interpreted in the broader context of similar efforts such as the Coquille Estuary Climate Change Vulnerability Assessment (Mielbrecht et al. 2014), and the Coos County Natural Hazard Mitigation Plan.

Adaptive Capacity

Adaptive Capacity is a natural, built, or human system's ability to accommodate a new or changing environment, exploit beneficial opportunities and/or moderate negative effects.

Current Condition

Overall, adaptive capacity for the Coquille River estuary was rated as **LOW**. The primary concerns for adaptive capacity are focused on natural waterway functionality, availability, and connectivity throughout the watershed. These concerns can be understood in terms of stressors impacting water quality and availability, such as water control structures present in the basin that are in need of maintenance, upgrades, replacement, or removal. These issues interact and compound to threaten habitats and species, and impact human communities.

The historic extent of many habitats in the Coquille estuary have been significantly degraded or reduced, particularly in the lower estuary. Here, many shorebirds rely on marine nutrient regimes that can be impacted by runoff and land use changes. The extent of eelgrass is diminishing with little focus on restoration compared to local tidal wetlands. Threats such as tsunami and sea level rise are also ever-present, and could substantially alter habitat distribution and availability throughout the estuary.

In the middle and upper watersheds, salmon struggle to complete their life histories, relying on diminishing coldwater refugia provided by small and medium tributaries. They also rely on non-marine nutrient inputs such as leaf litter and instream woody debris, particularly above river mile (RM) 12 where the influence of salinity and marine nutrients is significantly less. Several small tributary creeks have potential to increase their coldwater input to the mainstem but streambanks are largely damaged and require riparian vegetation restoration, as well as repairs to culverts and tide gates. Restoration and improved waterway connectivity in other low-lying areas such as those around Beaver Slough/Winter Lake, Iowa Slough, Fat Elk drainage district,

and west of George Clausen Road, would be of additional ecological benefit. Other coldwater fish species such as sturgeon and eulachon stand to benefit from these efforts as well.

While the habitats and species in the Coquille estuary have proven to be highly adaptive to many disturbances, they are far less resilient to the impacts of climate change and sea level rise. Implementing restoration to improve water quality and provide refugia can improve conditions for fish and wildlife, but requires changes to human practices on the landscape such as riparian habitat restoration and limiting livestock grazing at the water's edge.

Redundancies

The cumulative effects of limiting stressors in the Coquille River basin increasingly challenge the success of many habitats and species. Increasing water temperatures are reducing the availability and persistence of coldwater refugia for feeding and reproduction for many aquatic species, especially salmonids. Invasive bass species, which prey on juvenile salmonids and other native species, take advantage of warmer water conditions within the Coquille River and are an additional stressor in the river. This increases demand on the remaining habitats and resources available in other parts of the system, overwhelming their capacity to provide suitable conditions.

Management Actions

Restoring loss of waterway function and connectivity is regarded as difficult to accomplish due in large part to the patchwork of private land ownership and small subwatersheds throughout the Coquille River basin. There are varying levels of engagement, interest, and ability among landowners to improve the aging water control infrastructure, and relationships need to be navigated thoughtfully to ensure productive partnership action. Replacements of failing culverts and improvements to tide gates are top priorities for many stakeholders. Several organizations coordinate with private landowners for habitat restoration to reduce water temperatures and improve sediment loading and other water quality factors. However, funding sources and mechanisms available to support this work are insufficient to meet current needs.

The County, local communities, and Tribes have limited resources and capacity to address these issues or respond in the event of a widespread episodic event such as wildfire or a Cascadia subduction zone earthquake and tsunami, presenting a significant barrier to action. These capacity limitations can be partially ameliorated through coordinated local partnerships such as those between the City of Bandon, the Gorse Action Group, and Wild Rivers Coast Alliance, which aim to address and manage the invasive gorse issue.

Sensitivity

Sensitivity is the degree to which a natural, built, or human system is affected (either adversely or beneficially) by direct or indirect exposure to climate change conditions of hazards.

This section describes the primary sensitivities identified by the CQWG, community stakeholders, and participating Tribal Nations. While not exhaustive, these vulnerable assets, resources, and populations represent the highest level of concern, particularly with respect to the assessed water quality hazard.

Estuarine Habitats and Species

Figure 6. Coquille River aquatic habitats.

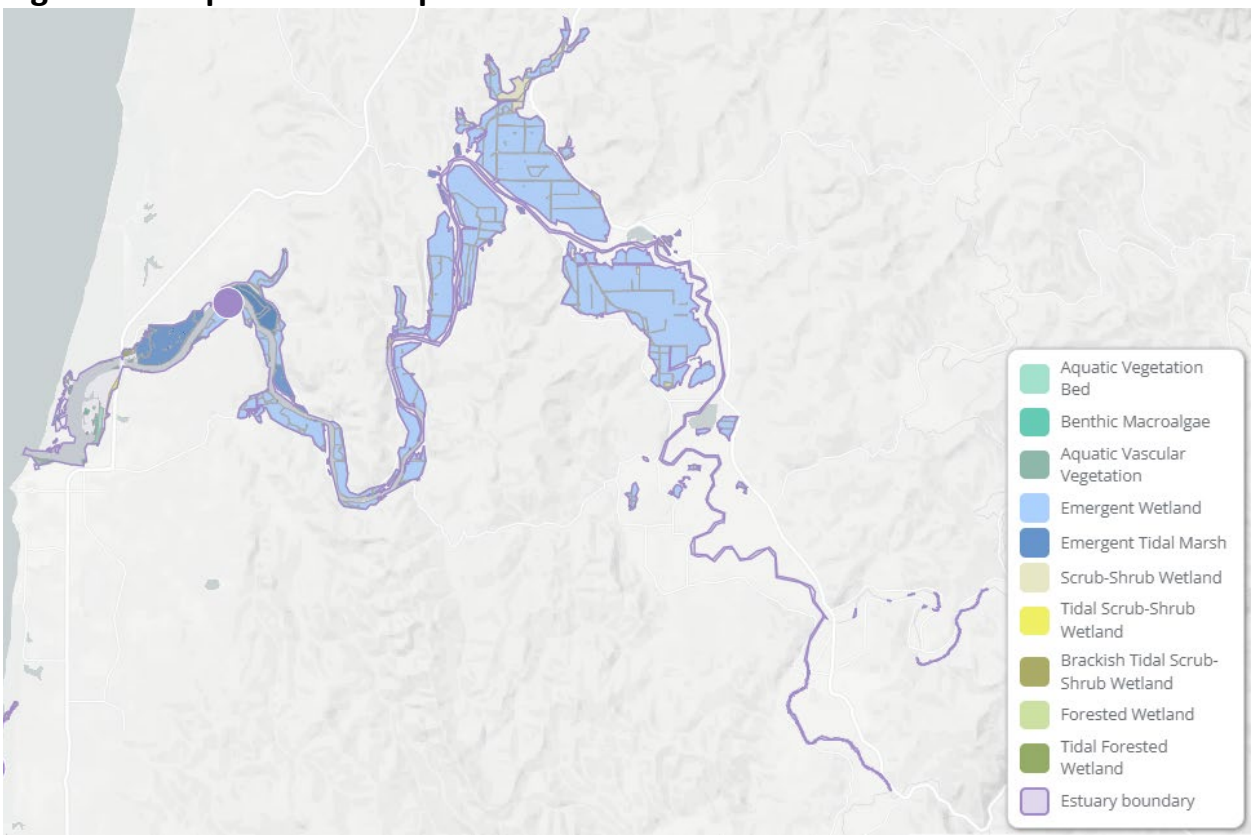


Image source: West Coast Estuaries Explorer

Sensitivity of habitats and species varies greatly, with a select few that are much more sensitive than others to changes in environmental conditions. Many in the Coquille River estuary are threatened by a number of environmental stressors that are already impacting water and habitat quality for fish and other aquatic organisms within the estuarine ecosystem. Impacts to water quality are a top concern among local stakeholders, and manifest most often via changes to stream temperature, agricultural runoff, increasing turbidity and sedimentation, and other alterations in chemistry.

In the lower estuary, sedimentation and ocean acidification may threaten survivability of fish, shellfish, and eelgrass. In the middle and upper estuary, rising temperatures, sedimentation, and predation combined with lack of coldwater refugia challenges the survivability of many fish

species. Most fish species that utilize the estuary are vulnerable, particularly Pacific lamprey, Chinook and coho salmon, steelhead, cutthroat, and rainbow trout, and white sturgeon. Coldwater fish species and freshwater mussels are particularly sensitive to increasing summer temperatures and high-flow winter storm events. Anadromous fish species are important for a variety of groups including tribal communities, recreational and commercial anglers, and reductions in fish harvest are already impacting local economies. Juveniles are the most sensitive life history stage for both fish and shellfish, but lack of rearing capacity in the system is damaging populations. Invasive smallmouth bass numbers are increasing and threaten native species by preying on juvenile fish, out-competing for resources, and benefit from warmer temperature regimes.

Salmonids

Rising water temperatures are a critical threat, affecting coldwater fish species throughout the basin. Salmonids are especially sensitive to temperature increases, particularly coho, steelhead, and Chinook. The Coquille basin Chinook salmon population is severely imperiled at approximately 0.5% of historic levels (ODFW & CIT 2022), down from 5-8% just a few years ago, having been impacted by increasing temperatures and smallmouth bass predation. Steelhead populations are down as well, while coho are presently stable (NOAA 2022). Lethal temperatures for these species are between 20-25°C (68-77°F; Richter & Kolmes, 2005), which are already observed regularly and increasingly throughout the basin in summer with a high of 28.3°C (83°F) observed in summer of 2021. The upper end of the estuary (Myrtle Point) and approximately 10-15 miles above that are the warmest part of the whole basin.

Turbidity and Sedimentation

Turbidity and sedimentation are increasing in the river, driven by damaged and denuded riparian and upland habitat (e.g., grazing and clearcut logging practices), limiting intercept of runoff, and leading to streambank destabilization. Increasing turbidity clogs fish gills and reduces dissolved oxygen (DO) availability, while sedimentation reduces light availability for eelgrass and other aquatic plants; these factors may be impacting native Olympia oysters as well. Salmonids are especially sensitive to changes in DO, with juveniles highly sensitive to even slight reductions of DO. Siltation can also limit fish migration, cover spawning gravel, reduce availability of aquatic invertebrates, and threatens to inundate tidal wetlands in the lower estuary.

Water Control Structures

Maintenance and upgrades needed on numerous water control structures is another vulnerability with clear solutions to prevent deteriorating conditions. Structures such as tide gates, levees, culverts, road fill, and splash dams were installed throughout the basin in the last 150 years largely to prevent flooding and drain the flat lowlands along the river for agricultural use. Simultaneously, riparian vegetation buffers along stream channels were denuded and removed to clear land for livestock grazing and hay production. Many streams have also been

channelized, straightened, and redirected to drain wetlands or for irrigation purposes, reducing natural complexity and riparian habitat and function. The cumulative effects of these modifications have increased temperatures, agricultural runoff, sediment transport, deoxygenation, flow velocities, and bank destabilization, resulting in basin-wide impacts to water quality and temperature.

Many of these structures are aging and in a state of disrepair, requiring maintenance, upgrades, replacement, or removal. The Nature Conservancy, ODFW, Coquille Watershed Association, Coos Soil and Water Conservation District, and other partners conduct work throughout the basin, partnering with local landowners to identify candidate sites for restoration and waterway reconnection. In recent years, this has included a massive new tide gate installation and restoration effort targeting juvenile salmon on China Creek at the Winter Lake site. However, similar projects are needed throughout the basin.

Bear Creek at RM9 could be contributing coldwater, however its riparian habitat within the lower reaches is damaged resulting in moderately cool stream contributions to lower Coquille River. This makes Bear Creek a higher restoration priority for cold water refugia. Similarly, restoration is needed at Lampa Creek (RM11), which could be contributing cold water but is currently violating ODEQ thermal tolerances. There are many more examples lower in the Coquille River watershed that have significant potential to be coldwater refugia with moderate habitat restoration actions.

Beaver Creek (Slough), at RM20 near Beaver Hill Road and North Bank Lane, has high restoration potential and is denuded of riparian habitat on the lower mile of stream. There are also several undersized culverts on the stream that are blocked and in need of upgrades. Restoration potential here is high, with opportunities to improve tidal wetland hydrology. Beaver Creek is currently within ODEQ thermal tolerances, but riparian tree removal has caused rapid warming outside of salmonid standards. In November 2022, nearly $3 million in funding was awarded to the Coquille Watershed Association to move forward with replacement of the Coaledo tide gate, restore riparian vegetation, and install livestock exclusion fencing in an effort to enhance fish passage and ecological function.

Further upriver, discharge from the sewage treatment plants in the Cities of Coquille and Myrtle Point have violated DO standards, leading to instream reductions of DO. Heavy rainfall events have resulted in partially treated discharge from the facility in Myrtle Point, which pulls directly from the river.

Figure 7. Coquille River aquatic habitats.

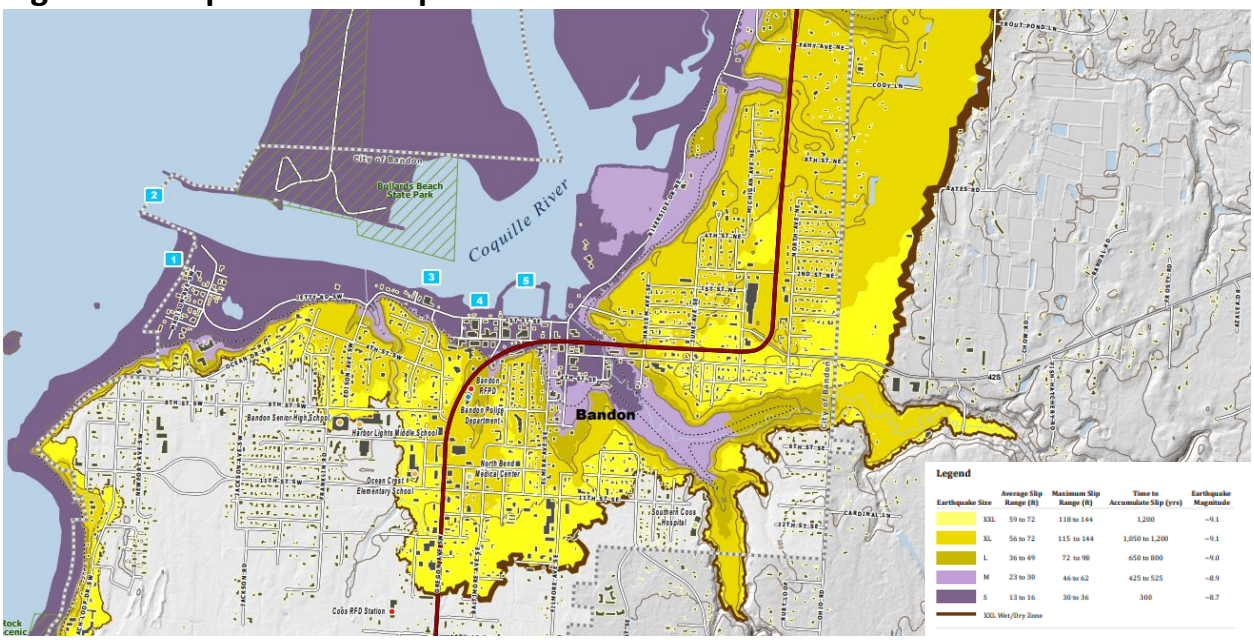


Image source: DOGAMI Tsunami Inundation Map Series[19]

Old Town Bandon lies in a floodplain parallel to the river and is vulnerable to flooding, storm surge, tsunami, saltwater intrusion, and sea level rise. Even a relatively small-scale tsunami is likely to inundate the downtown area and several surrounding businesses such as Face Rock Creamery, as well as the neighborhood near Redmond Pond and south jetty (Figure 7). Tectonic uplift on this section of the coast is currently keeping pace with sea level rise, but will likely be outpaced in the 2030s (Komar et al. 2010). Storm surge, saltwater intrusion, and larger flood events are more immediate threats to shoreline infrastructure, and may lead to increases in non-point source pollution in the lower estuary. Most structures in Old Town Bandon are built on piers, posts, or old fill in the 1920s and have not been well maintained, with saltwater now intruding into several buildings and businesses near the downtown waterfront. The City is investigating options to raise or move buildings out of the floodplain, but are confronted with prohibitive costs. Old Town Bandon has only two or three available storm drainage options and improvements to the storm drain system would help mitigate some of the issues. The City is interested in identifying nature-based solutions, such as adopting or updating more green-infrastructure friendly storm drainage codes, which could help mitigate the issue.

The Moore Mill site is an old log yard north of downtown with fill outside of the floodplain. Moore Mill Lumber Company owns the property and has mobile offices and some refrigeration tanks on site, but otherwise has not used the site for many years. Development interests

[19] https://www.oregongeology.org/pubs/tim/p-TIM-overview.htm

include aquaculture by the Port of Bandon, while others are interested in residential development despite difficulties with developing proper infrastructure for this use. Unclear zoning records challenge development progress there, but it has high potential for restoration, appropriate development, environmental education, and recreational uses, which the City is interested in facilitating.

Bandon Drinking Water Sources

Drinking water systems and sources for Bandon are increasingly challenged by drought conditions, and lack sufficient retention capacity. Siltation in the Ferry and Geiger Creek watersheds is filling the retention ponds, and threatening availability of the town's water supply. The source of the siltation is not presently known, but is likely to be partially mitigated through habitat restoration efforts in those watersheds. Seasonal droughts have been increasing in intensity and severity, at times reducing summer water storage to a 3-day supply, further compounding the issue. The City shares water rights with Oregon Department of Fish and Wildlife's Bandon Fish Hatchery, and must also manage downstream water quality impacts from cranberry bogs in the watershed. Siltation is also impacting wetlands throughout the lower estuary. Current updates to the water master plan include an effort to identify alternative solutions to this issue.

South Jetty Area

In the south jetty area, several locations are in need of improvements. The parking lot at the south jetty floods regularly with king tides and storm surge, with storm watchers often climbing out on the jetty rather than remaining on the bluff. A solution is needed to improve safety and separation from the influence of tidal events. The City has installed large boulders to prevent parking, but they are often moved by visitors. Alternatively, the City is interested in grading the lot to convert part of it into a retention basin to reduce flooding and keep water off the road.

The City and Port of Bandon are presently working to purchase land around Redmond Pond near the south jetty to preserve and improve its natural character and hydrological function. The adjacent residential lots are in the floodplain (and covered in gorse), and vulnerable to tsunami, king tides, and storm surge. The area will be a multi-use natural area with newly installed walking paths, a boardwalk, and a bird watching area. This will improve local safe access and egress in the event of a flood emergency, providing pedestrian access to Jetty Road. Work on this project begins spring of 2023, and will continue for up to five years.

On Jetty Road, storm drainage is in need of improvement, as well as the seawall, which is regularly breached in storms. Addressing this issue will be costly, and likely not incorporate a nature-based solution, however the City is open to alternative solutions. Right-of-way on Jetty Road is very narrow in this section, so alterations to that occupy more space than the current riprap (such as continuation of sidewalk from Redmond Pond) may require right-of-way acquisition to push the road slightly inland.

City of Coquille

The City of Coquille lies along the Coquille River at approximately RM30. Sturdivant Park and an old Georgia-Pacific (GP) mill site are the primary riverfront greenspaces, separated from town by State Route 42. The City is interested in improving pedestrian and watercraft access in the area, including extending the river walk, which includes restoring and enhancing local riparian habitat. The City is seeking pedestrian connection alternatives, and would like to extend the river walk potentially as far as 2.5 miles south to Johnson Log Pond on an old railroad right-of-way. A joint ODOT Community Paths grant application was submitted with Coos County for this work, which would include two bridge crossings and using conceptual designs, but engineering plans will still be needed. The City is also coordinating with Oregon State Marine Board to replace the boat dock at Sturdivant Park, and install a standup paddleboard/kayak launch near the old GP mill site.

In town, a series of culverts in the natural drainage pathway that flows under 4th St. and on nearby Dutch John Creek, are routinely clogged. This is largely attributed to beaver activity, but also undersized and failing culverts. Annual maintenance involves unplugging the culverts with an excavator and hiring a beaver trapper when necessary. Maintenance and replacement of the culverts has been deferred for several years, and the equipment is beginning to lift up and damage the roadway. This is a serious infiltration and inflow issue, but the City cannot currently afford the large price tag (likely millions of dollars) that will be needed to address it.

Just south of town, habitat restoration is needed on the lower reaches of Rink Creek to reduce stream temperature. The creek could be contributing coldwater to the Coquille River, but is currently in violation of ODEQ coldwater refugia standards.

Just north of town is a Roseburg Forest Products lumber mill with several log ponds behind a levee system adjacent to the Coquille River. Monitoring and maintenance of the integrity of the levees is an important priority, as levee failure could cause catastrophic damage to the river.

City of Myrtle Point

Upriver near the head of tide (approximately RM40) is the City of Myrtle Point. Water quality concerns are relatively minimal with the exception of the sewage treatment plant. Flooding is a bigger concern, especially in the southwest part of the city where several homes are in the floodplain next to the river, as well as the Coos County fairgrounds and some industrial sites. Addressing the problem would require installing a set of large box culverts and raising the road, which lies in the floodway. Several agricultural properties surrounding the city also routinely flood and are slowly drained into the river, but is mostly treated as a fact of life by local residents as there are no plans for development.

North of town, the North Fork of the Coquille River merges with the mainstem at RM40. The North Fork could be contributing coldwater but is currently in violation of ODEQ coldwater

refugia standards. There is opportunity for and interest in riparian habitat restoration along the North Fork to address this problem.

Wildfire Threat

Finally, while not related to water quality issues or specifically estuarine in nature, invasive gorse (*Ulex europeaus*) has long been a threat to the local community for 150 years, having twice burned the City of Bandon to the ground in 1914 and 1936. Gorse is especially prolific at Bullards Beach State Park, having greatly expanded its foothold in recent decades, and controlling its spread has proven to be extremely challenging and costly. Warmer, drier summers associated with climate change threaten to increase the gorse fire potential. Local collaborations have attempted to address the issue such as the Gorse Action Group, a public-private collaborative, but capacity and funding are limited. The City of Bandon has some ordinances in place to incentivize private landowners to control gorse, but without a consistently funded entity dedicated to addressing the issue progress will likely be slow.

Pathway to Resilience

Overall, sensitivity to hazard disturbance in the Coquille River estuary is generally seen as extreme. Future changes in climate, sea level, sedimentation, invasive species, and other stressors compound and interact dynamically with one another. Vulnerability and adaptability of species to these conditions will be a function of coordinated improvements in land use, making it difficult to predict future trends for the Coquille River estuary. Landward migration zones may be needed to accommodate successful adaptation. The extensive wetland areas contribute greatly to the estuary's resilience to hazard impacts, and have potential to adapt to changing future conditions. For sensitive species like salmonids however, recovery from turbidity, runoff, and increasing temperatures from land use practices will likely take decades.

Water quality is the key to many of the concerns in the Coquille River estuary, and is directly linked to human presence and land use practices with the landscape and natural resources throughout the basin, underscoring its interconnectedness. As salmon decline, local industry will change, and secondary effects will propagate throughout natural communities, resulting in fewer resources for other key species such as shorebirds, otters, and bald eagles. Resilience to these impacts will depend in part on increased awareness and collaboration with private landowners, particularly to address increasing water temperatures for salmonids.

Bandon Waterfront. Photo courtesy of DLCD.

Coquille River wetlands. Photo courtesy of DLCD.

V. Adaptation Strategies and Actions

The following section outlines potential actions identified by local stakeholders to address natural hazard resilience in the Coos and Coquille estuaries. The majority of these actions fall under the broad umbrella of "nature-based solutions", which typically rely on natural ("green") infrastructure and processes to mitigate the impacts of natural hazards and other environmental stressors. These stressors can be greatly exacerbated by human land use activities in the estuarine basins, but can often be mitigated through relatively simple actions such as habitat restoration and reconnection of waterways.

Adaptation Strategies

Vulnerability information gathered from the stakeholder outreach and engagement work was compiled and evaluated for initial vulnerability determinations, and used to help identify and develop lists of potential adaptation actions that local stakeholders and partners would be willing to support. This information was presented to stakeholders for validation in a series of adaptation action planning workshops and individual interviews held in spring and fall 2022, which focused on reviewing vulnerability assessment results and refining adaptation action details. The IPRE-led Coos Bay estuary effort focused on a wide range of potential actions that included a variety of structural and non-structural solutions. The potential actions identified for this ERAP effort are narrower in scope, focusing on nature-based solutions and green infrastructure options.

Nature-Based Solutions

The goal of the ERAP process is to identify and describe potential nature-based solutions for local estuarine resilience needs, and help prepare projects for future funding by NFWF and other funding organizations. The umbrella of nature-based solutions covers many kinds of actions, but stands in contrast to traditional "hard" (gray) infrastructure options. Gray infrastructure relies on steel and concrete structures such as seawalls, dams, tide gates, stormwater pumps, etc., to control flooding and erosion. While effective, engineering these structures is often a more costly solution and time-intensive process than nature-based solutions. They require more frequent maintenance, increase runoff, minimize natural hydrological function, reduce ecosystem service benefits, and are less aesthetically pleasing. These factors may manifest themselves as impacts on the local economy over time by increasing municipal costs and decreasing revenue generated by tourism and recreation.

Figure 8. Examples of nature-based solutions utilizing green infrastructure.

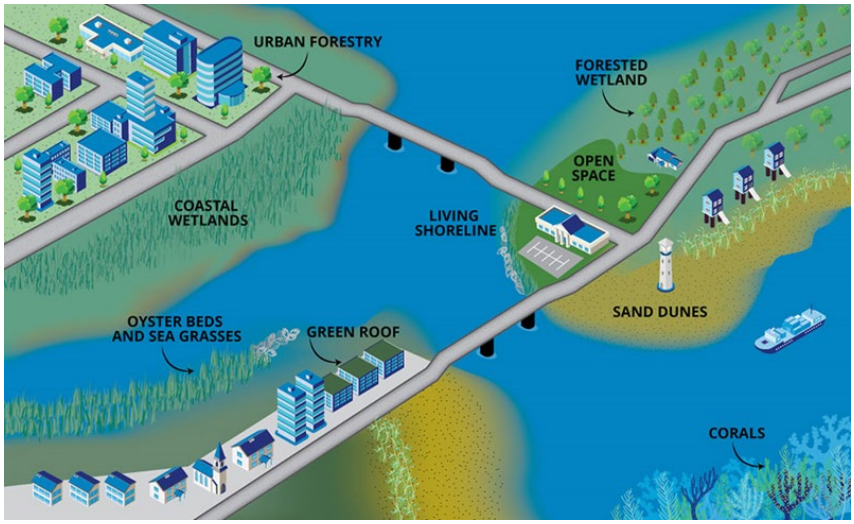


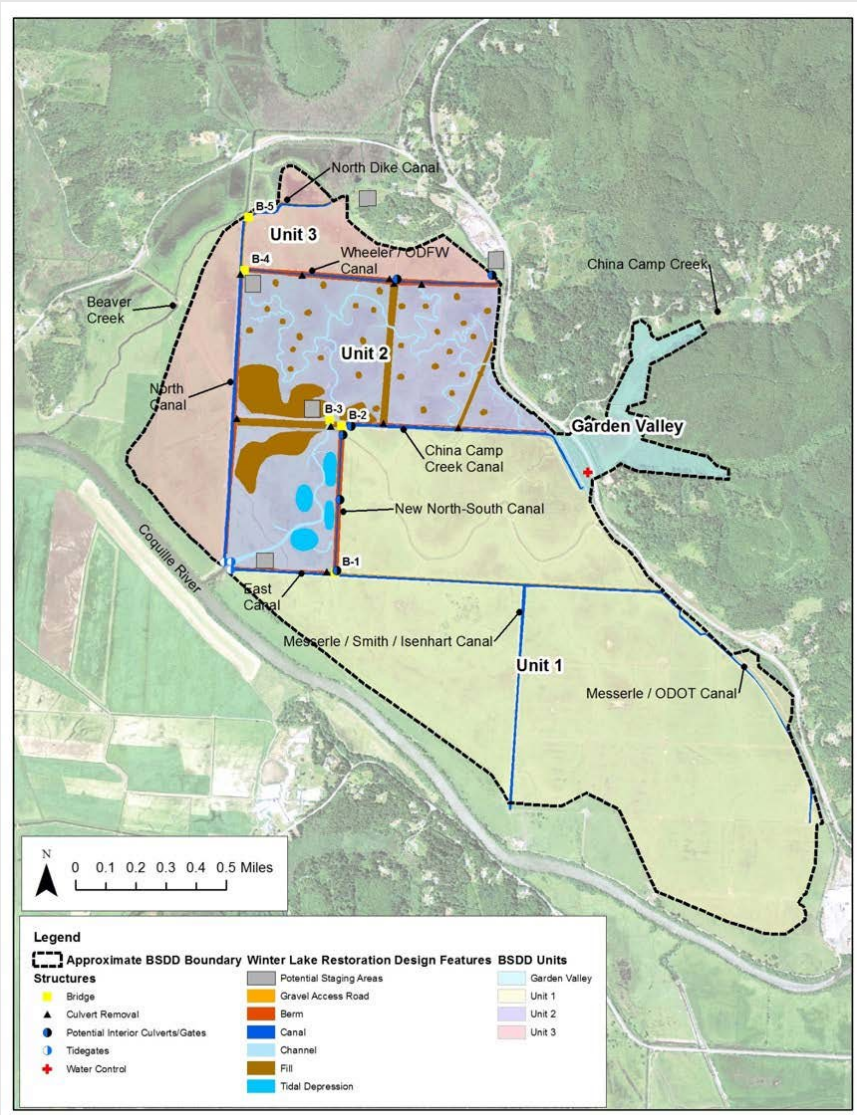
Image source: NOAA

When it comes to vulnerable coastal areas, natural infrastructure is a proven and cost-efficient approach to mitigate coastal hazards. The components vary but the basic premise is often the same: slowing and absorbing floodwaters by redirecting water, reducing wave height, and attenuating wave energy. They also provide many other benefits to fish and wildlife by creating coastal habitats, protecting sensitive species, improving water quality, reducing erosion, improving local conditions and economies, and many other benefits. The components may include coastal wetlands/marshes, oyster and coral reefs, beaches and sand dunes, coastal vegetation (e.g., seagrasses), permeable pavements and bioswales, green roofs and rain barrels, and incorporation of natural areas into city designs and other planning efforts. Natural infrastructure can help mitigate non-flood-related hazards as well, such as threats to water or air quality, or excessive wind, heat, or drought, but flooding is often the focus.

Successful green infrastructure practices often rely on natural areas and open spaces and incorporate multi-functionality (e.g., recreation, stormwater storage, filtration, etc). They connect people to open areas and help provide a sense of place. Potential projects should be placed in the context of the greater community. Typically, green infrastructure projects serve to preserve and enhance natural features by mimicking or enhancing existing hydrology or other natural functions. They can also provide ecosystem benefits by utilizing urban streetscapes (e.g., minimizing impervious cover, enhancing bioretention and filtration), and should offer a return on the investment through ecosystem services.

Highlighting Nature-Based Solutions: Winter Lake Restoration Project

This collaborative multi-phase project highlights the positive impact of leveraging local stakeholder partnerships to implement nature-based solutions and increase estuarine resilience. Located near the City of Coquille, the Winter Lake area is utilized in summer as a cattle pasture, but is inundated in wintertime. Cooperation between state agencies, conservation organizations, private landowners, and the Coquille Indian Tribe, produced a hybrid solution that provides benefits to important aquatic species (e.g., coho salmon) and to local agriculture.



Project Accomplishments

- Restored 1,700 acres of habitat for species such as coho salmon
- Reconnected nearly 8 miles of tidal channels
- Planted 100k trees and shrubs
- Acquired 600 acres of land
- Created 15 acres of tidal depression
- Installed 7 new tide gates
- Removed 3 miles of dikes
- Improved 4 miles of dikes
- Filled 1.5 miles of ditches

Outcomes So Far

- Improved tidal management
- Improved conditions for juvenile salmon and lamprey
- Improved habitat for migratory birds
- Several weeks added to annual grazing season
- Strengthened local partnerships and coordination

Image source: TNC

A Hybrid Approach Restoration work at the Winter Lake site relied on numerous green infrastructure tools and methods to reconnect waterways and enhance fish and wildlife habitats. The linchpin of the project's success is a cutting edge, multi-million dollar tide gate complex to regulate tidal flow for the site's seasonal transformations. While subsequent work is ongoing, management of the area focuses on enhancing tidal connectivity and complexity, water quality, floodplain vegetation, and fish passage.

Adaptation Actions

The adaptation actions identified below arose from the stakeholder outreach and engagement efforts conducted in 2020-2022. Some actions were already in development while others represent ideas that have been deprioritized due to unmet needs such as lack of funding or design plans. Details for each action are outlined, including lead organization and potential partners, green infrastructure components, project status and readiness, and prioritization rankings. **'Proposed Lead' and 'Potential Partners' columns do not represent formal commitments, but rather recommendations from steering committees and other stakeholders.** 'Status' and 'Project Readiness' columns represent general estimates of project status with respect to development and initiation. Prioritization rankings were negotiated by project partners and stakeholders, using the following criteria developed by IPRE:

Ease

- Low = Difficult to accomplish with existing resources/capabilities
- Medium = Moderately easy to accomplish with existing resources/capabilities
- High = Relatively easy to accomplish with existing resources/capabilities

Impact

- Low = Will have little impact on decreasing vulnerability/increasing resilience
- Medium = Will have moderate impact on decreasing vulnerability/increasing resilience
- High = Will have large impact on decreasing vulnerability/increasing resilience

Cost

- $ = $100K or less
- $$ = $100k to $1 million
- $$$ = $1 million or more

A priority ranking was then assigned to each action based on the factors above, and determined in consideration with stakeholder input:

Priority

- Low = generally ease (lower), impact (lower), cost is a factor
- Medium = generally ease (low, medium), impact (low, medium), cost is a factor
- High = generally ease (high, medium), impact (high, medium), cost is a factor

The adaptation action descriptions below provide additional details and context for the identified adaptation actions listed in Tables 3, 4, and 5*. High level milestones and timelines are outlined, and where possible, expected dates are assigned to major milestones. Anticipated target funding grants and programs are also listed. The green infrastructure components and

anticipated resilience benefits of each project are highlighted using icons to represent common elements of each. Refer to the symbol keys below for those sections. **See Acronyms for additional context*

Green Infrastructure Component(s) Key

 = restoration

 = invasive species control

 = riparian/stream channel enhancements

 = native plants

 = wetlands/marsh

 = levee/dike

 = water drainage/retention features

 = large woody debris/log cribs

 = natural area

 = myriad nature-based solution options

Anticipated Resilience Benefits Key

 = improved waterway connectivity and hydrologic function

 = flooding/storm surge reduction

 = improved fish passage

 = habitat enhancements

 = improved community resilience

 = erosion mitigation

 = improved safety and access

 = improved water quality/drinking water protection

 = fire protection

Implementation

Development of the Coos County ERAP was overseen by the Partnership for Coastal Watersheds and Coquille Working Group, representing numerous stakeholder organizations. While the County, cities, state and federal agencies, non-profit organizations, Tribes, and others are responsible for implementing the identified resilience actions, the structure of this effort can be leveraged for continued resilience planning. While the goal is to move all the identified resilience actions toward advanced stages of completion, ongoing coordination can help sustain proper maintenance and identify future opportunities.

The PCW can help recommend future resilience actions for development and funding, and along with the OCMP, periodically coordinate and facilitate meetings to evaluate progress. Organizations identified as potential project leads and partners should be engaged throughout development to support project planning and acquisition of funding. Other local planning efforts, such as Natural Hazard Mitigation Planning by county and city governments, can support and integrate these actions in their resilience strategies.

The PCW, CQWG, and OCMP recommend that partner organizations involved in the ERAP process convene at least once annually to review resilience actions, evaluate progress and funding opportunities, discuss coordination needs, share new data and information, and identify future resilience actions. Additional recommendations have been identified by OCMP to help clear the way for local communities and organizations to implement resilience work, including:

- Create a central digital exchange for funding opportunities, permitting assistance, and implementation support for community members and organizations developing and implementing resilience actions.
- Streamline regulatory processes for implementation, especially regarding state and federal coordination. The current regulatory process is too costly and often does not reflect the urgency of issues. A single permitting policy process that expedites and reduces costs to implement projects needs to be agreed upon by both state and federal agencies. Additional streamlining of regulations can be achieved by providing continued input at local, state, and federal levels.
- Encourage FEMA and NMFS coordination on floodplain regulation as concerns riparian planting projects in floodways.
- Develop shared outreach materials that target multiple stakeholder groups with real life examples for promoting green infrastructure solutions.
- Review and update zoning code regarding riparian setback exceptions in developed areas.

Coos Bay Estuary Adaptation Actions

In coordination with the leveraged IPRE effort for the Coos Bay estuary, 15 out of the initial 61 candidate actions were identified as nature-based solutions with options for green infrastructure components. Table 3 shows these actions retained under the IPRE adaptation action categories. Engagement with Coos County stakeholders and partners in the adaptation action planning workshops resulted in identification of 12 additional nature-based solution actions with specific sites identified (Table 4).

Table 3. Resilience Actions Identified for the Coos Bay Estuary by IPRE Effort

Action #	Action Description	Proposed Lead	Potential Partners	Nature based solution? (Y)	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
1	**Audit and upgrade existing infrastructure**							
1.07	Update capital improvement plan to include considerations for sea level rise. Prioritize areas projected to be within the sea level rise areas for capital improvements such as sewer line replacements.	Coos County, Coos Bay, North Bend	CIT, CTCLUSI, CTSI	Y - rezoning vulnerable areas	medium	medium	$	high
1.08	Create a clear strategy for capital improvements that combines short- and long-term actions for each jurisdiction aimed at reducing climate related impacts to infrastructure. Coordinate with ODOT to determine impacts and connections with their facilities.	City and County Public Works	CIT, CTCLUSI, CTSI	Y - strategy can include variety of GI options	high	medium	$	high
1.09	Confirm local transportation agencies and design contractors are following AASHTO "Applying Climate Change Information to Hydrologic and Hydraulic Design of Transportation Infrastructure" into transportation design.	City and County Public Works	ODOT, CIT, CTCLUSI, CTSI	Y - identifying opportunities for green infrastructure actions	low	medium	$	medium
2	**Audit and update zoning and comprehensive planning**							
2.02	Audit the zoning code to ensure it is not encouraging maladaptive development in areas that will flood. Identify potential impacts on physically and demographically vulnerable populations and eliminate barriers so that some populations do not disproportionately bear the brunt of climate change impacts.	City and County Planning	PCW members and others, CIT, CTCLUSI, CTSI	Y - rezoning vulnerable areas	medium	medium	$$	high
2.03	Add requirements to development standards to minimize impervious areas and minimize stormwater runoff on project sites through green infrastructure and infiltration.	City and County Planning	PCW members and others, CIT, CTCLUSI, CTSI	Y - green spaces, permeable pavements, bioswales, et al.	high	medium	$	high

2.05	Create a sea level rise/flooding overlay in the zoning code with specific requirements for how to develop in that area. Consult with the tribes about appropriate locations (or locations to avoid) and to avoid disturbance of sensitive cultural resources.	City and County Planning	PCW members and others, CIT, CTCLUSI, CTSI	Y – encourage /incentivize incorporation of green infrastructure options	medium	medium	$$	high
2.07	Utilize the "Sea Level Rise Planning Guide for Coastal Oregon" as a guide to develop model code to help planning departments implement land use changes to reduce impact from climate change, particularly sea level rise.	DLCD	City and County Planning, CIT, CTCLUSI, CTSI	Y – encourage /incentivize incorporation of green infrastructure options	medium	high	$	high
3	**Public Private Partnerships**							
3.01	Create community benefits agreements with project developers to include conservation and restoration and social/community benefits.	City and County Planning	CIT, CTCLUSI, CTSI, Rogue Climate	Y - conservation & restoration of natural areas	medium	medium	$	medium
4	**Floodplain Management**							
4.02	Develop an open space acquisition, reuse, and preservation plan that targets hazard areas. Consult with the tribes about appropriate locations (or locations to avoid) and to avoid disturbance of sensitive cultural resources.	City and County Planning and Parks & Recreation	local land trusts, CIT, CTCLUSI, CTSI, ODFW	Y - e.g., acquisitions for restoration of tidal floodplain	low	high	$$$	medium
5	**Implement green infrastructure**							
5.01	Incentivize or require use of green stormwater best management practices in stormwater design.	City and County Public Works	Coos County, Coos Bay, North Bend, CIT, CTCLUSI, CTSI	Y - green infrastructure for better stormwater management	medium	high	$	high
5.02	Collaborate with tribal nations on planning for green infrastructure and co-management of the ecosystem to understand how it can align with cultural stewardship of the estuary. Work with CIT, CTCLUSI, and CTSI to identify candidate sites or priority areas for protection.	City and County Parks & Recreation	CIT, CTCLUSI, CTSI, DLCD	Y - green infrastructure options for estuarine resilience	high	medium	$	medium
6	**Restoration**							
6.01	Identify sites where wetland restoration work can be done to reduce flooding. Prioritize focus on historic estuarine floodplain. Consult with the tribes about appropriate locations (or locations to avoid) and to avoid disturbance of sensitive cultural resources.	City and County Planning	watershed organizations, conservation organizations, CIT, CTCLUSI, CTSI, SWCDs, ODFW	Y - acquisitions and restoration of tidal floodplain	medium	high	$$$	high
6.02	Require more trees to be preserved and planted in landscape design to reduce runoff and provide shade.	City and County Planning	watershed organizations, conservation organizations, CIT, CTCLUSI, CTSI, SWCDs, ODFW, DEQ	Y - restoration work, improve natural function	medium	low	$$	low

6.04	Establish a strategy in which landward migration zones can be protected to allow tidal wetlands to move in response to future sea level rise. Management actions associated with this concept include conservation easements, land trades, levee removals, and acquisition, all of which will allow marshes to migrate naturally.	Conservation organizations	ODFW, BLM, CoosWA, USGS, USFWS, CIT, CTCLUSI, CTSI, SSNERR, DEQ, planning departments DSL, DLCD	Y - acquisitions, restoration, reconnecting historic floodplains, et al.	low	high	$$	medium
7	**Natural Resource Management**							
7.01	Develop coordinated ecosystem-based management framework to protect eelgrass that goes beyond existing state and federal wetland protections.	Conservation organizations	BLM, USFWS, CIT, CTCLUSI, CTSI, SSNERR, DSL, ODFW, Rogue Climate	Y - prioritize habitat restoration	medium	medium	$$	medium
8	**Cultural and Historical Resources and Inventory**							
	[No nature-based solutions identified for this category]							
9	**Economic Development**							
	[No nature-based solutions identified for this category]							
10	**Education**							
	[No nature-based solutions identified for this category]							

Table 4. Additional Resilience Actions Identified for the Coos Bay Estuary

Action #	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
11.01	**Wasson Creek** - Watershed restoration including upland forest management, and restoration of wetland stream complexes including enhancing coho salmon and Marbled murrelet habitat.	SSNERR	CIT, CTCLUSI, CTSI TKOs & THPOs, DSL, NOAA, CoosWA, OSU	Planning Phase	ongoing	low	high	$$$	high
11.02	**Winchester Creek Acquisition** - Acquisition of two parcels (~60 acres) for habitat restoration on Winchester Creek uplands.	SSNERR	WRLT, CC, DSL	Planning Phase	Aug. 2023	medium	high	$$$	high
11.03	**Winchester Creek Watershed** - Reduce heavy sediment accumulation, enhance spawning habitat for coho salmon and Pacific lamprey, acquire county land to restore riparian stream buffers, conduct study to determine appropriate configuration for property. Located in Coos Bay South Slough.	ODFW	CC, SSNERR, WRLT, CoosWA	Planning Phase: Assessing options for property configuration	2026	medium	medium	$$	medium
11.04	**SSNERR Visitors Center** - Redesign and improve entrance to SSNERR visitor center. Install bioswales, native landscaping.	SSNERR	FOSS	Design phase	2024 or 2025	high	low	$$	high
11.05	**Eelgrass Enhancements** - Conservation, protection, and enhancement of native eelgrass at strategic sites throughout the estuary. Coordinate with OSU/UO to develop student projects to enhance or contribute to this effort. 2022-2024 NERRS Graduate Fellow focused on seedbanks and restoration for resilience to warming.	SSNERR	Padilla Bay NERR, OSU, UO	Planning Phase	ongoing	high	high	$	high
11.06	**SSNERR Lands Marbled Murrelet Habitat Restoration** - Identify other suitable sites on SSNERR lands and implement for Marbled murrelet habitat restoration.	SSNERR	ODFW, USFWS	Idea Phase	2027	high	medium	$	medium
11.07	**SSNERR Lands Fire Plan** - Develop fire plan for prescribed and cultural burns on SSNERR lands to manage targeted habitats and fuels. Incorporate with biochar and defensible space training programs in partnership with local Tribes. Identify initial test sites in coordination with NOAA and DSL.	SSNERR	CC (forestry), CFPA, CIT, CTCLUSI, CTSI, BLM, NOAA, DSL, OPRD, OSU Fire Extension	Idea Phase	2 years	medium	medium	$	high
11.08	**Echo and Brunschmid Creeks Restoration** - Wetland restoration work on up to 38 acres on Echo Creek and Brunschmid Creek. Reevaluate options with failing dike to protect road and preserve and restore wetlands. Potential removal of tide gates, reroute stream, and replace failing culverts to reconnect tidal wetlands with upstream wetland habitat.	ODFW	CC, North Bend	Design Phase: Assessing options	3 years	high	high	$$	high

11.09	**Coos Flood Mitigation Funding** - Set aside funds to buy out flood-prone areas and turn them into green spaces or parks. Design areas as multi-use spaces for recreation, but that allow for natural flood inundation when needed.	Coos County	Coos Bay, North Bend	Idea Phase		low	high	$$	medium
11.1	**Green Crab Control** - Acquire funding for invasive green crab species control and removal efforts in partnership with state agencies in Washington and California.	SSNERR	ODFW, WA, CA, OISC, OIMB	Planning Phase	ongoing	medium	medium	$	high
11.11	**Tribal Lands Salmon Restoration** - Land acquisition and habitat and salmon population restoration work on tribal lands.	CIT	CTCLUSI, CoosWA, WSC	Planning Phase	ongoing	high	low	$	medium
11.12	**Noble Creek Restoration** - Protect private landowners and local lifeline route from inundation (90 acres), and restore hydrologic connectivity and function with infrastructure upgrades. Restore critical off-channel habitats for coho salmon and other fish species on 6.4 miles of stream. In Coos Bay.	Coos SWCD	CC, PLOs, ODFW, NRCS	Design Phase: at 30% design	ongoing	medium	medium	$$$	medium

Coos Bay Adaptation Action Descriptions

11.01 Wasson Creek

Watershed restoration including upland forest management and restoration of wetland stream complexes including enhancing coho salmon and Marbled murrelet habitat.

Milestones/Timeline

April 2023: start work
Jun-Aug 2023: install BDAs
Fall 2023: start forest implementation
Summer 2024: wetland construction/planting
2027: completion

Target Funding Source(s)

USFWS for forest restoration
Coos/Coho basin FIP
Coquille Community Tribal Funds

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.02 Winchester Creek Acquisition

Acquisition of two parcels (~60 acres) for habitat restoration on Winchester Creek uplands for Marbled murrelet habitat restoration.

Milestones/Timeline

2024: apply for funding
2025: acquisitions

Target Funding Source(s)

NERRS BIL (secured)
OWEB

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.03 Winchester Creek Watershed

Restoration and enhancement of salmon spawning gravel at sites in Winchester Creek watershed for coho salmon and Pacific lamprey to reduce heavy sediment accumulation. SSNERR will lead and develop a technical advisory team to produce assessment report. Acquire county land to restore riparian stream buffers, and conduct study to determine appropriate configuration for property.

Milestones/Timeline

2026: planning
2027: implementation/completion

Target Funding Source(s)

OWEB
NERRS BIL (planning phase)
Coos Basin Coho Partnership FIP grant

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.03 SSNERR Visitor Center

Redesign and improve entrance to SSNERR visitor center. Install bioswales, native landscaping to expand on recently installed native plant rain garden.

Milestones/Timeline

Nov 2023: complete design
Feb 2024: funding application
Jul 2024: start
2025: completion

Target Funding Source(s)

Friends of South Slough (FOSS) paying for design and will provide match for implementation funds
Internal NOAA PAC funds or external IRA funds for rest

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.05 Eelgrass Enhancements

Conservation, protection, and enhancement of native eelgrass (*Zostera marina*) at strategic sites throughout the Coos estuary. Coordinate with OSU and UO to develop student projects to enhance or contribute to this effort. Leverage 2022-2024 NERRS Graduate Fellow focused on seed banks and restoration for resilience to warming.

Milestones/Timeline

2020-21: pilot restoration, quarterly monitoring
2023: apply for funding

Target Funding Source(s)

OWEB, BIL, OOST, OSG, PMEP
Margaret A. Davison Graduate Fellowship
NERRs Science Collaborative

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.06 SSNERR Lands Marbled Murrelet Habitat Restoration

Identify additional suitable sites on SSNERR lands and implement habitat restoration for Marbles murrelet. Would likely follow restoration work on Wasson Creek (11.01).

Milestones/Timeline

- management review
- identify potentially suitable habitat

Target Funding Source(s)

USFWS

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.07 SSNERR Lands Fire Plan

Develop a fire plan for prescribed and cultural burns on SSNERR lands to manage targeted habitats and fuels. Incorporate with biochar and defensible space training programs in partnership with local Tribes. Identify initial test sites in coordination with NOAA and DSL. Draft fire plan already written and awaiting commission approval.

Milestones/Timeline

2023: obtain commission review/approval of fire plan
2024/5: start planning (2024 if funding/interest)
2025: identify test sites
2026: start burning

Target Funding Source(s)

NERS Restoration Funding (BIL)
Operations funds for remaining portion

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.08 Echo and Brunschmid Creeks Restoration

Wetland restoration work on up to 38 acres on Echo Creek and Brunschmid Creek. Reevaluate options with failing dike to protect road and preserve and restore wetlands. Potential removal of tide gates, reroute stream, and replace failing culverts to reconnect tidal wetlands with upstream wetland habitat.

Milestones/Timeline

- remove tide gates
- re-meander stream network upstream of crossing
- plant native wetland species
- improve passage through cattle crossing

Target Funding Source(s)

OWEB

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.09 Coos Flood Mitigation Funding

Set aside funds for Coos County to buy out flood-prone areas in Coos Bay estuary and turn them into green spaces or parks. Design areas as multi-use spaces for recreation, but that allow for natural flood inundation when needed.

Milestones/Timeline

- identify priority areas for acquisition
- evaluate costs and benefits of individual purchases
- conduct scoping and outreach activities
- apply for funding
- acquisitions

Target Funding Source(s)

[none yet identified]

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.10 Green Crab Control

Acquire funding for invasive green crab species control and removal efforts in partnership with state agencies in Washington and California.

Milestones/Timeline

2023: partnership planning

Target Funding Source(s)

OSG
NERRs Science Collaborative
Margaret A. Davison Graduate Fellowship
NSF (students)

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.11 Tribal Lands Salmon Restoration

Acquire funding for land acquisition for restoration of salmon populations and habitat on Tribal lands.

Milestones/Timeline

- identify priority sites
- evaluate costs and benefits
- apply for funding
- acquisitions

Target Funding Source(s)

OWEB FIP (secured)
NOAA, NFWF
USFWS Tribal Wildlife Grant

Green Infrastructure Component(s)

Anticipated Resilience Benefits

11.12 Noble Creek Restoration

Habitat restoration and waterway reconnection work to protect private landowners and local lifeline route from inundation (90 acres). Restore critical off-channel habitats for coho salmon and other fish species on 6.4 miles of stream. Replace two collapsing culverts with two 8x10' concrete box culverts to reestablish tidal connection and function. Replace two old wooden tide gates with doors hanging off with new tide gates with MTRs. Remove two smaller interior tide gates on private land. County wants to raise road grade.

Milestones/Timeline

2023: final designs, apply for implementation funding
2024-5: seeking additional funding
2025/6: implementation
2027: completion

Target Funding Source(s)

ODFW, OWEB
Business Oregon
NOAA Coastal Resilience

Green Infrastructure Component(s)

Anticipated Resilience Benefits

Coquille River Estuary Adaptation Actions

Stakeholder engagement efforts in the Coquille River estuary and basin resulted in identification of 29 nature-based actions (Table 5). These actions are organized by area, arranged in order traveling upriver, with a few broader basin-wide actions listed at the end.

Table 5. Resilience Actions Identified for the Coquille River Estuary

Action #	Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
1	Bandon	**South Jetty Parking Lot** - Address safety issues at south jetty parking lot. Improve access while maintaining separation from influence of tidal/inundation events. Grade area and/or make retention basin to reduce flood frequency and keep water off road.	City of Bandon	Port of Bandon	Idea Phase	n/a	high	high	$$	medium
2	Bandon	**Redmond Pond** - Protect south jetty community from storm surge and inundation, improve public access, enhance stormwater retention and drainage, develop multi-use natural area, through acquisitions and restoration around Redmond Pond in Bandon	City of Bandon	Port of Bandon	Planning Phase	ongoing	medium	medium	$$	medium
3	Bandon	**Jetty Road Seawall** - Identify potential nature-based solution to repair/replace/improve seawall along Jetty Rd. within limits of narrow right-of-way.	City of Bandon	USACE, Port of Bandon	Idea Phase	n/a	low	high	$$$	medium
4	Bandon	**Public Access/Emergency Egress Needs** - Protect downtown/south jetty communities with improvements to public access and emergency egress needs, develop general plan, update existing plans and maps, implement redundancies, and improve ADA access.	City of Bandon	DLCD	Planning Phase	ongoing	high	low	$$	medium
5	Bandon	**Moore Mill Log Yard Site** - Resolve zoning issues at Moore Mill log yard site for mixed-use, including natural areas and potential aquaculture.	City of Bandon	Moore Lumber, Port of Bandon, CIT, CTCLUSI, CTSI	Idea Phase	n/a	medium	high	$$	medium
6	Bandon	**Ferry Creek Retention Pond** - Pinpoint and mitigate siltation source(s) into Ferry Creek and retention pond. Dredge retention pond to improve water storage capacity.	City of Bandon	USACE, CTSI, ODFW	Idea Phase	n/a	medium	high	$$	high
7	Bandon	**Ferry Creek Watershed** – Protect sensitive drinking water source with habitat restoration to reduce sedimentation, enhance wildlife habitat, fire protection, and biodiversity.	City of Bandon	WRLT, PLOs, CTSI, ODFW	Idea Phase	n/a	high	high	$$	high
8	Bandon	**Lower Estuary Land Transactions** - Identify parcels and secure funding for land transactions in lower estuary to protect tidal wetlands. Focus on drinking water protection.		City of Bandon, WRLT	Idea Phase	n/a	low	high	$$$	medium

9	Bullards Beach	**Bullards Beach** - Gorse removal, native species planting (e.g., dune grass) at Bullards Beach State Park.	OPRD	Gorse Action Group	Planning Phase	ongoing	medium	high	$	high
10	Sevenmile Creek	**Sevenmile Creek** - Tide gate replacement, fencing, planting, potential channelization, on Sevenmile Creek.	Coquille Watershed Association	Coos SWCD, CIT, ODFW, PLO	Idea Phase	2024	medium	high	$$$	high
11	Beaver Hill	**Beaver Hill Road/North Bank Lane** - Restore hydrologic connectivity and function to protect key route from flooding/erosion risk, restore entire 50-acre wetland for storm surge overflow relief in Coquille River estuary. Includes restoration, large wood placements, and building log cribs.	Coquille Watershed Association	City of Bandon, CIT, PLO	Design Phase: At 60% design	ongoing	medium	medium	$$$	medium
12	Bear Creek	**Bear Creek** - Restoration of Bear Creek riparian habitat to reduce stream temperature.	Coos SWCD	ODFW, CoqWA, CIT	Idea Phase	ongoing	high	medium	$$	medium
13	Lampa Creek	**Lampa Creek** - Restoration of Lampa Creek riparian habitat to reduce stream temperature to meet DEQ coldwater standards.	Coos SWCD	ODFW, CIT	Design Phase: OWEB grant submitted	ongoing	high	medium	$	medium
14	Beaver Slough	**Coaledo Tide Gate Replacement and Beaver Slough Fish Passage** - Upgrade existing culverts and tide gates, implement Water Management Plan, and perform channel enhancements to maximize hydrologic connection to the Coquille River.	Coquille Watershed Association	Coaledo Drainage District, ODFW, Coos SWCD, CIT	Design Phase	ongoing	high	high	$$$	high
15	Winter Lake	**Winter Lake Phase III** - Beaver Slough Drainage District tide gate installations and tidal channel construction to restore hydrologic connectivity and function in Winter Lake basin.	Coos SWCD	ODFW, Beaver Slough Drainage District	Design Phase	ongoing	high	medium	$$$	medium
16	Lwr Coq Riv	**Gatov Creek** – Restore tidal and channel connectivity, and open up salmon rearing habitat.	Coos SWCD, ODFW	NRCS, PLOs	Design Phase: At 60% design	ongoing	high	medium	$$	high
17	Lwr Coq Riv	**Albertson Creek** - Restore tidal and channel connectivity, and open up salmon rearing habitat.	Coos SWCD, ODFW	NRCS, PLOs	Design Phase: At 60% design	ongoing	high	medium	$$	high
18	Lwr Coq Riv	**Randolph Island** - Restore tidal and channel connectivity, and open up salmon rearing habitat.	Coos SWCD, ODFW	NRCS, PLOs	Design Phase: At 60% design	ongoing	high	medium	$$$	high
19	Coquille	**Fourth St. Greenway** - Improve natural drainage pathway for Fourth St. greenway. Unclog and replace culverts, identify nature-based solutions to address drainage, inflow, and infiltration issues.	Coquille	ODOT	Idea Phase	n/a	medium	low	$$	low
20	Coquille	**Dutch John Creek** - Improve natural drainage pathway for Dutch John Creek. Unclog and replace culverts, identify nature-based solutions to address drainage, inflow, and infiltration issues.	Coquille	ODOT	Idea Phase	n/a	low	low	$$$	low
21	Coquille	**Rink Creek** - Riparian habitat restoration of Rink Creek to reduce stream temperature and protect drinking water source.	Coquille Watershed Association	ODFW, CWA, SWCD, Coquille	Idea Phase	n/a	high	medium	$	medium

22	Myrtle Point	**Southwest Myrtle Point** - Address flooding in SW part of city (e.g., set of box culverts, raise road) threatening several homes, county fairgrounds, industrial sites.	Coquille	Coos County, Myrtle Point	Idea Phase	n/a	low	high	$$$	medium
23	Myrtle Point	**North Fork Coquille River** - Riparian and in-stream habitat restoration, native riparian planting, bank stabilization, along North Fork Coquille River to address erosion, reduce stream temperature to meet DEQ coldwater standards, and improve prime salmonid habitat.	Coquille Watershed Association, Coos SWCD	ODFW, PLO	Design Phase: OWEB grant submitted	late 2023	high	medium	$$	medium
24	Broadbent	**South Fork Coquille River** - Bank stabilization and restoration (1200 ft) on South Fork Coquille River near Broadbent to improve riparian diversity, reduce erosion and sedimentation.	CIT	PLO	Planning Phase	2024	medium	high	$$$	high
25	Broadbent	**Dement Creek** - Habitat restoration and erosion control on Dement Creek to reduce sedimentation, including culvert replaced, roadwork, large wood placement, and native plantings.	Coquille Watershed Association	CIT, BLM, ODFW, PLO, CC	Planning Phase	ongoing	medium	medium	$$	high
26	Coquille River Basin	**Riparian Planting Program** - Riparian planting and protection program along tributaries entering estuary valley, especially along mainstem Coquille River downstream of Myrtle Point.	Coquille Watershed Association, ODFW	ODFW, CIT, Coos SWCD, Coquille Watershed Association	Idea Phase	n/a	medium	high	$$$	high
27	Coquille River Basin	**Tidal Wetland Connectivity & Ecological Function/Tide Gates** - For the ~130 tide-gated estuary land areas currently not involved in a project action. Outreach, engagement, and relationship development with private landowners to identify opportunities and implementation of Working Lands tide gate restoration projects.	Coquille Watershed Association, Coos SWCD, ODFW	ODFW, Coquille Watershed Association, Coos SWCD, PLOs	Idea Phase	n/a	high	medium	$$$	high
28	Coquille River Basin	**Gorse Control** - Secure dedicated funding to increase staff capacity to lead gorse control efforts broadly throughout the basin.		City of Bandon, Gorse Action Group, ODA, PLOs	Idea Phase	n/a	medium	medium	$$	high
29	Coquille River Basin	**Landowner Habitat Restoration Outreach** - Outreach and education to private landowners about benefits and need for habitat restoration, coldwater refugia, water quality, and other local natural resources needs/concerns/benefits.		SSNERR	Idea Phase	n/a	medium	medium	$	high

Coquille River Adaptation Action Descriptions

1. **South Jetty Parking Lot (Bandon)**
   Address safety issues at the south jetty parking lot. Improve access while maintaining separation from influence of tidal and other inundation events. Grade area and/or make a retention basin to reduce flood frequency and keep water off Jetty Rd. Aim is to reduce flooding, improve safety for visitors, and protect access to the local neighborhood.

   Milestones/Timeline
   - identify and evaluate NBS, other options
   - identify funding source(s) & apply
   - design
   - permitting
   - earthwork

   Target Funding Source(s)
   FEMA BRIC, LWCF
   Travel OR Competitive Grants Program

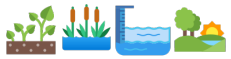
   Green Infrastructure Component(s)
   

   Anticipated Resilience Benefits
   

2. **Redmond Pond (Bandon)**
   Protect south jetty community from storm surge and inundation, improve public access, enhance stormwater retention and drainage, develop multi-use natural area, and restoration work. Acquire adjacent lots that are in the floodplain and shoreline overlay zone. Install sidewalk along Jetty Rd connecting 1st and 3rd St over pond within 5 years.

   Milestones/Timeline
   2024: develop pond walkway
   2025: acquire adjacent lots in overlay zone
   2026: build sidewalk on east end
   2028: project completion

   Target Funding Source(s)
   LWCF, Port of Bandon
   ODFW Oregon Conservation and Recreation Fund
   Recreational Trails Program
   ODOT Community Paths Grant

   Green Infrastructure Component(s)
   

   Anticipated Resilience Benefits
   

3. **Jetty Road Seawall (Bandon)**
   Identify potential nature-based solutions to repair/replace/improve seawall along Jetty Rd. within the limits of the narrow right-of-way.

   Milestones/Timeline
   - identify NBS
   - engineering plans
   - permitting (USACE, et al.)
   - right of way acquisition for sidewalk
   - earthwork
   - roadwork

   Target Funding Source(s)
   [none yet identified]

   Green Infrastructure Component(s)

   Anticipated Resilience Benefits

4. **Public Access/Emergency Egress Needs (Bandon)**
   Identify and improve public access and emergency egress needs along river shoreline areas, update planning, implement redundancies, and improve ADA access. City of Bandon is updating plans, developing model language and definitions for zoning, updating maps, and identifying ADA opportunities.

   Milestones/Timeline
   - evaluate public access needs
   - identify, apply for funding
   - identify model code
   - update planning

   Target Funding Source(s)
   FEMA BRIC, LWCF, ODFW OCRF
   Travel OR Competitive Grants Program
   Recreational Trails Program
   Safe Routes to School
   ODOT Community Paths Grant

   Green Infrastructure Component(s)

   Anticipated Resilience Benefits

5. **Moore Mill Log Yard Site (Bandon)**
   Resolve zoning issues at Moore Mill log yard site and convert to mixed-use, including natural areas, education, environmental activities, and potential aquaculture development.

   Milestones/Timeline
   - determine intended use
   - resolve zoning confusion
   - archeological survey?
   - solicit proposals from community

   Target Funding Source(s)
   DLCD

   Green Infrastructure Component(s)

   Anticipated Resilience Benefits

6. **Ferry Creek Retention Pond (Bandon)**
   Pinpoint and mitigate siltation source(s) into Ferry Creek and retention pond. Dredge retention pond to improve water storage capacity. Source of siltation is currently uncertain and needs to be identified prior to dredging.

   Milestones/Timeline
   - engage with PLOs on watershed issues
   - acquisition
   - USACE, et al, permits
   - earthwork

   Target Funding Source(s)
   ODEQ, ODFW, OWEB
   ODA Water Quality Grants
   ODEQ Non-Point Source 319 Grant
   Coos Watershed association

   Green Infrastructure Component(s)

   Anticipated Resilience Benefits

7. **Ferry Creek Watershed (Bandon)**
   Ferry Creek watershed habitat restoration for drinking water protection, wildlife habitat, fire protection, and biodiversity.

   Milestones/Timeline
   - engage with PLOs on watershed issues
   - acquisition
   - USACE, et al, permits
   - earthwork

   Target Funding Source(s)
   ODEQ, OWEB, ODFW
   ODA Water Quality Grants
   ODEQ Non-Point Source 319 Grant
   Coos Watershed Association

   Green Infrastructure Component(s)

   Anticipated Resilience Benefits

8. **Lower Estuary Land Transactions (Bandon)**
   Identify parcels and secure funding for land transactions in the lower estuary to protect tidal wetlands. Focus on drinking water source protection and other conservation goals.

   Milestones/Timeline
   - identify parcels
   - identify target funding source(s)

   Target Funding Source(s)
   BIL, OWEB
   ODEQ Drinking Water Protection
   DLCD CZM Habitat Protection and Restoration

   Green Infrastructure Component(s)

   Anticipated Resilience Benefits

9. **Bullards Beach (Bandon)**
   Gorse removal, native species planting (e.g., dune grass) at Bullards Beach State Park.

   Milestones/Timeline
   - secure funding
   - removals
   - landscaping/earthwork

   Target Funding Source(s)
   ODA, ODFW, IAE, OWEB

   Green Infrastructure Component(s)

   Anticipated Resilience Benefits

10. **Sevenmile Creek**
    Tide gate replacement, fencing, planting, potential channelization, on Sevenmile Creek. Replace tide gate with smaller interior pasture tide gates.

    Milestones/Timeline
    2023: PLO outreach & engagement
    2024: planning
    2025: design work and permitting
    2027: implementation

    Target Funding Source(s)
    OWEB, USFWS, NOAA, NFWF

    Green Infrastructure Component(s)

    Anticipated Resilience Benefits

11. Beaver Hill Road/North Bank Lane

Upgrade and clear undersized culverts at Beaver Hill Rd/North Bank Lane to reconnect 50 acres of storm surge overflow relief and restore the entire wetland. Project will include native planting in wetland and upland. Will harvest large trees in upland for large wood placement on floodplain to redirect water more slowly, and build log cribs for side channel habitat. One non-functional tide gate may also be removed.

Milestones/Timeline

2023: complete design work, apply for additional funding
2024: permitting
2025: earthwork

Target Funding Source(s)

USFWS ($150k secured)
OWEB, NFWF
NOAA Restoring Fish Passage Through Barrier Removal

Green Infrastructure Component(s)

Anticipated Resilience Benefits

12. Bear Creek

Restoration of Bear Creek riparian habitat to reduce stream temperature. Could be contributing coldwater to the estuary but the riparian area is damaged, so it is only moderately cool. At RM9.

Milestones/Timeline

2023: permitting; apply for additional funding
2024/5: implementation and completion

Target Funding Source(s)

OWEB, ODFW
ODA Water Quality Grants
ODEQ Non-Point Source 319 Grant
Coos Watershed Association

Green Infrastructure Component(s)

Anticipated Resilience Benefits

13. Lampa Creek

Restoration of Lampa Creek riparian habitat to reduce stream temperature to meet ODEQ coldwater standards. Stream could be contributing coldwater but it is currently violating ODEQ cold water refugia standards. At RM11.

Milestones/Timeline

2023: permitting; apply for additional funding
2024/5: implementation and completion

Target Funding Source(s)

OWEB, ODFW
ODA Water Quality Grants
ODEQ Non-Point Source 319 Grant
Coos Watershed Association

Green Infrastructure Component(s)

Anticipated Resilience Benefits

14. Coaledo Tide Gate Replacement and Beaver Slough Fish Passage

Upgrade existing culverts and tide gates, implement Water Management Plan, and perform channel enhancements to maximize hydrologic connection to the Coquille River mainstem. Last mile of Beaver Slough is damaged and in need of restoration. At RM20.

Milestones/Timeline

2023: permitting; apply for additional funding
2024: implementation and completion

Target Funding Source(s)

OWEB ($700k secured)
WRLT, NRCS EQIP, RCPP, ODFW
ODA Water Quality Grants
ODEQ Non-Point Source 319 Grant

Green Infrastructure Component(s)

Anticipated Resilience Benefits

15. Winter Lake Phase III

Beaver Slough Drainage District tide gate installations (*n.* 39) and tidal channel construction to restore hydrologic connectivity and function in Winter Lake basin.

Milestones/Timeline

2023-4: permitting, completion engineering design, apply for funding
2025: implementation
2028: completion

Target Funding Source(s)

NRCS EQIP, NFWF

Green Infrastructure Component(s)

Anticipated Resilience Benefits

16. Gatov Creek

Restore tidal and channel connectivity, and open up salmon rearing habitat. Design is nearing 60%.

Milestones/Timeline

2023: apply for additional design funding
2025: implementation
2026: completion

Target Funding Source(s)

NRCS
Business Oregon

Green Infrastructure Component(s)

Anticipated Resilience Benefits

17. Albertson Creek

Restore tidal and channel connectivity, and open up salmon rearing habitat. Design is nearing 60%. Secured partial funding for 2024 ($125k) through NRCS.

Milestones/Timeline

2023: apply for additional design funding
2025: implementation
2026: completion

Target Funding Source(s)

NRCS (secured partial funding - $125k)
Business Oregon

Green Infrastructure Component(s)

Anticipated Resilience Benefits

18. Randolph Island

Restore tidal and channel connectivity, and open up salmon rearing habitat. Design is nearing 60%. Secured partial funding for 2024 ($125k) through NRCS. ODFW also involved.

Milestones/Timeline

2023: apply for additional design funding
2025: implementation
2026: completion

Target Funding Source(s)

NRCS (secured partial funding - $125k)
OWEB, ODFW

Green Infrastructure Component(s)

Anticipated Resilience Benefits

19. Fourth St. Greenway (Coquille)

Improve the natural drainage pathway for the Fourth St. greenway. Unclog and replace culverts, identify nature-based solutions to address drainage, inflow, and infiltration issues.

Milestones/Timeline

- identify NBS options
- apply for funding
- design
- permitting
- earthwork

Target Funding Source(s)

OWEB, ODA, ODEQ

Green Infrastructure Component(s)

Anticipated Resilience Benefits

20. Dutch John Creek (Coquille)

Improve the natural drainage pathway for Dutch John Creek. Unclog and replace culverts, identify nature-based solutions to address drainage, inflow, and infiltration issues. Unclog a series of culverts that are routinely blocked. Beavers are present, contributing to the issue. Buildup has lifted the road and damaged it.

Milestones/Timeline

- identify NBS options
- apply for funding
- design
- permitting
- earthwork

Target Funding Source(s)

OWEB, ODA, ODEQ

Green Infrastructure Component(s)

Anticipated Resilience Benefits

21. Rink Creek (Coquille)

Riparian habitat restoration of Rink Creek to reduce stream temperature and protect drinking water source. Stream could be contributing coldwater but is currently violating ODEQ cold water refugia standards. Logging nearby has increased erosion and sedimentation, threatening drinking water source. Project includes needs assessment work (e.g., road/stream surveys of habitat condition), planting plan, and floodplain analysis. At RM28.

Milestones/Timeline

2025: apply for funding
2026: assessment work
2027: planning, floodplain analysis
2028: implementation

Target Funding Source(s)

OWEB, ODFW
ODA Water Quality Grants
ODEQ Non-Point Source 319 Grant
Coos Watershed Association

Green Infrastructure Component(s)

Anticipated Resilience Benefits

22. Southwest Myrtle Point

Address flooding in SW part of the city (e.g., set of box culverts, raise road) threatening several homes, county fairgrounds, industrial sites.

Milestones/Timeline

- evaluate potential issues and timelines
- identify and evaluate NBS, other options
- apply for funding
- design
- permitting
- earthwork

Target Funding Source(s)

[none yet identified]

Green Infrastructure Component(s)

Anticipated Resilience Benefits

23. North Fork Coquille River (Myrtle Point)

Riparian and in-stream habitat restoration, native riparian planting, and bank stabilization, along the North Fork Coquille River to address erosion, reduce stream temperature to meet ODEQ coldwater standards, and improve prime salmonid habitat. River could be contributing coldwater but it is currently violating ODEQ cold water refugia standards. Identified by Coho Strategic Action Plan as best opportunity for salmonid habitat restoration, benefits in the watershed. Potential to extend to E. Fork Coquille River. At RM40.

Milestones/Timeline

2023: OWEB grant, partnership building
2024: geomorphic assessment
2025: implementation

Target Funding Source(s)

OWEB, ODFW
ODA Water Quality Grants
ODEQ Non-Point Source 319 Grant
Coos Watershed Association

Green Infrastructure Component(s)

Anticipated Resilience Benefits

24. South Fork Coquille River (Broadbent)

Bank stabilization and restoration (1200 ft.) on South Fork Coquille River near Broadbent to improve riparian diversity, reduce erosion and sedimentation. Located on private land on South Fork Coquille River upstream of the community of Broadbent. Likely a two-phase project to initiate in 2024 pending successful NFWF grant. Second phase will be one year of post implementation monitoring starting in 2025.

Milestones/Timeline

2023: NFWF application
2024: earthwork
2025: begin monitoring phase
2026: complete monitoring

Target Funding Source(s)

NFWF

Green Infrastructure Component(s)

Anticipated Resilience Benefits

25. Dement Creek

Habitat restoration and erosion control on Dement Creek to reduce sedimentation, including culvert replaced, roadwork, large wood placement, and native plantings. Some funding already secured. Will work with partners to implement in 2023-2025.

Milestones/Timeline

- habitat restoration
- native riparian plantings
- bank setback
- large wood placement

Target Funding Source(s)

BLM, ODFW (match), OWEB

Green Infrastructure Component(s)

Anticipated Resilience Benefits

26. Riparian Planting Program (Coquille River Basin)

Riparian planting and protection program along tributaries entering the estuary valley, especially along the mainstem Coquille River downstream of Myrtle Point.

Milestones/Timeline

- identify funding sources and apply

Target Funding Source(s)

OWEB, NRCS EQIP, NRCS CREP

Green Infrastructure Component(s)

Anticipated Resilience Benefits

27. Tidal Wetland Connectivity & Ecological Function/Tide Gates (Coquille River Basin)

Coordinated effort for the ~130 tide-gated estuary land areas not currently involved in a project action. Outreach, engagement, and relationship development with private landowners to identify opportunities and implementation of Working Lands tide gate restoration projects.

Milestones/Timeline

- develop implementation plan
- apply for funding

Target Funding Source(s)

OWEB Stakeholder Engagement Fund

Green Infrastructure Component(s)

Anticipated Resilience Benefits

28. Gorse Control (Coquille River Basin)

Secure dedicated funding to increase staff capacity to lead gorse control efforts broadly throughout the Coquille River basin.

Milestones/Timeline

- develop implementation plan
- identify funding source
- apply for funding

Target Funding Source(s)

SWCD, ODA

Green Infrastructure Component(s)

Anticipated Resilience Benefits

29. Landowner Habitat Restoration Outreach (Coquille River Basin)

Outreach and education to private landowners about benefits and need for habitat restoration, coldwater refugia, water quality, and other local natural resources needs, concerns, and benefits. Include Oregon Invasive Species Council in effort.

Milestones/Timeline

- identify potential partnerships, build capacity
- develop implementation plan
- apply for funding

Target Funding Source(s)

OWEB Stakeholder Engagement Fund

Green Infrastructure Component(s)

Anticipated Resilience Benefits

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Tide gate at Winter Lake, Coquille River, 2022. Photo courtesy of Michael Moses.

Appendix A: Vulnerability Assessment Methods

To plan for potential resilience activities, an understanding of local needs, perspectives, and priorities on community vulnerability and adaptation planning for natural hazards must be assessed. Our team reviewed a variety of methods, approaches, examples, guidebooks, and other resources in the planning and resilience literature to guide a natural hazards vulnerability assessment (VA) for Coos County. These methods were developed by the University of Oregon's Institute for Policy Research and Engagement (IPRE) and piloted for the Coos Bay estuary VA, led by the Partnership for Coastal Watersheds (PCW). With feedback from the Coquille Working Group (CQWG), the methods described below were adapted to suit the needs and priorities of the Coquille River estuary and basin by evaluating several components of vulnerability. Stakeholder engagement was leveraged as the key to determining local understanding of natural hazard threats, and identifying priority sites, assets, resources, and populations.

The CQWG reached out to over 40 local stakeholder organizations and individuals, who were invited to participate in a pre-survey effort and a virtual community listening session to better understand local needs and concerns related to natural hazards vulnerability. Stakeholders were identified based on those with active interest areas with direct influence or interaction with the Coquille River estuary. Responses to the pre-survey were evaluated to help provide context to understanding in the community listening session. The listening session explored in greater detail the vulnerable assets, resources, and populations identified in the survey responses, as well as their adaptive capacity and sensitivities. The information following information summarizes the vulnerability assessment effort to help characterize the resilience of each consolidated sector group.

Coquille Working Group Context and Perspectives

The tables below provide summary results from a Google Jamboard exercise conducted with the Coquille Working Group (CQWG). This information reflects the CQWG's initial perspectives on Coos County resilience and establishes the context and framework for the vulnerability assessment work that followed in 2022.

Best Outcomes/Greatest Fears

The purpose of this exercise was to identify early in the planning process some of the CQWG's aims for best outcomes for the process, and some of their greatest fears. Sticky notes were placed on Jamboard slides and aligned roughly with four aspects of planning – *process*, *tools*, *impacts*, and *deliverables*. Similar responses have been consolidated for brevity.

Table A-1. Coquille Working Group Perspectives on the ERAP Process

Best Outcomes	Greatest Fears
Process	
• Projects that increase social livability in the estuary • Community buy-in to the products of the process • Net benefit for ecological production of fish and wildlife species • Preparing urban areas for climate change • Low cost of maintenance for implemented projects	• Plan becomes another binder on a shelf • Controversy/negative community reception • Lack of participation • Lack of coordination with appropriate partners/stakeholders • Costly projects that result in low social or ecological uplift • Lack of sustainability (no follow-up) • Failure to identify realistic projects that have benefits for goals (e.g., flood reduction, etc.)
Tools	
• Adaptive management practices • User-friendly data and reports • GIS mapping tools	• No way to measure success and communicate it to community
Deliverables	
• A plan that builds bridges to funding opportunities • Stronger partnerships	• A plan that can't be implemented • Clunky or unwelcome deliverables
Impacts	
• Increased funding for identified projects • Increase in wetland protection • Fewer mosquitos	• Decrease in public trust of process • Damage to non-renewable resources

Dimensions of Resilience

A variety of methods, approaches, examples, guidebooks, and other resources exist in the planning and resilience literature. In 2012, the National Research Council produced the report *Disaster Resilience: A National Imperative*, which assessed challenges to national disaster resilience. Four dimensions critical to evaluating resilience were identified:

1. **Vulnerable Populations**—factors that capture special needs of individuals and groups, related to components such as minority status, health issues, mobility, and socioeconomic status.
2. **Critical and Environmental Infrastructure**—the ability of critical and environmental infrastructure to recover from events; components may include water and sewage, transportation, power, communications, and natural infrastructure.
3. **Social Factors**—factors that enhance or limit a community's ability to recover, including components such as social capital, education, language, governance, financial structures, culture, and workforce.

4. **Built Infrastructure**—the ability of built infrastructure to withstand impacts of disasters, including components such as hospitals, local government, emergency response facilities, schools, homes and businesses, bridges, and roads.

The following table summarizes feedback from a Google Jamboard exercise in which the CQWG identified the relevant hazards, places, stakeholders, and opportunities for action, along the four dimensions of resilience. This exercise helped initially characterize resilience needs and to guide and focus the assessment effort.

Table A-2. Dimensions of Resilience for the Coquille River Estuary

Vulnerable Populations	
Hazards	**Stakeholders/Partners**
• Flooding along river-front roadways limiting local access	• Coquille Indian Tribe • Confederated Tribe of Siletz Indians • Oregon Dept. of Transportation • Coos County Roads Department • US Army Corps of Engineers
Places	**Opportunities for Action**
• Cultural/ecological resources at risk • Limited salmon habitat • Forested swamps • Retirement homes	• Floodplain reconnection projects • Preparing land and water to become estuarine with sea level rise (managed retreat) • Increase sense of common purpose for stakeholders/partners
Critical & Environmental Infrastructure	
Hazards	**Stakeholders/Partners**
• Flood • Drought • Loss of access to homes and property • Earthquake/tsunami	• Oregon Dept. of Transportation • Coos County Roads Department • US Army Corps of Engineers • Dairy/cattle groups
Places	**Opportunities for Action**
• Dikes/berms that are failing or in a state of weakened function • Stormwater systems in Bandon, Coquille, Myrtle Point are all very primitive with insufficient capacity to handle and process stormwater • Bridges not seismically stabilized to maintain emergency access	• Wetland connectivity • Upland water storage • Tide gates • Culverts • Wetland migration and habitat availability
Social Factors	
Hazards	**Stakeholders/Partners**
• Sea level rise • Drought • Sediment transport/deposition • Storm surge • Weather extremes	• Agricultural interests • Private landowners

• Loss of recreational access infrastructure (e.g., boat launches, parks, ocean shores access, hunting on refuge land, etc.)	
Places	**Opportunities for Action**
• Low-lying streets in Bandon • Areas used for subsistence gathering	• Loss of pastureland • Mosquito issue reducing quality of life
Built Infrastructure	
Hazards	**Stakeholders/Partners**
• Undersized and aging culverts • Failing tide gates	• Oregon Dept. of Transportation • Coos County Roads Department • US Army Corps of Engineers
Places	**Opportunities for Action**
• OR Highway 42 and North Bank Lane • Low-lying roads • Drinking water infrastructure (intake, dam, processing facility) • Wastewater treatment infrastructure • Bullards Beach State Park • Boat launches, piers, and marinas • Coquille River north and south jetties	• Encourage removal of aging or failing water control structures from the floodplain • Support federal funding for major maintenance and repair of north and south jetties., and continued maintenance dredging of the federal navigational channel to project depth. • Support modernization of boat launches, piers, and marinas for safe and accessible facilities.

Vulnerability Assessment Model

The baseline VA model identified for this process was adapted from the International Council for Local Environmental Initiatives (ICLEI) assessment model[20]. The model takes a community-scale view of resilience and aims to improve it by connecting goals and services to infrastructure systems and community lifelines, identifying social and economic interdependencies, and focusing on practical planning for recovery. The IPRE adapted and piloted these methods in 2013 for the City of Eugene Climate Vulnerability Assessment[21] and later adapted a more simplified version for the 2020-22 Coos Bay VA. While the Eugene CVA focused on climate change-related impacts, it also incorporated considerations for natural hazards vulnerability, borrowing from established Oregon Office of Emergency Management (OEM) risk assessment methodology[22] and IPRE's relative risk assessment. The EPA's Being Prepared for Climate Change[23] guidebook outlines similar methods for assessing vulnerability and risk-based adaptation action plans and has been used by the Tillamook Estuaries Partnership and the Oregon Central Coast Estuary Collaborative to create their VAs and action plans. The Coquille VA described here is an adaptation of IPRE's methods used in Coos Bay and,

[20] https://cig.uw.edu/wp-content/uploads/sites/2/2020/12/snoveretalgb574.pdf
[21] https://cpb-us-e1.wpmucdn.com/blogs.uoregon.edu/dist/3/4943/files/2017/11/Eug_CVA_PilotReport-20f52o2.pdf
[22] https://www.oregon.gov/lcd/NH/Documents/Apx_9.1.19_OEM_Hazard_Analysis_Methodology_OPT.pdf
[23] https://www.epa.gov/sites/default/files/2014-09/documents/being_prepared_workbook_508.pdf

with priorities identified by our local stakeholders, aims to fill any potential gaps in understanding of local vulnerability, with an eye toward natural infrastructure solutions.

Evaluation Components

Feedback collected from the stakeholder engagement effort was evaluated to determine local vulnerability to the assessed hazard(s) of concern. The primary components of vulnerability determined by the evaluation are 1) adaptive capacity, 2) sensitivity, and 3) risk (Figure A- 1).

Figure A-1. Factors of hazard vulnerability defined.

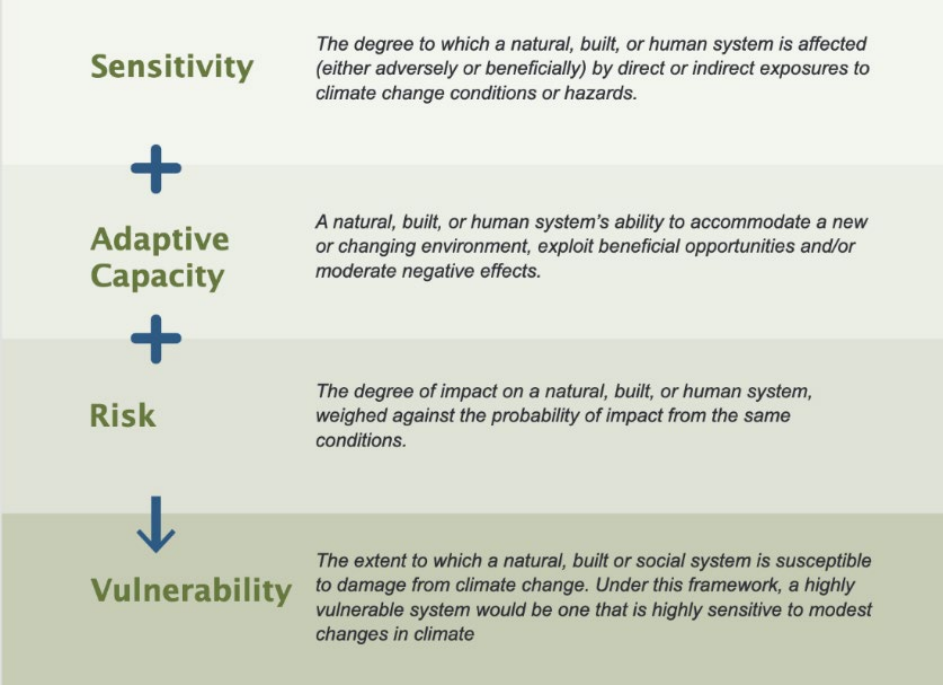


Image source: IPRE

To assess these components, the model adapted from ICLEI utilizes a variety of assessment tools to deliver narrative questions to stakeholder representatives. The assessment tools of the Coquille VA model are:

- An online survey effort
- Sector-specific stakeholder listening session(s)
- Individual interviews

The online questionnaire is used to establish contact with stakeholders, inform them of the process, and gather preliminary information to help shape the listening sessions. Respondents to the survey are then organized into broadly related sectors and invited to sector-specific listening sessions. Given sufficient level or response, participants may be grouped by economic

sector and evaluated separately. For the Coos Bay VA, six sector-based listening sessions were conducted, including Cultural & Historic Heritage, Natural World, Built Infrastructure & Planning, Economy & Industry, and Public Health & Social Systems. A sixth Tribal Nations listening session was added to ensure inclusion of Tribal perspectives. The pool of stakeholders in the Coquille River basin is much smaller than Coos, and consequently only a single listening session was needed. Guided discussion is used to structure the listening sessions and walk participants through a series of questions focused on assessing adaptive capacity and sensitivity of their sector with respect to a chosen hazard of concern. Individual interviews are substituted for stakeholders unable to participate in the listening sessions, following the same structure.

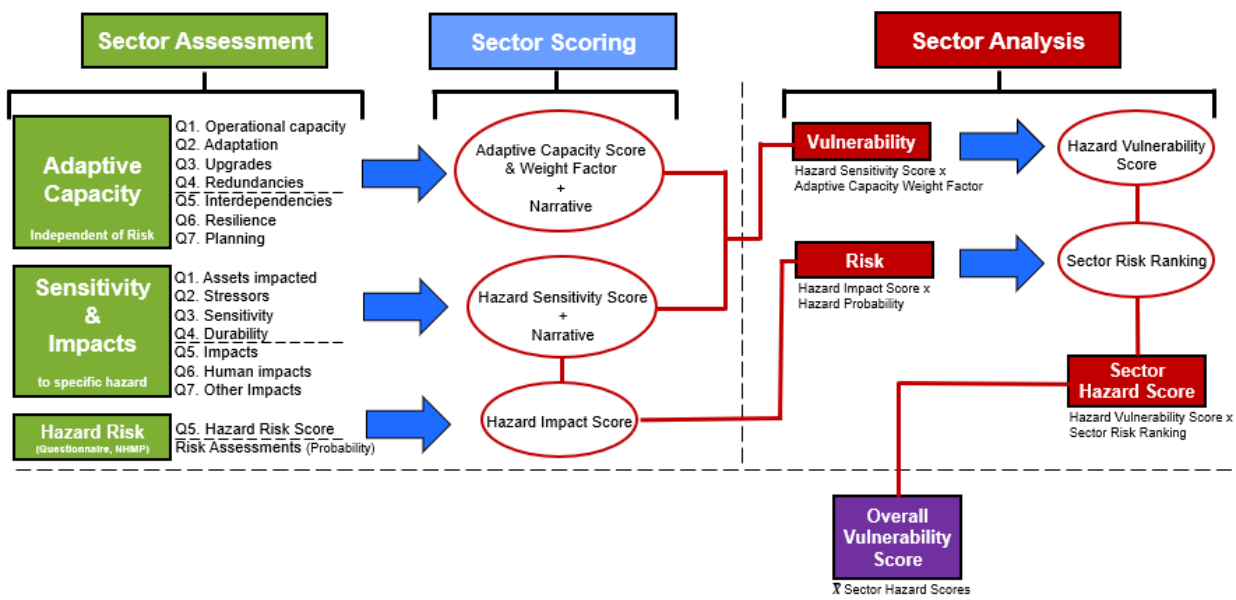
Stakeholder feedback gathered using these tools is evaluated and subjectively scored to characterize vulnerability in the study area, which can then be used to help prioritize actions. Several questions provide a quantitative score utilizing Likert-type scales (1 to 5) or ranked responses and can be used to derive the vulnerability score. Narrative or discussion-based questions are also used to gather specifics on vulnerable assets, resources, and populations, provide additional context and nuanced explanations, and are qualitatively evaluated to adjust scoring as needed.

Hazard Assessment

The tools and components of the vulnerability assessment model yield both quantitatively scored and qualitatively evaluated responses. This data is used to determine local adaptive capacity and hazard vulnerability. Given sufficient participation, these components can be evaluated and compared across stakeholder sectors.

A scoring system to determine vulnerability was adapted from the Eugene and Coos Bay VAs (Figure A-2). Participants agree on evaluating their greatest hazard of concern for each assessment effort, typically limiting evaluation of one hazard per listening session. This scoring system yields sector and hazard-specific scores for hazard vulnerability, hazard impact, risk, and an overall sector hazard score. Relativistic comparisons are then made across sectors for the same hazard. Sector hazard scores can be added together to reflect an overall vulnerability score for a given hazard across all sectors evaluated and compared to other vulnerability scores for the same hazard in other jurisdictions. For the Coquille VA, no sector-based comparisons were required.

Figure A-2. Vulnerability Assessment Sector Scoring Diagram.



Adapted from IPRE

Sector Analysis

Scores for adaptive capacity, sensitivity, and impact are assigned to Likert-type scales between 1 and 5, with low scores indicating low adaptive capacity, sensitivity, or impact, and high scores indicating high adaptive capacity, sensitivity, or impact. Sector assessment scores were derived by calculating a mean for each set of relevant questions, for example:

$$\frac{(Q1 \text{ score} + Q2 \text{ score} + Q3 \text{ score} + \ldots)}{\text{Total Number of Questions}}$$

The adaptive capacity scores were assigned to a weight factor, following previous adaptations of IPRE's methods, and guidance from the Oregon Office of Emergency Management Hazard Analysis Methodology[24], in order to calculate the hazard vulnerability score (Table 5). Scores for risk and sensitivity (impacts Qs) are added together to form an impact score. Narrative responses are evaluated to qualitatively adjust the adaptive capacity score if necessary, and compared against an adaptive capacity check question, before assigning a weight factor.

[24] https://www.oregon.gov/lcd/NH/Documents/Apx_9.1.19_OEM_Hazard_Analysis_Methodology_OPT.pdf

Sensitivity is determined similarly to adaptive capacity, averaging the scores of the sensitivity-specific questions from listening session/individual interview questions.

Table A-3. Adaptive Capacity Value Scale

Adaptive Capacity Score	Adaptive Capacity Ranking	Assigned AC Weight Factor
1 – 1.99	Very Low	1.50
2 – 2.99	Low	1.25
3 – 3.99	Medium	1
4 – 4.99	High	0.50
5	Very High	0.25

Scores collected from the pre-survey and listening session efforts are evaluated to produce scores for four variables. The following is adapted directly from IPRE's Lane County Vulnerability Assessment.

I. Vulnerability Score

Sector Vulnerability to Hazard = Hazard Sensitivity Score x Adaptive Capacity Weight Factor

Each hazard assessed yields a hazard sensitivity score. That score is multiplied by the weight factor (only) to get an adjusted score for that sector's vulnerability to that particular hazard. This is repeated for each hazard assessed (if more than one). The lower vulnerability scores the better.

II. Risk Score

Sector Risk to Hazard = Hazard Impact Score x Hazard Probability

Each hazard assessed has a local probability of occurrence. This probability factor is multiplied by the sector's impact score for that particular hazard. This is repeated for each hazard assessed (if more than one). The lower risk scores the better. Risk probability scores were derived from the Oregon Natural Hazards Mitigation Plan[25].

III. Sector Hazard Score

Sector Hazard Score = Hazard Vulnerability Score x Risk Score

[25] https://www.oregon.gov/lcd/NH/Pages/Mitigation-Planning.aspx

Each hazard has an overall score that reflects the sector's overall susceptibility to the hazard assessed. This score can be used across sectors to analyze what sectors are at greatest or least risk of disruption due to this hazard. **Effectively, this is the actual hazard vulnerability score for a given sector.**

IV. Overall Vulnerability Score

Overall Vulnerability Score = Average Score of all Sector Hazard Scores

Each sector may assess a different number or types of hazards according to their perceived threats. In order to compare overall scores across sectors, the Overall Vulnerability Score is the average for all Hazard Scores for a given sector. This provides a comparable number to analyze overall sector health against other sectors. The lower the Overall score the better.

Appendix B: Pre-Survey Questionnaire

Coquille Estuary Vulnerability Assessment Survey Questionnaire

Introduction Page

Greetings!

Thank you for agreeing to fill out this questionnaire. The State of Oregon is conducting a planning process aimed at improving resilience to natural hazards in select coastal jurisdictions. This work will focus on impacts to Oregon's estuaries, with a focus on natural ("green") infrastructure solutions. This may include projects such as floodplain and habitat restoration, construction of levees, dunes, or other natural barriers, use of bioswales, raingardens, or permeable pavements, rezoning or other land use changes, and many more.

To better understand local hazard vulnerabilities and resilience needs, stakeholder feedback will be collected through a survey effort (this questionnaire), followed by stakeholder listening sessions to provide additional context and information. The project team seeks to identify what resilience needs are of greatest concern, and what critical infrastructure, areas, and/or natural resources should be assessed in greater detail for vulnerabilities. Your responses will also help identify where different organizations' priorities may overlap.

Information collected through this survey and the proposed listening sessions will inform a menu of potential adaptation actions to be explored over the next 12-18 months, and will culminate in the creation of an Estuarine Resilience Adaptation Plan (ERAP) for Coos County estuaries.

This survey should take about 15 minutes to complete.

We aim to schedule listening sessions for [timeframe]. Once your responses have been reviewed, you will be emailed a link to a scheduling poll to provide your availability. Listening sessions will be approximately two hours and conducted via Zoom. Individual interviews may be conducted in lieu of listening sessions upon request.

Please complete the survey by [timeframe].

Please contact Michael Moses (michael.moses@dlcd.oregon.gov) with any questions.

Definitions Page

Some helpful terms and definitions:

Estuary: Estuaries are bodies of water, and their surrounding coastal habitats, typically found where rivers meet the sea. Estuaries harbor unique plant and animal communities because their waters are brackish — a mixture of fresh water draining from the land and salty seawater. This includes areas influenced (presently or historically) by river flow, tides, and localized weather.

Natural (or "green") Infrastructure: Natural infrastructure, also referred to as "green" infrastructure, uses existing natural areas or engineered solutions that mimic natural processes such as flooding, erosion, and runoff, to minimize, redirect, or redistribute their impacts. Additional benefits can include increased recreational opportunities, improvements to wildlife habitat, water quality improvements, and many more.

Hazard: is any situation that has the potential of causing damage to people, property, or the environment. For the purposes of this questionnaire, we are focusing on hazards induced by the forces of nature ("natural hazards").

Resilience: Resilience is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events (such as natural hazards).

Stakeholder: Individuals, organizations, or communities who have an interest in or are affected by decisions, planning, or policies.

Vulnerability: The extent to which a natural, built, or social system is susceptible to damage from natural hazards. Under this framework, a highly vulnerable system would be one that is highly sensitive to modest impacts from natural hazards.

1. Please provide the following information:

Name

Organization

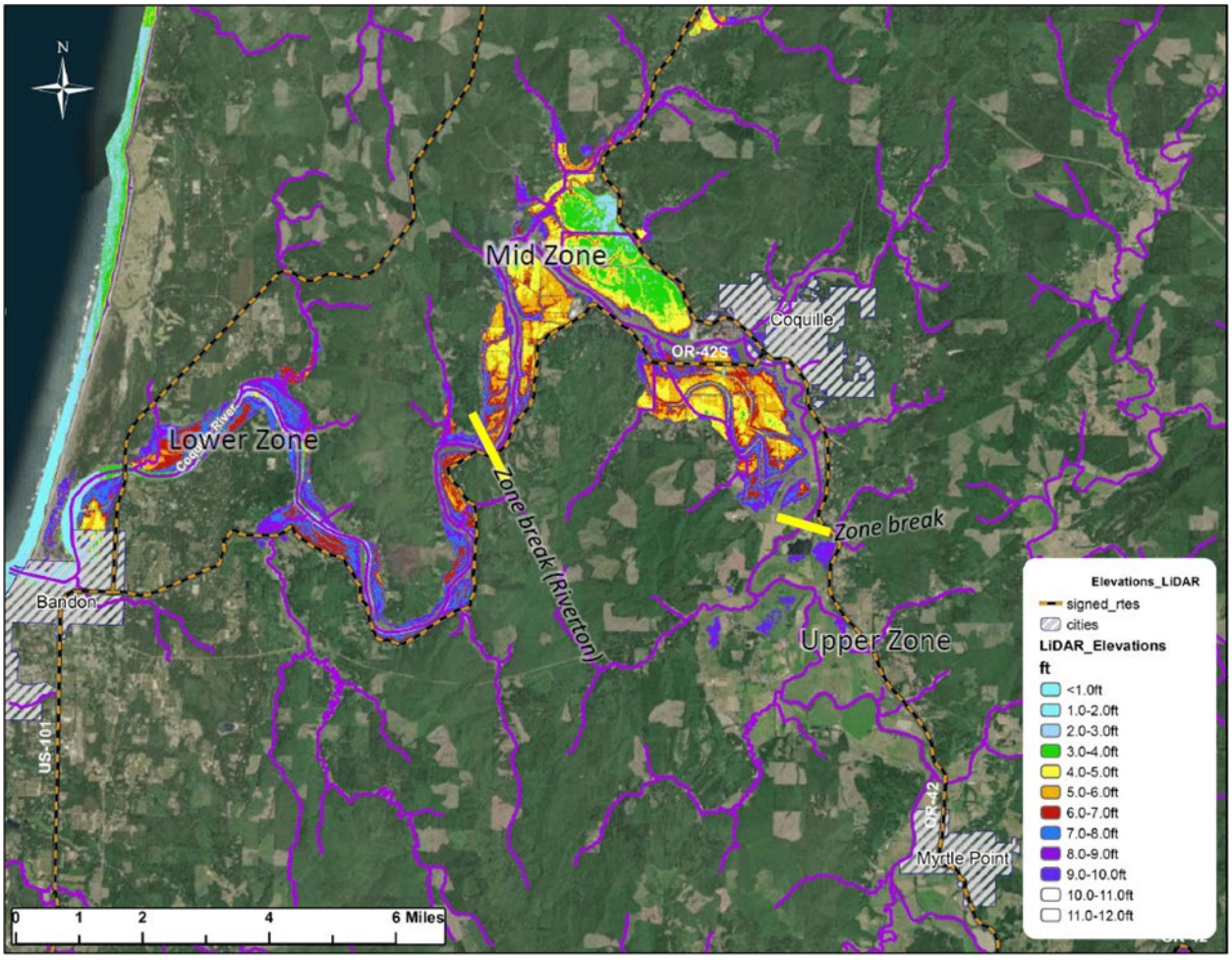
Preferred Email Address

2. Please select the sector that is most closely related to your job duties or organization for the purposes of hazard planning, or use the space below under 'other' to enter a different sector.

- [ ] Agriculture
- [ ] Forestry & Wood Products
- [ ] Fishing and Shellfish Cultivation
- [ ] Other Natural Resources
- [ ] Transportation (e.g. roads, ports, shipping, etc.)
- [ ] Emergency Services
- [ ] Health Services
- [ ] Social Services (e.g. low-income services, job placement, childcare, etc.)
- [ ] Utilities
- [ ] Housing
- [ ] Parks/Open Space
- [ ] Education
- [ ] Community & Cultural Centers
- [ ] Business (e.g. tourism, hospitality, retail, services, etc.)
- [ ] Industry (e.g. manufacturing, materials, construction, etc.)
- [ ] Land Use Planning
- [ ] Other (Please Specify)

3. Which one of the sectors you selected do you most identify with, or is the most relevant?

For the purposes of responding to this questionnaire, please consider the context of the landward areas of estuarine influence on the following map, or adjacent areas that may directly interact with them.



4. Which reach/area of the Coquille River estuary is your primary area of concern?

- Bandon Jetty to Riverton (Lower Zone)
- Riverton to Johnson Mill Rd. (Mid Zone)
- Johnson Mill Rd. to Myrtle Point (Upper Zone)

5. What planning efforts, if any, has your organization undertaken to investigate, prepare for, adapt to, or otherwise mitigate risk associated with any of the potential hazards listed below? Please list any organizations you have partnered or collaborated with on hazard planning. If a hazard is not listed below, please include it in your response.

If you have documentation that would help us gather information about Coos County hazard vulnerability, please include a weblink (URL) with your response.

Please consider the following list of potential hazards in your response.

Chronic Hazards (those that carry the potential for cumulative, long-term impact):

- Air quality (increased pollutants: ozone, smoke, pollen, etc.)
- Average air temperature rise (long-term)
- Changes to water temperature, quality, or chemistry (e.g. ocean acidification)
- Changes to climate regime (climate change)
- Increased invasive species and pests, or other impacts to fish and wildlife
- Sea level rise and saltwater intrusion
- Decreased summer precipitation; heavier winter storms
- Changing ocean cycles (Pacific Decadal Oscillation, El Niño/La Niña, spring transition timing)
- Erosion, accretion, or deposition of beaches, dunes, or soils (long-term)
- Subsidence
- Decrease in distribution/health of native species (especially those that provide natural barriers/infrastructure)

Episodic Hazards (discrete events with immediate impact):

- Heavy rains and river flooding
- Tidal flooding, king tides
- Tsunamis
- Landslides
- Erosion, accretion, or deposition of beaches, dunes, or soils (short-term)
- Heat waves (short-term)
- Cold snaps (short-term)
- Severe weather events (high winds, storm surge)
- Drought
- Wildfire
- Earthquakes
- Water table issues

5. What level of risk do you perceive the following current or projected hazards pose? Consider your organization, its mission, the resources and assets it manages, the communities and populations it serves, and your area(s) of concern.

   Risk is a combination of (a) the probability that an event will occur, and (b) the consequence of its occurrence.

	Does Not Apply	Do Not Know	No Risk	Very Low	Low	Medium	High	Very High
Air quality (increased pollutants: ozone, smoke, pollen, etc.)	○	○	○	○	○	○	○	○
Average air temperature rise (long-term)	○	○	○	○	○	○	○	○
Changes to water temperature, quality, or chemistry (e.g. ocean acidification)	○	○	○	○	○	○	○	○
Changes to climate regime (climate change)	○	○	○	○	○	○	○	○
Increased invasive species and pests, or other impacts to fish and wildlife	○	○	○	○	○	○	○	○

Sea level rise and saltwater intrusion	○	○	○	○	○	○	○	○
Decreased summer precipitation; heavier winter storms	○	○	○	○	○	○	○	○
Changing ocean cycles (Pacific Decadal Oscillation, El Niño/La Niña, spring transition timing)	○	○	○	○	○	○	○	○
Erosion, accretion, or deposition of beaches, dunes, or soils (long-term)	○	○	○	○	○	○	○	○
Subsidence	○	○	○	○	○	○	○	○
Decrease in distribution/health of native species	○	○	○	○	○	○	○	○
Heavy rains and river flooding	○	○	○	○	○	○	○	○
Tidal flooding, king tides	○	○	○	○	○	○	○	○

Tsunamis	○	○	○	○	○	○	○	○
Landslides	○	○	○	○	○	○	○	○
Erosion, accretion, or deposition of beaches, dunes, or soils (short-term)	○	○	○	○	○	○	○	○
Heat waves (short-term)	○	○	○	○	○	○	○	○
Cold snaps (short-term)	○	○	○	○	○	○	○	○
Severe weather (high winds, storm surge)	○	○	○	○	○	○	○	○
Drought	○	○	○	○	○	○	○	○
Wildfire	○	○	○	○	○	○	○	○
Earthquakes	○	○	○	○	○	○	○	○
Water table issues	○	○	○	○	○	○	○	○

Other (please specify)

7. What asset(s) or resource(s) (e.g., specific natural resources, critical habitat, vulnerable populations, cultural resources, equipment/tools, infrastructure, structures, etc.) are most vulnerable to the hazard(s) you chose in Q5? Feel free to limit your answer to one asset or resource, or expand on several that are most vulnerable.

In your response consider specifying:

1. Which assets/resources
2. Locations of assets/resources
3. How often they are impacted (i.e. Is this chronic or episodic? How long does the impact last, days, weeks, months?) (current/projected)
4. In what ways they are impacted

8. What is the one most critical hazard you chose in Question 5? What can be done by your organization and others to reduce the risks posed by this hazard? Please indicate at least one (1) most critical hazard, but feel free to list others.

List of hazards from Question 5:

- Air quality (increased pollutants: ozone, smoke, pollen, etc.)
- Average air temperature rise (long-term)
- Changes to water temperature, quality, or chemistry (e.g. ocean acidification)
- Changes to climate regime (climate change)
- Increased invasive species and pests, or other impacts to fish and wildlife
- Sea level rise and saltwater intrusion
- Decreased summer precipitation; heavier winter storms
- Changing ocean cycles (Pacific Decadal Oscillation, El Niño/La Niña, spring transition timing)
- Erosion, accretion, or deposition of beaches, dunes, or soils (long-term)
- Subsidence
- Decrease in distribution/health of native species (especially those that provide natural barriers/infrastructure)
- Heavy rains and river flooding
- Tidal flooding, king tides
- Tsunamis
- Coastal erosion, landslides
- Erosion, accretion, or deposition of beaches, dunes, or soils (short-term)
- Heat waves (short-term)

- Cold snaps (short-term)
- Severe weather events (high winds, storm surge)
- Drought
- Wildfire
- Earthquakes
- Water table issues

9. On a scale from 1 to 5, how urgent (time sensitive) is the need to reduce the risk(s) of the most critical hazard you identified in Question 5? In your response, consider impacts to your most vulnerable assets and resources.

1. Not urgent
2. Slightly urgent
3. Somewhat urgent
4. Very urgent
5. Extremely urgent

10. Are there specific time frame indicators for the risk(s) you chose in Question 6? Please explain why you chose your answer. Time frame indicators could be within a certain time window (e.g. immediately, months, years, decades), when a specific event has occurred (e.g. earthquake, tsunami), or when a particular threshold has been crossed (e.g. sea level rise, average temperature, seawater pH, etc.)

11. What other information regarding hazards can you tell us about (e.g. concerns, partnerships, planning efforts, adaptation actions, budget/capacity restraints)?

Thank you for participating in our survey!

You will have an opportunity to provide additional feedback during an online listening session to be held via Zoom in June 2022.

We will send you an email poll with instructions for providing your availability to attend the meeting. We look forward to working with you to create a vulnerability assessment and adaptation plan for Coos County estuaries!

For questions or comments please contact Michael Moses
- michael.moses@dlcd.oregon.gov (971) 332-0946.

Appendix C: Listening Session Questions

Listening Session Questions: Sensitivity and Adaptive Capacity

Questions may be adapted based on the context of the specific asset and interviewee.

Refer to pages 4-7 for a list of hazards and definitions, followed by the most vulnerable assets identified for each sector. The following questions will be asked with respect to that context.

Sector: _____

Most critical hazard: _____

Adaptive Capacity: A natural, built, or social system's ability to adjust to new or changing conditions, make use of beneficial opportunities, and/or reduce negative effects. Adaptive capacity is assessed independently of hazard or climate change considerations.

1. Do the specific facilities, infrastructure (built or natural), sites, or habitats in your sector currently operate at capacity (i.e. Have habitats at natural sites been restored to the greatest extent possible)? If not, when do you foresee demand/utilization exceeding capacity?
    - **1 = Now**
    - **2 = 1-4 years**
    - **3 = 5-20 years**
    - **4 = 21-50 years**
    - **5 = Never**

2. How feasible is it to replace, repair, restore, or mitigate loss of function of the facilities/infrastructure/sites/habitats in your sector?
    - **1 = Impossible**
    - **2 = Difficult**
    - **3 = Moderate**
    - **4 = Easy**
    - **5 = Very easy**

3. When will the facilities/sites/infrastructure in your sector need to be overhauled or replaced?
    - **1 = Now**
    - **2 = 1-4 years**
    - **3 = 5-20 years**
    - **4 = 21-50 years**

- **5 = Never**

4. What level of redundancies or backups exist for these facilities/infrastructure/sites/habitats? If so, what, where, etc?
    - **1 = None**
    - **2 = A little**
    - **3 = Some**
    - **4 = A lot**
    - **5 = Complete**

5. Which other resources do your resources/assets/populations fundamentally rely on? Please include specifics. (e.g., Your sector cannot function with a disruption to transportation networks, or without a specific water source.)
    - Similarly, which other resources/assets/populations rely on them?

6. In what ways might your sector's resources/assets/populations be able to adapt or bounce back from a disruption? (Consider: strengths and weaknesses of your sector, diversity of resources/assets/populations, reliability of funding, capacity, redundancies, etc.)

7. What, if any, are the hazard adaptation, mitigation, or emergency response plans related to these resources/assets/populations?

Sensitivity & Impacts: The degree to which a natural, built, or social system is affected (adversely or beneficially) by direct or indirect exposure to natural hazards.

1. Which resources/assets/populations do you see as most vulnerable to [hazard]? Please list specific names, locations, etc.

2. Are these resources/assets/populations currently impacted by any stressors? If yes, what are the stressors and how impacted is the resource? (Example stressors may be things such as climate change, land use change, funding, adaptability of resources/assets/populations, etc.)
    - **1 = Not really at all**
    - **2 = A little**
    - **3 = Moderately**
    - **4 = A lot**
    - **5 = Entirely**

3. How sensitive would you rate these assets/resources/populations to [hazard]?
    - **1 = Extremely insensitive:** the resource will not be affected by a large hazard or chronic events, or the effects will be negligible.
    - **2 = Mostly insensitive:** some effects may be noticed, but the resource will be largely unaffected by a large hazard or chronic events.

- **3 = Unknown sensitivity:** it is unclear whether the resource will be affected by a large hazard event or chronic events.
- **4 = Somewhat sensitive:** a large hazard event will have moderate effects on the resource, or chronic events will have moderate effects in the short-term.
- **5 = Extremely sensitive:** a large hazard event will have devastating effects on the resource, or chronic events will have devastating effects in the short-term.

4. How long will it take to return to normal levels if the facilities/sites/resources are affected by [hazard]?
   - **1 = Days or weeks**
   - **2 = Months**
   - **3 = 1-5 years**
   - **4 = 5-10 years**
   - **5 = Decades**

5. To the best of your knowledge, what is the degree and extent of impact to those resources/assets/populations expected by [hazard]?
   - **1 = Not affected or negligible effects**
   - **2 = Minor:** damage/impact is minimal, recoverable; extent is localized
   - **3 = Moderate:** damage/impact is considerable, resulting in long-term effects
   - **4 = Major:** damage/impact is substantial and/or irreversible
   - **5 = Catastrophic:** damage/impact causes total devastation

6. Using your best judgment, how much of the surrounding human community would be adversely affected if the resources/assets/populations were impacted by [hazard]?
   - **1 = None**
   - **2 = A little**
   - **3 = Some**
   - **4 = Most**
   - **5 = All**

7. What are the expected long-term or indirect impacts caused by [hazard] to your sector's assets/resources/populations?

*****

8. Based on today's discussion, how would you rank your community (up river/down river @ Bandon Marsh NWR) overall with respect to adaptive capacity?
   - **1 = Very low**
   - **2 = Low**
   - **3 = Medium**
   - **4 = High**
   - **5 = Very high**

Context of Potential Natural Hazards in Southwestern Coos County

The purpose of the listening sessions is to gain a deeper understanding of the needs and vulnerabilities of Oregon coastal communities to natural hazards. As we work through the session, please keep the following context in mind for our discussion:

Some helpful terms and definitions:

Estuary: Estuaries are bodies of water, and their surrounding coastal habitats, typically found where rivers meet the sea. Estuaries harbor unique plant and animal communities because their waters are brackish — a mixture of fresh water draining from the land and salty seawater. This includes areas influenced (presently or historically) by river flow, tides, and localized weather.

Natural (or "green") Infrastructure: Natural infrastructure, also referred to as "green" infrastructure, uses existing natural areas or engineered solutions that mimic natural processes such as flooding, erosion, and runoff, to minimize, redirect, or redistribute their impacts. Additional benefits can include increased recreational opportunities, improvements to wildlife habitat, water quality improvements, and many more.

Hazard: is any situation that has the potential of causing damage to people, property, or the environment. For the purposes of this questionnaire, we are focusing on hazards induced by the forces of nature ("natural hazards").

Hazard Exposure: The presence of people, livelihoods, species, ecosystems, services, resources, infrastructure, or other environmental, economic, social, or cultural assets in places that could be adversely affected by a hazard.

Resilience: Resilience is the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events (such as natural hazards).

Stakeholder: Individuals, organizations, or communities who have an interest in or are affected by decisions, planning, or policies.

Vulnerability: The extent to which a natural, built, or social system is susceptible to damage from natural hazards. Under this framework, a highly vulnerable system would be one that is highly sensitive to modest impacts from natural hazards.

Questions to Consider Regarding Hazard Exposure in Your Sector

- How much of your sector or your sector's components (e.g. resources, assets, populations) are projected to be exposed to the most critical hazard of interest?
- On what kind of timescales do you anticipate these components to be exposed to this hazard? [Example: weeks, months, 1-4 years, 5-10 years, decades]
- What do you believe is the certainty, likelihood, or probability of these projections?

List of Oregon Coastal Natural Hazards:

Chronic Hazards (those that carry the potential for cumulative, long-term impact):

- Air quality (increased pollutants: ozone, smoke, pollen, etc.)
- Average air temperature rise (long-term)
- Changes to water temperature, quality, or chemistry (e.g., ocean acidification)
- Changes to climate regime (climate change)
- Increased invasive species and pests, or other impacts to fish and wildlife
- Sea level rise and saltwater intrusion
- Decreased summer precipitation; heavier winter storms
- Changing ocean cycles (Pacific Decadal Oscillation, El Niño/La Niña, spring transition timing)
- Erosion, accretion, or deposition of beaches, dunes, or soils (long-term)
- Subsidence

Episodic Hazards (discrete events with immediate impact):

- Heavy rains and river flooding
- Tidal flooding, king tides
- Tsunamis
- Landslides
- Erosion, accretion, or deposition of beaches, dunes, or soils (short-term)
- Heat waves (short-term)
- Cold snaps (short-term)
- Severe weather events (high winds, storm surge)
- Drought
- Wildfire
- Earthquakes
- Water table issues