Lincoln County

Estuarine Resilience Action Plan

2025

Prepared for the communities and residents of Lincoln County
with support from the MidCoast Watersheds Council,
Oregon State University Extension Service, and Oregon Sea Grant.

OREGON
Coastal Management Program
DEPARTMENT OF LAND CONSERVATION & DEVELOPMENT

Lincoln County

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Cover photo: Coquille Point in Yaquina Bay looking toward Newport. May 2014. Courtesy of Oregon ShoreZone[1].

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Executive Summary

The Lincoln County Estuarine Resilience Action Plan (ERAP) is a partner-led framework for strengthening the natural hazards resilience of estuaries, communities, ecosystems, and infrastructure in coastal Lincoln County, Oregon. Developed through an extensive collaborative process involving local governments, Tribal partners, conservation organizations, watershed councils, state and federal agencies, and other local community partners and interested parties, the ERAP provides actionable strategies to reduce natural hazard risks, restore degraded systems, and support long-term adaptation in a changing climate and landscape.

Lincoln County's estuaries, Yaquina Bay, Alsea Bay, Siletz Bay, the Salmon River, Depoe Bay, and several smaller systems such as Beaver Creek, are deeply interconnected with the region's culture, economy, and environment. These estuaries support working waterfronts, vital transportation corridors, public access and recreation, culturally significant resources, critical habitat for numerous species such as salmon and shorebirds, and natural flood and water quality regulation. However, they are also vulnerable to a wide range of hazards, including riverine and coastal flooding, tsunami, erosion, water quality degradation, infrastructure exposure, and the compounding impacts of climate change.

Plan Purpose and Structure

ERAPs aim to fill critical gaps by bridging local planning priorities with landscape-scale natural hazard and climate resilience strategies. While Lincoln County communities have existing hazard mitigation plans, estuary management plans, and infrastructure frameworks, the ERAP provides a unique geographic and thematic focus on coastal resilience by:

- **Assessing** current and future vulnerabilities within and around each major estuary;
- **Identifying** nature-based and hybrid strategies that reduce risk while supporting ecological and community co-benefits;
- **Integrating** local, Tribal, and regional priorities into shared action pathways; and
- **Supporting** implementation through clear actions, coordination opportunities, and funding guidance.

The plan includes estuary-specific subsections that summarize vulnerabilities and priority strategies, as well as a countywide strategy framework that integrates cross-cutting issues such as land use, ecosystem restoration, infrastructure resilience, water quality, emergency preparedness, and others into a unified set of recommended actions.

Key Findings

The ERAP process revealed shared and site-specific concerns across Lincoln County's estuarine areas and communities. While each estuary has distinct physical, ecological, and community characteristics, several common patterns emerged:

Hydrology and Flooding: Lincoln County's estuaries experience a complex interplay of tidal inundation, river flooding, and storm-driven surge that threaten natural and built environments. Yaquina Bay, especially around the deep-draft port facilities near Newport and South Beach, faces chronic flooding risks that threaten local infrastructure, worsened by rising sea levels and intensifying storms. Similarly, Alsea Bay's historically diked and drained floodplain struggles with managing water levels to balance flood protection and wetland health. In Siletz Bay, diking and wetland loss have altered natural floodplain functions, contributing to flooding impacts on rural and community infrastructure. The Salmon River estuary remains one of the least modified in the county, yet rural roads and agricultural lands within its floodplain face increasing flood exposure due to changing hydrology. Beaver Creek, while a smaller estuary, endures frequent flooding along key rural roadways exacerbated by historic wetland conversion and channel modifications, impacting access and safety. Together, these estuaries illustrate the diverse and localized flood vulnerabilities across Lincoln County.

Water Quality: Water quality challenges are widespread across Lincoln County's estuaries, affecting these systems' ability to support beneficial uses such as drinking water, recreation, and healthy aquatic habitats. Elevated water temperatures and nutrient loading have led to water quality impairments, particularly in Alsea Bay and the Salmon River estuary, where standards for temperature, dissolved oxygen, and bacteria are often not met. Urban runoff and aging wastewater infrastructure contribute to elevated bacterial contamination risks in populated areas including Newport on Yaquina Bay and Waldport on Alsea Bay, impacting public health and recreational use. Nutrient inputs further threaten Yaquina Bay, intensifying eutrophication potential and complicating ecosystem health. Groundwater quality remains under-monitored, limiting understanding of subsurface contaminant pathways and their impacts across estuaries. Addressing these water quality issues will be critical for sustaining both community needs and ecological functions.

Ecological Health and Habitat Loss: Lincoln County's estuaries support diverse habitats vital to fish and wildlife but face significant habitat degradation from historic and ongoing human activities. Yaquina and Siletz Bays have experienced extensive losses of tidal wetlands due to diking, drainage, and shoreline armoring, leading to fragmentation and reduced connectivity for species such as coho salmon, lamprey, and various shorebird populations. Conversely, the Salmon River estuary supports high biodiversity and remains one of the most intact natural estuarine systems on the Oregon Coast, serving as essential critical habitat for Endangered Species Act (ESA)-listed coho salmon. Alsea Bay's wetlands

have been significantly altered by human modifications, although restoration efforts are underway to improve habitat complexity and function. Some of these areas are threatened by invasive species such as European green crab and *Spartina* cordgrass that jeopardize native fish and bird habitats. Invasive species pressures are a persistent and countywide challenge that complicate restoration goals and require sustained management.

Built Infrastructure Vulnerabilities: Flooding and environmental change increasingly threaten Lincoln County's infrastructure, with aging transportation and water systems facing repeated stress. Key rural roads in the Beaver Creek area flood regularly, undermining local access and emergency response. In urban centers like Newport and Waldport, wastewater and stormwater infrastructure are challenged by capacity limitations and aging components, raising concerns for system resilience during peak flow and storm events. Funding constraints and regulatory complexities hinder timely upgrades to critical infrastructure, while permitting challenges delay projects designed to increase system resiliency and support ecosystem restoration. Managing infrastructure for resilience and recovery is an urgent priority for maintaining community safety and environmental quality.

Regulatory and Collaborative Landscape: Successful resilience planning and restoration across Lincoln County's estuaries depends on strong coordination among federal, state, and local partners, including the US Army Corps of Engineers, Oregon Parks and Recreation Department, Department of State Lands, and county and city governments. Overlapping regulations and complex permitting processes often delay implementation of flood risk reduction and habitat restoration projects. Strengthening partnerships and streamlining regulatory pathways will be essential for advancing nature-based solutions that balance ecological integrity with community needs. Collaborative governance approaches foster alignment of restoration goals, flood management, and community priorities.

Community and Social Dimensions: Communities across Lincoln County share many common goals related to estuary resilience, including reducing flood risks, protecting water quality, and maintaining critical infrastructure. Local priorities and approaches vary based on geography, land use, and community structure. These differences reflect the diversity of the county and highlight the need for place-based strategies tailored to local conditions and values. Broad community engagement and transparent communication are critical for building trust, raising awareness of estuarine vulnerabilities, and fostering shared commitment to adaptive solutions that reflect local needs and priorities.

Opportunities for Resilience: Lincoln County's estuaries present significant opportunities to enhance resilience through integrated, nature-based approaches. Restoring tidal wetlands and reconnecting floodplains in Yaquina Bay, Alsea Bay, and Siletz Bay can reduce flood risks, improve habitat quality, and bolster ecological connectivity. Targeted control of invasive species is essential to protect native ecosystems and support restoration success.

Infrastructure upgrades, especially to wastewater treatment, stormwater management, and transportation networks, can help mitigate water quality impairments and improve community safety. Effective partnerships, data-informed planning, and sustained community involvement will be crucial to overcome barriers and realize resilient, thriving estuarine systems across Lincoln County.

Resilience Strategies

The ERAP prioritizes nature-based and hybrid strategies that aim to reduce risk while supporting ecological health, social benefits, and long-term adaptability. Strategy categories include:

Restoring Estuarine and Tidal Wetlands to improve flood storage, sediment dynamics, and habitat connectivity;

Enhancing Upland Buffers and Setbacks to support marsh migration and reduce shoreline erosion;

Investing in Resilient Infrastructure such as elevated or realigned roadways, culvert upgrades, and water system improvements outside hazard zones;

Protecting and Managing Floodplains through conservation easements, regulatory tools, and voluntary landowner incentives;

Improving Water Quality and Aquatic Habitat through stormwater retrofits, septic upgrades, and stream restoration;

Strengthening Emergency Preparedness with updated tsunami evacuation routes, vertical evacuation planning, and community outreach.

Chapter IV outlines potential actions based on existing conditions, community priorities, and feasibility constraints. Proposed actions include habitat restoration, shoreline stabilization, improved stormwater and sediment management, infrastructure adaptation, and coordinated planning efforts. These actions reflect the diverse needs and conditions across Lincoln County's estuaries and emphasize nature-based and collaborative approaches to resilience.

Implementation and Use

The ERAP is designed as a practical tool for public agencies, planners, emergency managers, Tribes, conservation organizations, and community leaders. The ERAP provides tools and information to help partners advance estuary resilience efforts over time. It includes preliminary asset and exposure information, along with estuary-specific maps that can help inform future project development and support funding applications. Strategy tables link

proposed actions to existing plans and programs, offering a foundation for coordinated implementation. The plan also outlines evaluation considerations to help communities assess project feasibility, potential co-benefits, and alignment with funding opportunities. Finally, it suggests a path forward for resilience actions to help guide implementation, foster collaborative learning, and support adaptive management over time. Local governments can use the ERAP to inform comprehensive plans, capital investment decisions, hazard mitigation strategies, and land use policies. State and federal agencies can use it to identify project-ready investments and coordination pathways. Community organizations can use it to elevate shared priorities and build support for funding and action.

Looking Ahead

The Lincoln County ERAP is a starting point for ongoing collaboration and action. While it provides clear strategies and implementation tools, its long-term success depends on continued partnerships, capacity-building, and resource alignment. Local implementation will require creative funding solutions, support for landowners and communities, and coordination across multiple planning and permitting frameworks.

As climate and hazard risks increase, the need for integrated, estuary-focused resilience planning has never been greater. This plan offers a path forward grounded in local knowledge, shared values, and a commitment to protecting the people, places, and ecosystems that define Lincoln County's coast. Partners across the county are encouraged to use the ERAP to guide investments, shape priorities, and build a more resilient future, together.

Image: Toledo. By TWC & LightHawk.

I. Introduction

Image: Restaurant deck, bayfront, Newport. By Meg Reed.

Coastal Lincoln County, Oregon and its extensive and diverse estuarine systems face a complex array of challenges due to its position along the Pacific Coast. Communities throughout the county are nestled around key estuarine areas like Yaquina Bay, Alsea Bay, Siletz Bay, and Depoe Bay, among others. These estuaries provide habitats for fish and wildlife while supporting tourism, fishing, and recreation, making them important for local economies and ecosystems. However, as natural hazards such as climate change, sea level rise, storm surge, and tsunami pose persistent threats, these communities are increasingly vulnerable to disruptions from flooding, erosion, and other impacts.

Addressing these vulnerabilities requires a robust and forward-thinking approach to resilience planning. Lincoln County has made strides in coastal management and resilience, with various initiatives aimed at preserving and enhancing the health of its estuarine environments. Building on these existing efforts, there is an urgent need for a cohesive strategy that integrates local knowledge, leverages ongoing projects, and addresses gaps in current planning. **This action plan aims to enhance coastal resilience by unifying goals and priorities across the county, strengthening partnerships, and advancing targeted actions to protect and restore estuarine ecosystems while safeguarding community interests.** By focusing on both immediate needs

and long-term sustainability, Lincoln County can better navigate the challenges ahead and ensure a resilient future for its estuarine areas and coastal communities.

Background and Purpose

In 2022, the Oregon Coastal Management Program (OCMP) received funding from the National Fish and Wildlife Foundation's (NFWF) National Coastal Resilience Fund (NCRF) to develop an Estuarine Resilience Action Plan for Lincoln County estuarine areas and communities. This initiative seeks to bolster the county's resilience against the growing threats of climate change, sea level rise, and natural hazards such as storms and flooding. The focus of the plan is to restore and enhance natural systems through **nature-based solutions** that leverage natural ("green") infrastructure to improve the protection of coastal communities, support recovery efforts, and sustain critical fish and wildlife habitats.

This document was designed through a collaborative, community-driven approach, involving interested parties from local governments, state and federal agencies, watershed councils, and other organizations with a vested interest in estuarine resilience. The planning process also includes input from coastal Tribal Nations to ensure the plan reflects diverse perspectives and priorities. By identifying and evaluating potential resilience actions, **the ERAP aims to address local vulnerabilities, prioritize effective adaptation strategies, and support the implementation of projects that enhance both ecological health and community safety.** This plan provides a roadmap for advancing resilience efforts and achieving sustainable outcomes for Lincoln County's estuarine environments and the communities that depend on them.

Oregon's Estuaries: A Dynamic and Vital Landscape

Oregon's estuaries are among the most productive and ecologically significant environments along the Pacific coast. These tidal ecosystems form at **the confluence of freshwater and saltwater**, creating a constantly shifting mosaic of habitats that support an extraordinary diversity of life. Shaped by river inflows, tidal currents, and sediment deposition, estuaries function as crucial nurseries for marine and anadromous fish, as well as critical feeding, resting, and nesting sites for migratory birds. They also provide essential ecosystem services, buffering coastal areas from storm surges, filtering pollutants from upland waters, and sequestering carbon within expansive marshes and mudflats (Brophy et al., 2019). However, these same dynamic processes make estuaries highly sensitive to the impacts of human activity and climate change, with habitat loss, altered hydrology, and sea level rise presenting increasing challenges to their long-term stability (Brophy et al., 2020).

The ecological fabric of Oregon's estuaries is woven together by a complex network of habitats, including tidal marshes, eelgrass beds, mudflats, and forested wetlands. Eelgrass meadows, for example, serve as critical spawning and rearing habitats for juvenile fish, crab, and shellfish,

while also stabilizing sediments and improving water clarity. Salt marshes and forested tidal wetlands provide refuge and foraging grounds for species like coho salmon and Pacific lamprey, supporting key phases of their life cycles before they transition to the open ocean (Brophy et al., 2017). The intertidal and subtidal zones teem with invertebrates such as clams, mussels, and shrimp, forming the foundation of estuarine food webs that sustain larger predators, including harbor seals, Bald Eagles, and otters (Yaquina Bay EMP, 2023). These intricate biological relationships highlight the vital role estuaries play in maintaining coastal biodiversity and fisheries productivity.

Beyond their ecological importance, estuaries are deeply embedded in **Oregon's cultural and economic landscape**. Since time immemorial, Indigenous communities such as the Confederated Tribes of Siletz Indians and Confederated Tribes of the Coos, Lower Umpqua, and Siuslaw Indians have been relying on estuaries for subsistence fishing, shellfish harvesting, and trade. Their traditional ecological knowledge continues to inform modern conservation and restoration efforts. In the last century, estuaries have been focal points for maritime industries, including fishing, aquaculture, and shipping, with communities like Newport and Toledo developing infrastructure and industry around their rich natural resources and physical protection (OCCEC, 2021). However, this development has come with costs: diking, dredging, and urbanization have significantly altered estuarine landscapes, reducing tidal wetland extent and disrupting sediment transport processes (MCWPP, 2022). Land use changes in the watersheds like forestry and agriculture, which have converted significant amounts of tidal wetlands, have further impacted estuarine water quality. Clearing for agriculture is one of the primary drivers for forested tidal swamp loss, with more than 90% of this habitat lost in Oregon's estuaries (Brophy et al., 2019). Restoration of tidal wetlands altered for agricultural and timber uses is far more achievable than in areas developed for industrial purposes.

Human communities remain closely tied to estuaries, not just through development but also through shared vulnerabilities. Estuaries act as natural buffers against coastal hazards, absorbing storm surges and mitigating flooding, but their ability to provide these protections is increasingly threatened by sea level rise, warming waters, and intensified storm events. Infrastructure such as roads, bridges, and ports must adapt to changing estuarine conditions, while communities face difficult decisions about balancing economic development with ecosystem resilience.

Approximately 13.5% of Lincoln County residents lived below the poverty level in 2021-2022 (OHA, 2022). Disparities also exist in educational attainment, with portions of the population lacking a high school diploma (US Census Bureau, 2023). These factors can limit access to resources and information necessary for preparing for and responding to coastal hazards, such as flood warnings or evacuation notices. For example, low-income households may struggle to afford flood insurance or implement property-level adaptations, and interpreting technical information for flood risks can present accessibility challenges. Furthermore, Lincoln County's rural areas face unique challenges such as higher poverty rates, limited access to healthcare,

and reduced access to quality childcare and education (Oregon Office of Rural Health, n.d.), with social isolation potentially hindering effective communication and support during emergencies (ODHS, n.d.). The growing Hispanic and Latino population, accounting for 14.4% of the population in 2023 (US Census Bureau, 2023), highlights the need for culturally and linguistically appropriate communication strategies to ensure all community members receive critical information during hazard events.

Addressing these social factors in conjunction with ecological restoration is vital for building genuine resilience in Lincoln County's estuarine regions (Brophy et al., 2017). By recognizing and addressing these social vulnerabilities, resilience planning can better protect all people who live, work, and recreate along the Oregon Coast.

A Shifting Ecological Landscape

Lincoln County's estuaries have long been recognized as biologically rich and ecologically significant, providing critical habitats for numerous species. However, the modern condition of these ecosystems reflects a legacy of human alteration, compounded by emerging climate stressors. The historical transformation of Oregon's estuarine wetlands has been profound. Over 85% of the vegetated tidal wetlands on the West Coast have been lost due to diking, filling, and other land use changes (Brophy et al., 2019). In Oregon, these losses have been particularly pronounced for scrub-shrub and forested tidal wetlands, which were historically far more extensive (Brophy et al., 2020). These wetland types play an outsized role in carbon sequestration, flood attenuation, and fish habitat provisioning, making their decline a significant ecological concern. While estuarine conservation and restoration efforts have increased in recent years, the ongoing pressures of rising sea levels, altered sediment flows, and habitat fragmentation pose new challenges (Brophy et al., 2017). Restoration of forested tidal wetlands in particular is a long-term commitment from which it will take decades to realize the full suite of benefits given the time it takes for trees to establish and mature.

Estuarine Conditions in Lincoln County

Lincoln County, located on the central coast of Oregon, is renowned for its diverse natural landscapes, including a rugged coastline, lush forests, and over 128 square miles of estuarine area. The county's geography is marked by its dramatic shoreline, characterized by cliffs, sandy beaches, and scenic bays, with several notable large estuaries such as Yaquina Bay, Alsea Bay, and Siletz Bay, among others. These estuaries are vital ecological zones that support a variety of habitats, including tidal marshes, mudflats, and freshwater wetlands, which provide crucial breeding and feeding grounds for numerous species of fish (Figure 1), birds, and other wildlife.

Historically, Lincoln County has seen significant events including the development of major port cities like Newport and the impact of natural hazards such as tsunamis and earthquakes, which

have shaped its infrastructure and community planning. The estuaries, with their rich biodiversity and important fisheries, play a key role in both the local economy and environmental health. Several coastal communities, including Newport, Lincoln City, and Waldport, rely on these estuarine environments for tourism, fishing, and recreation, highlighting the need for ongoing conservation and management efforts to preserve these critical habitats.

The health of fish and wildlife in Oregon's estuaries is closely tied to the structure and function of the broader landscape. Tidal wetlands, channels, and upland transition zones form an integrated system where species, hydrology, and physical processes are deeply interdependent. Changes in sediment delivery, tidal exchange, or freshwater inflows can reshape habitat conditions, influencing fish movement, vegetation patterns, and water quality. Habitat degradation, from diking to altered streamflows, can trigger cascading effects across trophic levels and reduce essential services like nutrient cycling and flood attenuation. These interactions reflect the complexity of estuarine systems, where changes in the environment and human activity constantly shape ecological conditions.

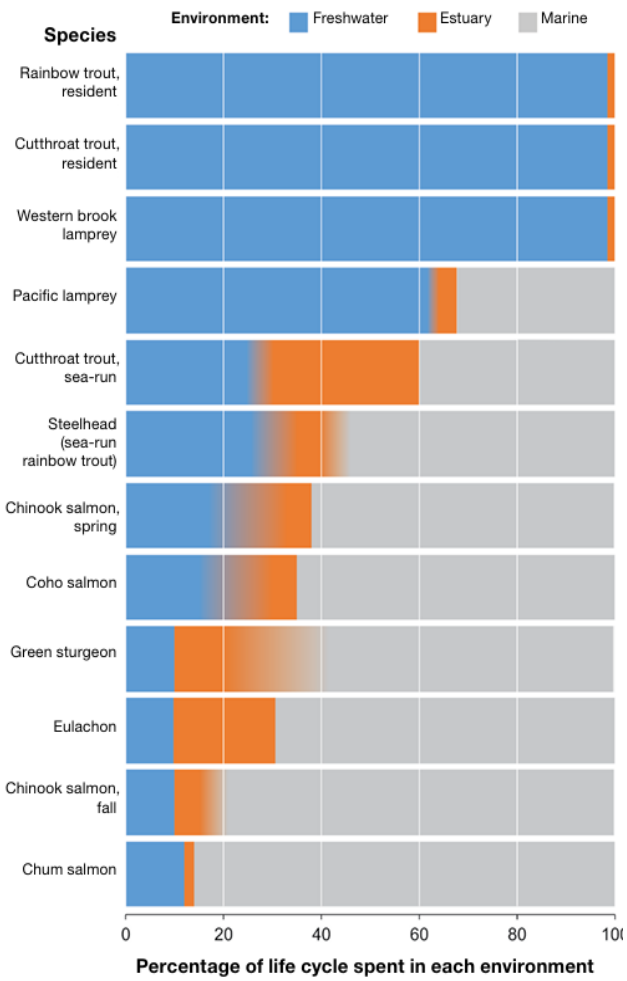

Figure 1. Generalized proportion of the life cycle of focal fishes in freshwater, estuary, and marine environments of coastal Oregon. Source: USFS Climate Change Vulnerability and Adaptation in Coastal Oregon (2024).

Salmon River Estuary: A Model for Restoration

The Salmon River estuary stands as one of the most successful estuarine restoration projects on the Oregon Coast (Schrank, 2021). Beginning in the 1970s, a series of dike removals have allowed tidal wetlands to reestablish, creating conditions that closely resemble those of undisturbed estuaries. Monitoring data from the past two decades indicate that these restored wetlands provide vital functions for juvenile salmon, including increased foraging opportunities and improved hydrological connectivity (Brophy et al., 2019). The estuary also supports a diverse assemblage of estuarine-dependent species, from cutthroat trout to estuarine invertebrates (OCCEC, 2021). Its recovery serves as an instructive case study for other estuarine systems facing similar historical legacies of alteration.

Siletz Bay: A Conservation Success Story in Progress

Once heavily modified by diking and wetland conversion, Siletz Bay has become a focal point for restoration efforts aimed at reintroducing natural tidal exchange (OCCEC, 2021). Today, the bay supports important runs of coho salmon and provides nesting grounds for Western Snowy Plovers, Osprey, and Bald Eagles (Yaquina Bay EMP, 2023). The Siletz Bay National Wildlife Refuge has been instrumental in ongoing wetland recovery projects, which have expanded tidal marshes, begun to restore forested tidal wetland habitats, and improved fish access to critical rearing areas. While these efforts have yielded notable improvements, continued adaptation will be necessary to address the long-term challenges posed by climate-driven shifts in sediment deposition, water salinity (MCWPP, 2022), and sea level rise.

Yaquina Bay: Industry and Ecology in Tension

Yaquina Bay, the largest estuary in Lincoln County, exemplifies the complex balance between economic activity and ecological integrity. A hub for commercial fishing, maritime trade, and research, the bay supports important shellfish industries, including Dungeness crab, bay clams and oyster farming, while also serving as critical rearing habitat for salmonids, juvenile rockfish and a variety of forage fishes (Yaquina Bay EMP, 2023). It is also an important stopover habitat for migratory shorebirds and wintering habitat for waterfowl and other estuary dependent birds. However, industrialization and urbanization have reshaped much of its ecological character. Dredging for navigation, modifications to the shoreline, watershed land use changes, over-harvesting of native oysters, and declining eelgrass coverage have all affected habitat quality (MCWPP, 2022). Despite this, conservation efforts have targeted key areas for wetland restoration, particularly in the upper estuary, where the reintroduction of tidal flow to historic wetlands has shown promise for improving fish passage and sediment dynamics (OCCEC, 2021).

Alsea Bay: A Dynamic but Vulnerable System

Alsea Bay remains a crucial habitat for fish and wildlife, particularly for fall Chinook salmon and a variety of migratory shorebirds (OCCEC, 2021). However, the bay's estuarine function has been altered by sedimentation and changes in hydrology, which have reshaped tidal channels and wetlands. Some of these changes stem from past land use, but future impacts such as sea level rise and shifting salinity gradients are expected to further influence habitat distribution (Brophy et al., 2017). Conservation groups and local agencies have identified restoration opportunities to improve connectivity between tidal wetlands and freshwater inflows, with a focus on maintaining estuarine resilience in the face of changing conditions (MCWPP, 2022).

Future Considerations

The future of Lincoln County's estuaries will be shaped by the accelerating impacts of climate change. Sea level rise is expected to drive fundamental shifts in estuarine habitat distribution, increasing salinity in some areas while leading to submergence in others (Brophy et al., 2017). Coastal erosion and altered sediment dynamics may further transform estuarine landscapes,

particularly in low-lying wetlands (OCCEC, 2021). Additionally, ocean acidification, warming waters, and changing precipitation patterns could affect estuarine food webs, with cascading impacts on fish and wildlife populations, their habitats, and industries that depend on them (MCWPP, 2022).

Modeling sea level rise impacts on Oregon's tidal wetlands suggests that estuarine habitats will need space to migrate upslope and inland if they are to persist in the coming decades (Brophy et al., 2017). This underscores the importance of conservation strategies that prioritize habitat connectivity and allow for natural habitat migration or expansion. Restoration efforts that enhance tidal exchange, reduce artificial barriers, and protect vulnerable estuarine zones will be crucial in ensuring that Lincoln County's estuaries remain ecologically functional in the face of a changing climate (OCCEC, 2021).

Planning Context for Estuary Resilience

The estuaries in Lincoln County have been significantly altered by development, affecting floodplains, hydrology, habitats, species, and infrastructure. For instance, Yaquina Bay has been impacted by the construction of dikes and levees, which were intended to protect agricultural land from flooding but have also altered natural water flow patterns and sediment transport (DEQ, 2011). The estuaries historically supported a rich diversity of fish species, including Chinook and coho salmon. However, development and land use changes have led to habitat degradation. Initiatives like the Oregon Central Coast Estuary Collaborative (OCCEC) **Focused Investment Partnership** (FIP)[2] aims to restore tidal wetlands including Sitka spruce swamps - over 90% of which have been lost in Oregon estuaries (Brophy et al., 2019), prepare landward migration zones for future inundation and tidal wetland vegetation, and improve fish passage to support salmon populations. The City of Newport, located on Yaquina Bay, has a long history of development tied to its harbor and port facilities. The construction of the Newport harbor in the early 20th century facilitated the growth of the commercial fishing industry but also led to modifications in estuarine habitats. Later infrastructure projects, such as the Yaquina Bay Bridge and the expansion of the harbor, have further influenced the estuarine environment (Newport, 2016).

Oregon's Statewide Land Use Planning Goals[3] provide a robust framework for managing the state's diverse landscapes, ensuring sustainable development while protecting environmental resources. Among these, the four coastal-specific goals, Goal 16 (Estuarine Resources), Goal 17 (Coastal Shorelands), Goal 18 (Beaches and Dunes), and Goal 19 (Ocean Resources), are critical for safeguarding coastal ecosystems, fostering resilience to natural hazards, and supporting the long-term economic and social well-being of coastal communities. These goals establish clear

[2] https://www.midcoastwatersheds.org/focused-investement-partnership

[3] https://www.oregon.gov/lcd/op/pages/goals.aspx

guidance for managing estuaries, shorelands, and ocean resources while balancing the needs of natural systems with human activities.

In Lincoln County, the estuarine and adjacent coastal shoreland zoning guided by Goals 16 and 17 exemplifies this balance. All local governments with authority over an estuary must prepare and adopt a management plan and land use regulations according to four estuary management classifications:

> **Deep-draft development** for estuaries with maintained jetties and channels more than 22 feet deep;
>
> **Shallow-draft development** for estuaries with maintained jetties and channels up to 22 feet deep;
>
> **Conservation** for estuaries without a maintained jetty or channel within or adjacent to an urban area with altered shorelines;
>
> **Natural** for estuaries without a maintained jetty or channel not adjacent to an urban area and with little development.

Estuaries such as Siletz Bay, Yaquina Bay, and Alsea Bay are given a management designation (see Table 2) and then are further divided into one of three estuary management units based on their ecological characteristics and past and potential future uses. These are Natural, Conservation, and Development units, each with specific allowable activities and protections outlined by Goal 16. For example, Natural zones prioritize habitat preservation and prohibit intensive development, while Development zones accommodate water-dependent uses like marinas or ports, provided they align with environmental safeguards. This zoning system ensures that estuaries can support critical habitats for species such as salmon and migratory birds while enabling sustainable economic activities like aquaculture, tourism, fishing, and navigation. Statewide Planning Goal 17 outlines planning and management requirements for the lands bordering estuaries, coastal shorelands, and the ocean shore. In general, the requirements of Goal 17 apply in combination with other planning goals to direct the appropriate use of shoreland areas. Provisions in Goal 17 specifically focus on the protection and management of resources unique to shoreland areas. Examples of such unique resources include areas of significant wildlife habitat, lands especially suited for water dependent uses, lands providing public access to coastal waters, dredge material disposal sites, and potential restoration or mitigation sites. Like Goal 16, Goal 17 requirements are implemented through local comprehensive plans and zoning at both the county and city level.

By integrating local needs with state-level protections, Lincoln County's estuary management and planning strives for balancing ecological integrity and economic development. Updating

and improving estuary management plans also offers an opportunity to support resilience to climate change and other stressors. This planning is also important for addressing changes in estuarine conditions as a result of climate change, landscape alterations, and habitat and biodiversity loss.

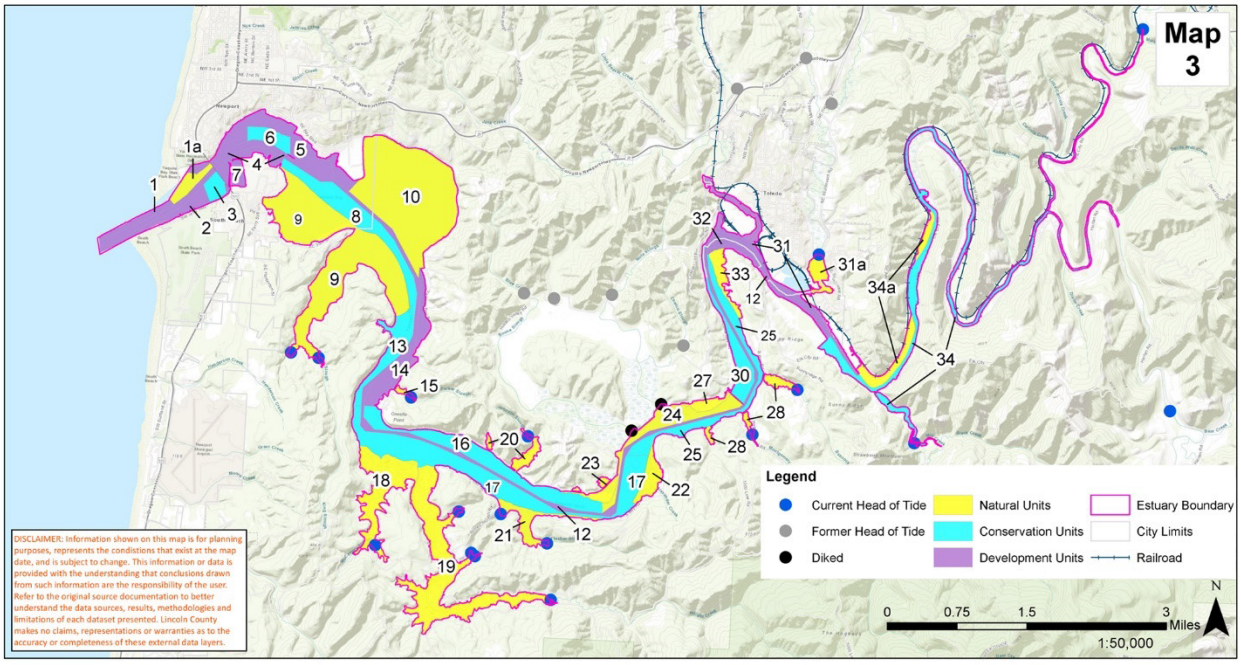

Figure 2. Yaquina Bay Estuary Zoning. Source: Yaquina Bay Estuary Management Plan (2025).

Several state and local planning, policy, and regulatory frameworks interact directly with the planning and use of Oregon's estuaries, complementing the Statewide Land Use Planning Goals. State agencies also must comply with statewide planning goals and often help implement some of the requirements, such as the Department of State Lands through its removal-fill program (see more below). These frameworks help coordinate diverse management needs, including habitat conservation, water quality protection, and economic development, while aligning with overarching state goals.

Oregon Coastal Management Program

Oregon is one of 34 states and territories with a nationally recognized Coastal Management Program under the federal Coastal Zone Management Act of 1972 (CZMA). The Oregon Coastal Management Program (OCMP), housed within the Oregon Department of Land Conservation and Development (DLCD), protects coastal and ocean resources while ensuring livable, resilient communities on the Oregon Coast. This networked program also includes 10 other state agencies and 41 county and city governments.

The OCMP supports estuarine planning by funding technical assistance to local governments, facilitating federal consistency reviews for projects, and ensuring alignment with state coastal land use planning goals. Federal consistency reviews, a requirement of the CZMA, ensure that

federal activities, such as US Army Corps of Engineers (USACE) navigational dredging or National Oceanic and Atmospheric Administration (NOAA) Fisheries habitat restoration, align with state and local policies.

Oregon Department of Fish and Wildlife Habitat and Species Management

The Oregon Department of Fish and Wildlife (ODFW) plays a key role in managing fish and wildlife populations that depend on estuarine habitats, including salmon, shellfish, shorebirds, and marine mammals. ODFW provides technical input on estuarine restoration projects, habitat protection measures, and fisheries management to ensure alignment with conservation goals. The agency also oversees harvest regulations for shellfish and other estuarine species, which are vital to both ecological health and local economies. ODFW's Estuarine Habitat Program and Marine Reserves Program contribute science and monitoring that inform estuary planning and help track the effectiveness of management actions. In addition, ODFW reviews land use actions and permit applications that may affect estuarine resources, supporting the integration of habitat considerations into planning and development decisions.

Oregon Parks & Recreation Department Coastal Access and Recreation Management

The Oregon Parks and Recreation Department (OPRD) manages state parks and recreation areas along the coast, including estuary shorelines that provide public access, recreation opportunities, and habitat protection. OPRD oversees park planning, facility development, and visitor services in estuarine areas, helping to balance public use with resource conservation. Through the Ocean Shore State Recreation Area and scenic waterways programs, OPRD also regulates uses along tidal shorelines and submerged lands under its jurisdiction. The agency collaborates with local governments and state partners on estuary management plans, restoration projects, and access improvements that enhance recreational opportunities while protecting sensitive habitats. OPRD's stewardship helps ensure that estuarine areas continue to provide ecological, cultural, and recreational benefits to Oregonians.

Oregon Department of State Lands Wetland and Waterway Permitting

Oregon Department of State Lands (DSL) oversees permits for activities in freshwater and saltwater wetlands and waterways, including for estuarine dredging, fill, and restoration projects, and proprietary lease authorization information. These permits are informed by zoning established in estuary management plans, as well as DSL's regulations, and are critical for ensuring that development and restoration align with state conservation goals.

USACE has a parallel permitting process for removal-fill activities under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Coordination between DSL and USACE ensures that estuarine projects meet both state and federal standards. For example, dredging within a boat basin in Yaquina Bay requires permits from both entities.

DSL also issues waterway use authorizations. These authorizations allow certain uses (often commercial or industrial) of Oregon-owned waterways, including estuaries, while compensating Oregonians for usage of these public resources.

Oregon Department of Environmental Quality and Water Quality Standards

The Oregon Department of Environmental Quality (DEQ) enforces water quality standards under the federal Clean Water Act, with specific implications for estuarine health. Total Maximum Daily Loads (TMDLs) address pollutants like temperature, sediment, and nutrients in watersheds feeding into estuaries. Compliance with TMDLs often requires local and regional planning to reduce pollution sources and improve water quality, directly influencing estuarine environments. At the federal level, the Environmental Protection Agency (EPA) oversees the development and approval of TMDLs, ensuring alignment with national water quality objectives.

DEQ also oversees permits for discharges of pollutants to waters of the state or to the ground. Uses and activities happening in and around estuaries often are required to get a water quality permit from DEQ. For example, USACE projects, such as dredging, must comply with state-issued water quality certifications under Section 401 of the Clean Water Act.

Many of Lincoln County's estuaries are currently listed by DEQ as impaired for water quality, particularly due to elevated temperatures that exceed TMDL limits and affect sensitive aquatic species. According to DEQ's most recent 303(d) list, Yaquina Bay, Alsea Bay, Siletz Bay, the Salmon River Estuary, and Depoe Bay are all impaired for temperature. Additionally, several estuaries face impairments from bacteria (*E. coli*), dissolved oxygen, nutrients, and sedimentation. For example, Yaquina Bay is listed as impaired for bacteria, nutrients, dissolved oxygen, and sediment, while Alsea and Siletz Bays are impaired for bacteria. Addressing these impairments requires coordinated watershed and estuary management efforts to meet TMDL requirements and restore water quality in support of both ecological health and beneficial uses such as recreation and shellfish harvesting.

Table 1. Water Quality Impairments for Lincoln County Estuaries

Estuary	Temperature	Bacteria (*E. coli*)	Dissolved Oxygen	Nutrients (N, P)	Sediment/ Turbidity
Yaquina Bay	Impaired	Impaired	Impaired	Impaired	Impaired
Alsea Bay	Impaired	Impaired	Not listed	Possible	Not listed
Siletz Bay	Impaired	Impaired	Not listed	Not listed	Not listed
Salmon River	Impaired	Not listed	Not listed	Not listed	Not listed
Depoe Bay	Impaired	Not listed	Not listed	Not listed	Not listed

Source: Oregon DEQ 2022 Integrated Report[4]

[4] www.oregon.gov/deq/wq/pages/wqassessment.aspx

Oregon State Marine Board

The Oregon State Marine Board (OSMB) manages boating regulations, including the designation of no-wake zones and boating restrictions in estuaries to minimize habitat disturbance and maintain water quality. The agency also has many programs to protect and improve water quality, such as funding for floating restrooms, pumpouts, and dump stations. OSMB also implements an aquatic invasive species prevention program, clean marina and clean boater certification programs, and an abandoned and derelict vessel removal program. This work complements broader state and federal efforts to protect sensitive estuarine habitats.

Federal Laws and Agency Coordination

Federal laws, such as the ESA, Clean Water Act, and National Environmental Policy Act (NEPA), frequently intersect with estuarine planning, most often through permitting. NOAA Fisheries and the US Fish and Wildlife Service (USFWS) coordinate with state and local agencies on habitat restoration, species recovery, and fisheries management in estuarine zones.

USACE plays a central role in estuarine management through its navigational dredging and removal-fill permitting responsibilities. These activities are essential for maintaining ports like the Port of Newport in Yaquina Bay. Federal actions and permits must also align with state and local policies to minimize ecological impacts through federal consistency reviews carried out by the OCMP. NEPA further requires environmental reviews for significant federal projects, ensuring that estuarine ecosystems are considered in decision-making processes.

Tribal Nations

Tribal nations in Oregon play an essential role in estuarine resilience through their sovereign authority, stewardship responsibilities, and participation in resource management and restoration efforts. Federally recognized tribes such as the Confederated Tribes of Siletz Indians (CTSI) and the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians (CTCLUSI) have treaty-reserved rights, cultural connections, and natural resource interests that intersect with estuarine planning and management. Tribal governments coordinate with state and federal agencies on fisheries management, habitat restoration, and species protection efforts in estuarine areas. Their involvement is particularly important in projects affecting salmon recovery, shellfish harvesting, and the protection of culturally significant resources and places. In recent years, tribes have also led or partnered on estuary restoration projects that advance both ecological goals and the restoration of traditional uses.

Federal and state agencies are required to consult with tribes during permitting and environmental review processes, ensuring that tribal interests and knowledge are considered in decision-making. This coordination extends to large-scale habitat restoration, water quality programs, and climate adaptation planning in estuarine zones, where tribal perspectives help shape priorities and project designs.

Local Comprehensive Plans and Estuary Management Plans

Counties and cities, including Lincoln County, develop Comprehensive Plans and zoning codes to carry out the Statewide Land Use Planning Goals at the local level. Counties also develop Estuary Management Plans (EMPs) for all the estuaries within their jurisdiction, which are then incorporated into their Comprehensive Plans and zoning codes. All cities that also have jurisdiction over estuaries adopt the portions of the EMPs that are relevant to them. In this way, EMPs are multi-jurisdictional and require close coordination between counties and cities. EMPs define zoning, permitted uses, and conservation measures specific to estuaries, balancing local priorities for resource protection and development. Local planners depend on the EMP and associated ordinances to realize the outcomes of community collaborative planning. Local planning staff are required to use the document and associated maps and resource inventory during land use permit application processes and to complete Land Use Compatibility Statements (LUCS) during state agency permit reviews.

State agencies are also required to comply with Statewide Land Use Planning Goals and use the EMPs to understand local compliance with the Goals. State agencies are likely to participate in EMP updates, especially to review overlapping requirements and authorities and to ensure their own compliance with land use laws. They can also provide technical expertise to local planners on estuary matters during individual permit reviews.

Regional and Nonprofit Collaborations

Organizations such as the MidCoast Watersheds Council (MCWC), The Nature Conservancy (TNC), The Wetlands Conservancy (TWC), and others, work alongside local governments to implement projects that align with state and local estuarine management goals. These partnerships often focus on habitat restoration, community education, and climate resilience.

Federal funding, such as NOAA grants under the CZMA and the EPA's National Estuary Program, frequently supports these collaborative efforts. For example, recent restoration work in Boone-Nute Slough on the upper Yaquina River has reconnected tidal flows and improved fish passage by removing tide gates and modifying levees, benefiting juvenile salmon rearing habitat and estuarine wetlands. Led by the CTSI, MCWC, and numerous other partners, the project supports broader efforts to restore natural estuarine processes and enhance resilience in the Yaquina estuary, benefiting from partnerships that leverage both state and federal resources.

Study Area

The study area encompasses Lincoln County's estuaries, including the major estuaries of the Salmon River, Siletz Bay, Yaquina Bay, Alsea Bay, and Depoe Bay[5], as well as several smaller

[5] As defined in OAR 660-017-0015

(minor) estuaries and coastal creeks such as Beaver Creek, Yachats River, and Big Creek, and all the adjacent historic tidal floodplains and communities (see

Table *2* for additional details). These estuaries support diverse habitats, species, and economic activities, forming a critical nexus between natural ecosystems and human livelihoods. Each estuary's management designation under Goal 16[6] reflects its unique ecological and economic roles, guiding permissible uses and conservation priorities.

Yaquina Bay is designated as a "**Deep-draft Development**" estuary, one of three in Oregon along with Coos Bay and the Columbia River. This designation supports navigation and marine transportation with deeper channels, typically greater than 22 feet in depth, and allows for activities such as dredging, construction and maintenance of jetties, and water-dependent commercial activities.

Table 2. Characteristics of Select Lincoln County Estuaries

Estuary Name	CMECS[7] Classification*	EPA 2010 Classification*	Estuary Management Classification	Estuary Area (acres)**	Historic vegetated tidal wetlands (acres)**	% tidal wetland loss from diking***
Salmon River	Riverine	Moderately river dominated drowned river mouth (bar built)	Natural	882	46	1.2
Siletz Bay	Riverine	Moderately river dominated drowned river mouth	Conservation	2,711	548	20.9
Depoe Bay	Riverine	Marine harbor/cove (drowned river mouth)	Shallow-draft development	12	N/A	N/A
Yaquina Bay	Riverine	Tide-dominated drowned river mouth	Deep-draft development	6,649	1,661	54.5
Beaver Creek	Riverine	Tidally restricted coastal creek	Natural	240	N/A	0
Alsea Bay	Riverine	Moderately river dominated drowned river mouth	Conservation	3,562	223	22.9
Yachats River	Riverine	Tidally restricted coastal creek	Conservation	63	N/A	N/A

*Heady et al. 2014
**PMEP 2020
***Brophy 2019

Depoe Bay is designated as a "**Shallow-draft Development**" estuary, the only in Lincoln County. Shallow-draft development estuaries are characterized by maintained jetties at their mouths

[6] https://www.oregon.gov/lcd/OCMP/Pages/Estuary-Planning.aspx

[7] https://iocm.noaa.gov/standards/cmecs-home.html

and dredged main channels, typically to a depth of 22 feet or less. These estuaries allow for a mix of natural, conservation, and development management units, supporting a balance between economic activities and environmental protection. This classification accommodates residential, commercial, and industrial uses while preserving some natural areas within the estuary.

Alsea and Siletz Bays, Yachats River, and Beaver Creek are designated as "**Conservation**" estuaries, which aim to protect estuarine habitats while still allowing for limited, low-impact development and uses, such as water-dependent activities, small-scale marinas, and aquaculture. However, significant alterations like dredging or major development are restricted to maintain the ecological functions of these areas.

The Salmon River and Big Creek are designated as "**Natural**" estuaries, emphasizing the preservation of significant fish and wildlife habitats, with stringent restrictions on major alterations and development.

These estuary management designations[8], shaped by Oregon's land-use planning framework, help Lincoln County balance environmental stewardship with community and economic interests, ensuring the long-term health and function of its estuarine ecosystems.

Collaborative Efforts and Key Planning Resources

The work to develop this ERAP in Lincoln County was guided by a steering committee composed of local land use, natural resource management, economic development, and restoration practitioners such as staff from city planning departments, state and federal agencies, tribes, watershed councils, ports, non-profit organizations, soil and water conservation districts, and others. MCWC served as the lead local partner, helping to guide ERAP development. Other participating organizations included:

- City of Lincoln City
- City of Waldport
- Port of Toledo
- City of Newport
- City of Toledo
- Port of Alsea
- Port of Newport
- Confederated Tribes of Siletz Indians
- Oregon Shores Conservation Coalition
- Oregon Department of Fish and Wildlife
- Oregon Department of Geology and Mineral Industries

[8] https://secure.sos.state.or.us/oard/displayDivisionRules.action?selectedDivision=3067

- Oregon Department of State Lands
- Oregon Parks and Recreation Department
- Oregon State University
- Oregon State University Extension Service
- Oregon Sea Grant
- The Nature Conservancy
- The Wetlands Conservancy
- US Fish and Wildlife Service
- US Forest Service

The ERAP development process also relied on a strong foundation of existing plans, studies, and collaborative efforts that address estuarine health and resilience. These resources provided valuable technical information, informed understanding of local priorities, and helped align the ERAP's strategies with ongoing initiatives. Together, they provide a foundation of current science, regulatory guidance, and on-the-ground experience that helps local governments, resource managers, and partners align future actions and investments to improve estuary resilience. By referencing and coordinating with these existing efforts, the ERAP aims to support a cohesive, partnership-driven approach to improving estuary conditions and reducing natural hazard risks across the county.

Key planning resources and initiatives that informed ERAP development include:

MidCoast Watersheds Council

The MCWC[9] works to improve the health and resilience of watersheds along Oregon's central coast, with a strong emphasis on estuarine restoration. Tidal wetland restoration efforts focus on reestablishing natural tidal processes, enhancing habitat complexity through placement of large woody debris in channels and on the floodplain, restoring tidal channel networks, creating topographic diversity to support emergent marsh, scrub/shrub, and Sitka spruce swamp, removing invasives and planting native species, and supporting fish and wildlife populations, particularly salmon.

Key Restoration Efforts

- **Siletz Bay National Wildlife Refuge - Lower Drift Creek Restoration:** Launched in 2023, this project plans to remove barriers to tidal flow by modifying dikes and culverts, recreate tidal channel networks, restore forested and scrub-shrub tidal swamps, and place large woody debris to enhance habitat complexity on ~80 acres of federal land. These efforts improve resilience to flooding and sea level rise while benefiting coho salmon, coastal bird species, and other wildlife.
- **Yaquina Bay Estuary Restoration:** MCWC has worked to improve tidal exchange and fish habitat by breaching dikes, restoring historic channels, placing large woody debris to

[9] https://www.midcoastwatersheds.org/

create nurse logs and habitat complexity, and establishing native species through seeding, staking, and planting over multiple years to restore natural habitat conditions. These actions support juvenile salmon and other estuarine-dependent species.

- **Alsea Bay Estuary Restoration:** MCWC has advanced restoration planning and on-the-ground projects to improve tidal connectivity and habitat conditions in the Alsea Bay estuary, including breaching or modifying tide gates, enhancing channel networks, and restoring native vegetation. These efforts aim to benefit juvenile salmon, waterfowl, and other estuarine species while increasing floodplain resilience to sea level rise and flooding.
- **Oregon Central Coast Estuary Collaborative:** As a key partner, MCWC contributes to a broader initiative focused on restoring and conserving estuarine habitats across Oregon's central coast. This collaborative aims to restore 900 acres of tidal wetlands and enhance hydrological connectivity to bolster habitat resilience.

Key Reports and Products

MCWC has produced several significant reports that guide restoration planning and assess watershed conditions:

- **Annual Reports** document restoration projects, community engagement, and financial summaries, offering a comprehensive overview of MCWC's impact.
- **Watershed Assessments,** such as the *Rock Creek (Siletz) Watershed Assessment Final Report*[10], provide in-depth analyses and recommendations for targeted restoration.
- **Estuarine Wetland Site Prioritization Reports** identify and rank restoration opportunities within the Yaquina and Alsea River basins to enhance habitat resilience.

Through these initiatives, MCWC plays a critical role in restoring and preserving estuarine ecosystems along Oregon's central coast, ensuring long-term benefits for fish, wildlife, and their habitats.

Planning Resources

Other planning efforts helped shape the scope and development of the ERAP process. Below is a summary of key planning initiatives conducted for Lincoln County that informed this effort.

Mid-Coast Water Planning Partnership's Water Action Plan (2022)[11]

The Mid-Coast Water Planning Partnership's Water Action Plan is a collaborative framework addressing water challenges in Oregon's mid-coast region. It focuses on integrated water management strategies, including water conservation, water quality improvement, ecosystem protection, and resilient infrastructure. The plan supports estuarine resilience by promoting

[10] https://digitalcollections.library.oregon.gov/nodes/view/294022

[11] https://www.midcoastwaterpartners.com/mcwpp-water-action-plan

actions like floodplain reconnection and riparian restoration, which enhance the ability of estuarine areas and surrounding communities to adapt to climate change stressors and mitigate natural hazards such as flooding and erosion. This approach aligns with broader regional conservation initiatives, as outlined in its appendices, which provide valuable context for estuarine management and community resilience.

Oregon Central Coast Estuary Collaborative Strategic Action Plan (2021)[12]

The OCCEC Strategic Action Plan outlines a framework for restoring and protecting estuarine ecosystems across five major estuaries: Salmon River, Siletz Bay, Yaquina Bay, Alsea Bay, and Siuslaw River. The plan identifies priority actions such as restoring tidal wetlands, improving fish passage, managing invasive species, and enhancing water quality monitoring. It emphasizes collaboration among stakeholders, adaptive management practices, and the integration of climate change projections to address challenges like sea level rise and altered hydrology. This action plan is directly relevant to estuarine resilience planning by providing a roadmap for improving ecosystem health and supporting the ability of estuaries and surrounding communities to adapt to natural hazards and climate stressors.

Oregon Climate Change Research Institute

Sixth Oregon Climate Assessment (2023)[13]

The Sixth Oregon Climate Assessment provides a comprehensive overview of climate change impacts, projections, and adaptation strategies relevant to Oregon. This assessment synthesizes scientific data and research to inform decision-making across sectors, including water resources, coastal management, and community planning. The assessment is highly relevant for estuarine resilience planning, as it offers insights into projected sea level rise, changes in precipitation patterns, and increased risks of extreme weather events, all of which can significantly impact estuarine ecosystems and surrounding communities. As of January 2025, the seventh Oregon Climate Assessment has been released, but does not have a chapter on coastal hazards.

Future Climate Projections, Lincoln County (2020)[14]

This report focuses on downscaled climate projections for Lincoln County, Oregon, offering specific data on anticipated temperature and precipitation changes. It provides critical insights into how local climate patterns may evolve, which is vital for planning and adaptation efforts. The report's findings directly inform estuarine resilience planning by enabling a better understanding of future water availability, potential increases in extreme weather events, and the need for targeted strategies to protect vulnerable estuarine habitats and communities.

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[12] https://www.orcentralcoastestuaries.com/restoration-links

[13] https://blogs.oregonstate.edu/occri/oregon-climate-assessments/

[14] https://blogs.oregonstate.edu/occri/projects/dlcd/

Lincoln County Natural Hazards Mitigation Plan (2020)[15]

The Lincoln County Multi-Jurisdictional Natural Hazards Mitigation Plan (NHMP) is a comprehensive strategy to reduce the long-term impacts of natural hazards across the county. It emphasizes collaboration between public agencies, private organizations, and citizens to build a resilient community capable of effective recovery. The plan identifies priority hazards, including coastal erosion, floods, tsunamis, and wildfires, and outlines specific mitigation actions to minimize their effects. For estuarine resilience, the plan's strategies to reduce flood risks, manage coastal erosion, and enhance community preparedness are particularly relevant, contributing to the protection of estuarine ecosystems and the safety of surrounding communities.

Lincoln County Climate Action Plan (2020)[16]

Developed by local citizens in partnership with groups like Citizens Climate Lobby and 350 Oregon Central Coast, the Lincoln County Climate Action Plan outlines a community-driven strategy for Lincoln County to achieve carbon neutrality by 2035. The plan highlights the need for ambitious climate action, driven by community engagement, and proposes a range of topic-specific strategies to reduce emissions and sequester carbon. With its emphasis on local leadership and community involvement, this plan is relevant to estuarine resilience by addressing the broader climate context that exacerbates coastal hazards and impacts estuarine ecosystems.

Other Helpful Resources

USFS Climate Change Vulnerability and Adaptation in Coastal Oregon (2024)[17] report assesses the vulnerability of natural resources on federal lands in coastal Oregon to climate change and identifies adaptation strategies to enhance resilience in ecosystems, including those relevant to estuarine areas.

Oregon Department of Geology and Mineral Industries (DOGAMI)[18] open-file reports database provides technical reports, mapping tools, and analyses that document natural hazard risks across Oregon, including coastal erosion, tsunami inundation, flooding, and landslides. Reports such as the **Natural Hazard Risk Report for Lincoln County (2020)[19]** offer detailed hazard assessments specific to each county and community, including vulnerability mapping for estuarine areas. These resources provide data-driven insights to identify at-risk areas, inform adaptive management strategies, and support mitigation efforts tailored to local conditions.

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[15] https://www.co.lincoln.or.us/404/Natural-Hazards-Mitigation-Plan

[16] https://www.co.lincoln.or.us/1157/Climate-and-Health

[17] https://research.fs.usda.gov/treesearch/68797

[18] https://www.oregon.gov/dogami/pubs/pages/ofr/p-ofr.aspx

[19] https://pubs.oregon.gov/dogami/ofr/p-O-20-11.htm

The recently-updated **Yaquina Bay Estuary Management Plan**[20] provides an integrated management scheme for estuarine aquatic areas in Yaquina Bay, guiding development and conservation through overall policies, sub-area policies, and management unit designations with specific implementation measures. It addresses current conditions, incorporates climate change considerations, and reflects the importance of ecosystem services for the resilience of the local economy and community.

Oregon Sea Grant's Oregon Coastal Hazards Ready (OCHR) Library & Mapper[21] is an ArcGIS StoryMap that displays 39 case studies of coastal hazards preparedness. The Mapper is designed to assist individuals, communities, and tribal and local governments in identifying approaches to prepare for acute and chronic coastal hazards.

Assessing Vulnerability

Building resilience on the Oregon Coast requires a deep understanding of the diverse natural hazard threats facing each community. Like other areas on the Oregon Coast, vulnerabilities in Lincoln County are shaped by local conditions, making a place-based approach essential. Strengthening resilience depends on meaningful engagement with communities, stakeholders, and other interested parties, not only to identify their priorities and concerns but also to develop strategies that address them effectively. To gain a clearer picture of local vulnerabilities, a comprehensive assessment was conducted in 2024 as part of the ERAP process. This effort focused on the impacts of natural hazards on human communities and the built environment, serving as a complement to related initiatives. The assessment drew on methods and tools adapted for use in prior ERAP efforts in Tillamook and Coos Counties, which were derived from the University of Oregon's Institute for Policy Research and Engagement (IPRE) methods utilized for the **Coos Bay Estuary Climate Hazard Adaptation Plan**[22], and themselves developed from the EPA's **Being Prepared for Climate Change**[23] guidebook.

The Lincoln County steering committee reached out to over 100 local organizations and community members who were invited to participate in a survey followed by community listening sessions to better understand local needs and concerns related to natural hazards vulnerability. Participants represented a broad array of economic sectors but often focused on those living or working in areas that interact directly with the estuaries. The community listening sessions explored in greater detail the vulnerable assets, resources, and populations identified in the survey responses. Individual interviews were also utilized to supplement this information and provide greater detail and context. Additional adaptation planning workshops

[20] https://www.yaquina-emp.org/

[21] https://seagrant.oregonstate.edu/sgpubs/oregon-coastal-hazards-ready-ochr-library-mapper

[22] https://partnershipforcoastalwatersheds.org/

[23] https://www.epa.gov/cre/being-prepared-climate-change-workbook-developing-risk-based-adaptation-plans

held later in the process provided opportunities to cross-check community feedback and further refine the adaptation strategy. The information provided in Chapter III summarizes these results to help characterize resilience for each of the major estuarine areas of Lincoln County.

Image: Lincoln City Adaptation Action Workshop, November 2024. Courtesy of Felicia Olmeta Schult.

Dimensions of Resilience

A variety of methods, approaches, examples, guidebooks, and other resources exist in the planning and resilience literature to evaluate and describe natural hazard resilience. Assessing estuarine community resilience in Lincoln County was approached through the framework identified by the National Research Council report **Disaster Resilience: A National Imperative**[24],

[24] https://abag.ca.gov/sites/default/files/disaster_resilience_a_national_imperative.pdf

which assessed challenges to national disaster resilience. Four dimensions critical to evaluating resilience were identified:

Table 3. The four Dimensions of Resilience identified by the National Research Council.

Dimensions of Resilience
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.
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.
Vulnerable Populations: Factors that capture special needs of individuals and groups, related to components such as minority status, health issues, mobility, and socioeconomic status.
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.

Adaptation Strategy

Nature-Based Solutions

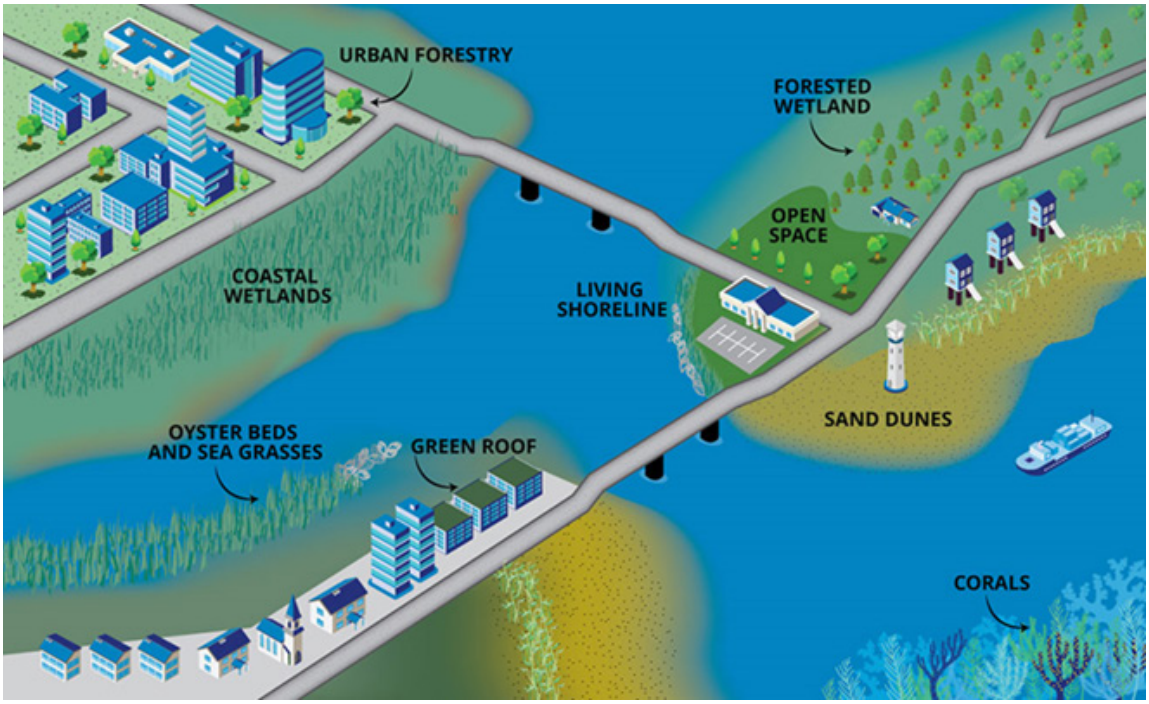


Figure 3. Example nature-based solutions for coastal areas. Image source: NOAA

To effectively address the risks posed by natural hazards and climate impacts, this plan aims for an adaptation strategy that leverages nature-based solutions. This approach integrates the restoration and enhancement of natural systems with traditional adaptation measures to build resilience in both ecological and human communities.

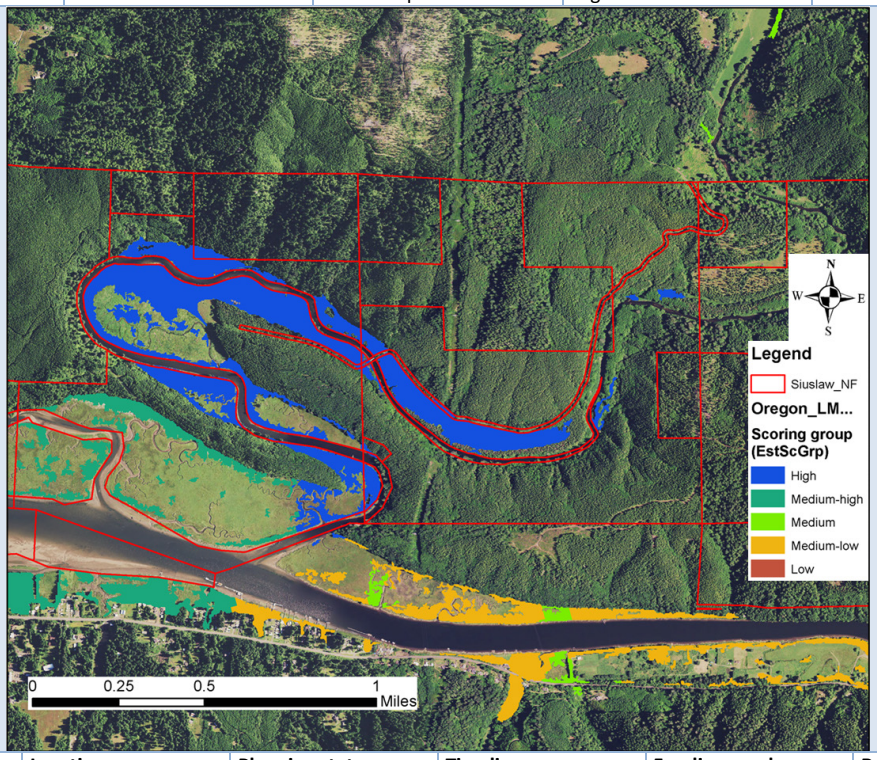
Nature-based solutions in coastal environments refer to the use of natural processes and ecosystems to address environmental challenges and enhance resilience. These solutions **mimic or enhance the inherent functions of natural systems**, typically relying on natural ("green") infrastructure, to mitigate the impacts of climate change, manage hazards, protect communities, and support ecological health. By integrating natural elements into planning and management, nature-based solutions aim to provide sustainable, cost-effective alternatives to traditional hard ("gray") engineering approaches.

In coastal contexts, nature-based solutions include a range of practices such as wetland restoration, dune rebuilding, and riparian buffer restoration. For example, restoring salt marshes and tidal wetlands in Siletz and Alsea Bays can help absorb storm surges, reduce coastal flooding, and improve water quality by filtering pollutants. Reconstructing coastal dunes and enhancing beach vegetation near areas like South Beach can stabilize shorelines, reduce erosion, and provide habitat for wildlife. Similarly, protecting and expanding riparian buffers

Figure 4. Highlighting Nature-Based Solutions: Drift Bend Oxbow Restoration Project

This 60-acre oxbow restoration is the largest known opportunity for estuarine habitat restoration in the Alsea. Located on a peninsula of former tidal wetland adjacent to Drift Creek, the site includes rare spruce swamp and scrub-shrub marsh habitats that have been almost entirely lost from the Yaquina and Alsea estuaries. The project aims to restore natural tidal connectivity, remove invasive vegetation, and create a diverse network of channels and habitat features that support juvenile salmon, shorebirds, and estuarine plant communities. Once implemented, the project is expected to provide long-term benefits for ecosystem function and climate resilience in the Alsea River system.

Ecological significance: At 60 acres, this project would be the largest estuarine restoration effort ever undertaken in the Alsea system.	**Habitat diversity:** The site includes one of the best opportunities on the mid-Oregon Coast to restore tidal spruce swamp and scrub-shrub estuarine wetlands.	**Tidal reconnection:** Restoration will breach former dikes and creating tidal channels to reestablish natural hydrologic patterns and sediment processes.	**Invasive species control:** Project plans include large-scale removal of invasive reed canarygrass, blackberry, and others displacing native vegetation.	**Salmon habitat benefits:** Improved habitat complexity and access to off-channel rearing areas will benefit coho, Chinook, and chum salmon.



Lead organizations: MidCoast Watersheds Council and Siuslaw National Forest (landowner)	**Location:** Drift Creek peninsula near the confluence of the Alsea River and Drift Creek	**Planning status:** Conceptual design and site assessments underway	**Timeline:** Final design and permitting late 2025; phased construction to follow pending funding	**Funding needs:** Additional funds needed for implementation and long-term monitoring	**Related efforts:** Builds on past restoration and complements basin-scale recovery goals for Drift Creek

A Collaborative Approach This project is being developed by the MidCoast Watersheds Council in partnership with the Siuslaw National Forest, which owns the site and previously led restoration efforts at the southern end of the peninsula. Planning builds on long-term restoration goals for Drift Creek and reflects years of collaboration with landowners, tribal representatives, and local stakeholders. Current work is focused on conceptual alternatives and baseline site assessments, with the goal of reaching final design and permitting by the end of 2025. Project partners are actively seeking implementation funding, with an eye toward phasing construction to align with available resources and site access constraints.

By restoring tidal connectivity and estuarine habitats at Drift Bend, this project will not only support the recovery of native fish and wildlife but also strengthen the ecological resilience of the Alsea estuary in the face of climate change and other long-term stressors.

along rivers and estuaries can enhance floodplain function, improve fish habitat, and increase biodiversity.

On the Oregon Coast, several notable examples highlight the success of nature-based solutions. Restoration of numerous estuarine wetlands, such as those around Yaquina Bay and Alsea Bay, have demonstrated significant benefits in improving habitat for fish and bird species while enhancing flood protection. Additionally, the removal of outdated dams and the restoration of natural river flows in the Salmon River estuary have contributed to increased fish populations and more resilient riverine ecosystems (Gossett et al., 2016).

Economic benefits for Oregon coastal communities are tightly linked to these ecological improvements. For instance, the Southern Flow Corridor[25] tidal wetland restoration in Tillamook Bay (443 acres) not only improved salmon habitat but also increased nearby home values by 10% (averaging $19,000 per home) and supported $14.6 million in regional economic output through job creation and reduced flood damage (Shaw & Dundas, 2021). Healthier fish populations from restored habitats also directly benefit Oregon's commercial nearshore fisheries, which contributed millions in personal income annually.

Economic benefits for Oregon coastal communities are tightly linked to these ecological improvements. Healthier fish populations from restored habitats directly benefit Oregon's commercial nearshore fisheries, which contributed millions in personal income annually. Additionally, enhanced wetlands and estuaries boost nature-based tourism, a critical economic driver for coastal communities that relies on scenic beauty and recreational opportunities like fishing, kayaking, and wildlife viewing.

These nature-based approaches not only address immediate environmental and hazard-related issues but also offer long-term benefits by fostering ecosystem health, supporting biodiversity, and providing recreational opportunities. By prioritizing natural processes and integrating them into coastal management strategies, communities can build resilience against climate impacts while preserving the ecological integrity of coastal environments.

Strategic Actions for Resilience

Natural hazards present significant challenges for the estuarine ecosystems and human communities in Lincoln County. The ERAP adaptation strategy seeks to mitigate the impacts of natural hazards and enhance resilience of both natural and human systems in the region by integrating wetland restoration, coastal protection, community planning, and public engagement. Efforts to protect and restore Lincoln County's estuarine habitats have increasingly focused on collaborative, science-based strategies that rely on the following kinds of actions:

[25] https://www.tbnep.org/project/southern-flow-corridor/

- **Habitat Restoration:** Prioritizing the expansion of tidal wetland restoration projects to reconnect fragmented areas and enhance habitat for fish and wildlife, while also exploring opportunities for eelgrass meadows and Olympia oyster reefs (Yaquina Bay EMP, 2023). Given that Lincoln County's estuaries have experienced significant historic wetland loss, these restoration initiatives are vital for carbon sequestration, buffering against floods, supporting wildlife, and increasing overall ecosystem resilience to climate impacts.
- **Climate Adaptation Planning:** Integrating climate resilience into estuary management to account for future habitat shifts, specifically incorporating sea level rise projections into local land use and zoning regulations to ensure that new developments and infrastructure are resilient to future conditions (Brophy et al., 2017). By incorporating sea level rise projections into planning processes, coastal communities can better manage risks and protect both people and property.
- **Sustainable Land Use Practices:** Reducing urban and agricultural runoff to improve water quality and mitigate habitat degradation (MCWPP, 2022). This includes promoting practices that minimize pollutants entering estuaries, such as reducing fertilizer use, managing stormwater runoff, and preventing erosion from construction sites and agricultural lands; activities that are crucial for safeguarding estuarine ecosystems.
- **Coastal Protection:** Complementing wetland restoration with coastal protection measures, such as living shorelines, vegetated foredunes, strategically placed levees or setbacks, and managed retreat strategies, helps shield vulnerable areas from the dual threats of flooding and erosion. These measures, when designed in harmony with natural systems, can provide robust protection while preserving the natural dynamics of the coastline.
- **Community Engagement and Stewardship:** Strengthening partnerships between local governments, tribes, conservation groups, and industry stakeholders to support long-term estuarine health (OCCEC, 2021). Fostering community support and proactive behavior by raising public awareness about climate risks and the benefits of nature-based solutions and by engaging residents in discussions about adaptation strategies.
- **Collaborative Partnerships for Restoration:** Fostering partnerships among diverse stakeholders to identify, prioritize, and implement restoration opportunities that address multiple ecological needs and enhance overall ecosystem resilience.
- **Data-Driven Decision Support:** Enhancing the availability and accessibility of data, models, and mapping tools to support informed decision-making regarding estuarine management and resilience. This includes efforts to gather, integrate, and analyze relevant information on ecological conditions, natural resource inventories, natural hazards, and community vulnerabilities.

The continued success of these efforts will depend on sustained investment, adaptive management, and a commitment to balancing ecological integrity with the region’s economic

and cultural priorities. Three notable examples of these actions are in development concurrent with the Lincoln County ERAP process:

Beaver Restoration: This initiative highlights the potential of collaborative partnerships through the Oregon Central Coast Beaver Partnership (OCCBP). Formed in 2024, this collaborative group brings together diverse stakeholders including the MCWC, TWC, Bonneville Environmental Foundation, Utah State University, and various local, state, federal, and Tribal partners. The OCCBP aims to enhance understanding of beaver populations and their habitat potential in coastal watersheds, from headwaters to estuaries.

The partnership employs a standardized survey protocol to collect data on beaver sign and habitat characteristics, which will be used to calibrate the Beaver Restoration Assessment Tool (BRAT)[26] for coastal conditions. Once localized, this tool will guide practitioners in identifying optimal locations for beaver restoration activities, thereby potentially enhancing wetland habitats crucial for ESA-listed coho salmon recovery and improving ecosystem resilience to climate change impacts. It will also help practitioners avoid areas where beaver are unlikely to establish and persist, or where they may conflict with human communities and infrastructure.

Recognizing the potential for beaver-human conflict, the OCCBP also focuses on promoting coexistence strategies and non-lethal management techniques. This approach aims to maximize the ecological benefits of beaver activity while minimizing potential conflicts with human land use, offering a balanced pathway to restoring beaver populations and the valuable ecosystem services they provide.

Compound Flood Modeling: A key example of how improved data and modeling can enhance decision-making is an ongoing project at Oregon State University to assess and project flood risks in Oregon's estuaries. Researchers are improving and applying a hybrid framework for estimating compound flood risk, which combines statistical and dynamical modeling techniques. This innovative approach, known as TESLA-Future (Time-varying Emulator for Short and Long-term Analysis), incorporates Global Climate Model outputs to provide more accurate projections of future flood risks under various climate scenarios.

The project aims to develop a suite of climate scenario-based Total Water Levels (TWLs) for Yaquina Bay estuary and potentially a few more estuaries in Oregon. By coupling TESLA-Future with a reduced complexity coastal flood model called SFINCS (Super-Fast Inundation of CoastS), researchers can efficiently compute compound flooding due to various factors such as fluvial, pluvial, tidal, and wind-driven processes.

This work aims to provide coastal communities with crucial information for resilience and adaptation planning. The resulting tools and guidance documents will enable decision-makers and interested parties to explore how the region's long-term risk to compound coastal flood

[26] https://brat.riverscapes.net/

hazards might change under different climate scenarios, enhancing their ability to develop effective resilience strategies.

These initiatives exemplify the collaborative and data-driven approaches that are essential for addressing complex environmental challenges and enhancing the resilience of Lincoln County's estuarine and riparian ecosystems.

Blue Carbon Calculator: The Oregon Blue Carbon Calculator is a new tool being developed through a partnership of local, state, and scientific organizations, with funding from the Oregon Watershed Enhancement Board. “Blue carbon” refers to carbon dioxide captured and stored by coastal environments, such as salt marshes and seagrass beds, which play a vital role in fighting climate change by locking away carbon for long periods. The calculator is designed to help people understand and measure how much greenhouse gas (GHG) is removed or released by different actions in wetland areas, including restoration, conservation, or changes in land use.

The tool will be available as both a spreadsheet and an online platform. Users such as natural resource and land use managers, planners, and conservationists, will be able to enter information about land cover changes, like restoring a wetland or converting it to another use. The calculator then estimates the GHG emissions or removals over a 50-year period, based on the best available science and data for the region. This information helps users see the climate impact of their projects and supports better decision-making. It also provides valuable data for those seeking funding for carbon finance projects or needing to report on climate benefits for regulatory purposes.

By making it easier to estimate the climate benefits of wetland restoration and management, the Oregon Blue Carbon Calculator will help communities, agencies, and conservation groups prioritize projects that maximize carbon storage and climate resilience. It empowers users to make informed choices about land use, supports the development of new conservation funding opportunities, and ultimately helps protect the many other benefits healthy wetlands provide, such as wildlife habitat, water quality, and flood protection.

Image: Yaquina Bay. Courtesy of Oregon ShoreZone.

II. Natural Hazards in the Estuaries

Image: Lint Slough in Alsea Bay. Courtesy of Oregon ShoreZone.

The Oregon Coast is exposed to a diverse array of natural hazards due to its dynamic landscape and the interplay of climatic and geological forces. The following section provides a brief assessment of the primary natural hazard threats facing the region's estuaries and adjacent communities. It examines both chronic hazards, such as ongoing coastal erosion and gradual sea level rise, and acute hazards, including severe storms, flooding, and seismic events like tsunamis triggered by offshore earthquakes at the Cascadia Subduction Zone. Chronic hazards are those that develop and persist over long periods of time, steadily degrading coastal environments and infrastructure, while acute hazards are sudden, high-impact events that can cause immediate and extensive damage.

Climate change acts as a multiplier, intensifying both chronic and acute hazards (IPCC, 2023). Rising sea levels increase the frequency and extent of tidal flooding, erode shorelines, and diminish critical estuarine habitats (NOAA, 2022). More extreme and unpredictable weather patterns lead to heavier rainfall, exacerbating stormwater runoff, erosion, and sedimentation, while droughts can alter the salinity balance crucial for estuarine ecosystems (IPCC, 2023). Ocean acidification, another consequence of increased atmospheric carbon dioxide, threatens

marine life and further disrupts estuarine health (NOAA, 2022). The cumulative effect of these hazards, occurring simultaneously or in succession, significantly amplifies risks, undermining the resilience of both natural systems and human communities. This compounding of threats can overwhelm local adaptation strategies, leaving the coast increasingly vulnerable to environmental, economic, and social disruptions.

These risks are not distributed equally. Marginalized and vulnerable communities, including Indigenous and low-income people, often face greater exposure to environmental hazards and may have fewer resources to adapt or recover (DLCD, 2024). Many of these groups live in areas more prone to flooding or erosion and may lack adequate infrastructure or access to emergency services. As a result, climate change not only intensifies existing environmental threats but also exacerbates social and health disparities, creating additional challenges for adaptation and resilience planning for the future of Lincoln County's estuaries and the people who depend on them (DLCD, 2024).

Climate Change

The Oregon Coast, including Lincoln County and its estuaries, faces significant and growing risks from climate change, with impacts expected to intensify throughout the 21st century as a result of rampant anthropogenic greenhouse gas emissions (Fleishman, 2023; IPCC, 2021; Mote et al., 2019). These changes are projected to manifest through several primary mechanisms: sea level rise, increased storm frequency and intensity, ocean acidification, and altered precipitation patterns. Each of these mechanisms not only pose direct threats to the region's natural and built environments but also interacts with, and amplifies, existing hazards, resulting in cumulative impacts that threaten the ecological, economic, and social resilience of coastal communities (Fleishman, 2023; DLCD, 2020; Lincoln County, 2021).

Recent decades have brought observable shifts in the regional climate of the Oregon Coast. Average annual air temperatures have increased by approximately 2°F since the early 20th century, with projections indicating continued warming throughout the 21st century (Fleischman, 2023). Warmer temperatures are expected to alter seasonal precipitation patterns and reduce snowpack in the Coast Range, affecting watershed hydrology and streamflows. These changes may result in longer summer dry periods, increasing the risk of drought stress for both ecosystems and communities, and heightening the risk of wildfire in inland portions of the county. Additionally, climate-driven shifts in ocean temperature, upwelling dynamics, and oxygen levels are already affecting the nearshore marine environment, with implications for fisheries, coastal food webs, and the livelihoods they support (NOAA, 2023; Mote et al., 2019). While the precise local effects will vary, these long-term changes in climate conditions intersect with other natural hazards and may amplify existing environmental and infrastructure vulnerabilities in Lincoln County.

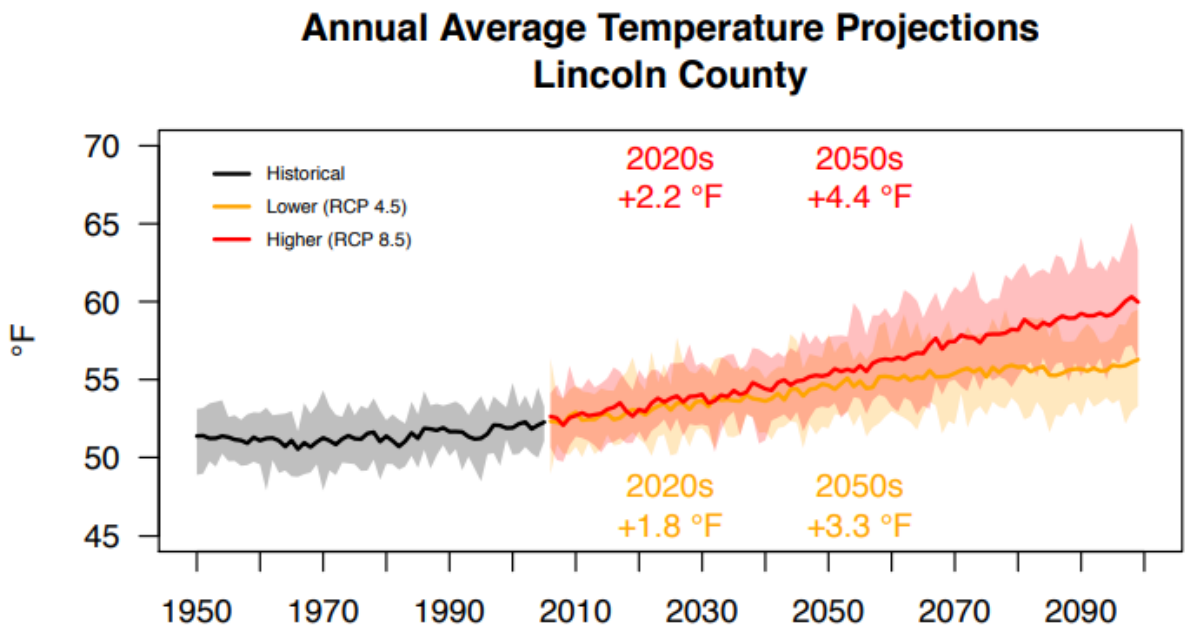


Figure 5. Projected annual average temperatures for Lincoln County based on climate models under two emission scenarios. The graph shows the multi-model mean and range, with comparisons to historical baseline for future periods. Source: Dalton (2020).

Sea Level Rise

Sea level rise is one of the most immediate and consequential threats to Lincoln County's estuaries and coastal areas. Driven by the melting of glaciers and ice sheets and the thermal expansion of seawater as global temperatures rise, sea level rise is projected to inundate low-lying areas, increase the frequency and severity of coastal flooding, and threaten critical infrastructure such as roads, bridges, and water treatment facilities (Fleishman, 2023; Sweet et al., 2022; NOAA, 2018; OWEB, 2020). By 2050, sea levels along the Oregon Coast are projected to rise up to 1.2 feet (NOAA, 2023) and could rise by 1.6 to 5.3 feet by 2100, depending on future greenhouse gas emissions scenarios (Fleishman, 2023; Mote et al., 2019). This will elevate the baseline for tidal and storm-driven inundation and increase the frequency of high-tide flooding. King tide events already cause minor flooding in places like Yaquina Bay and Alsea Bay, signaling the kinds of chronic impacts expected in the future. This increase will particularly threaten transportation corridors like US Highway 101 and estuarine and wetland ecosystems that provide essential habitat and ecosystem services (DOGAMI, 2020; Brophy et al., 2019).

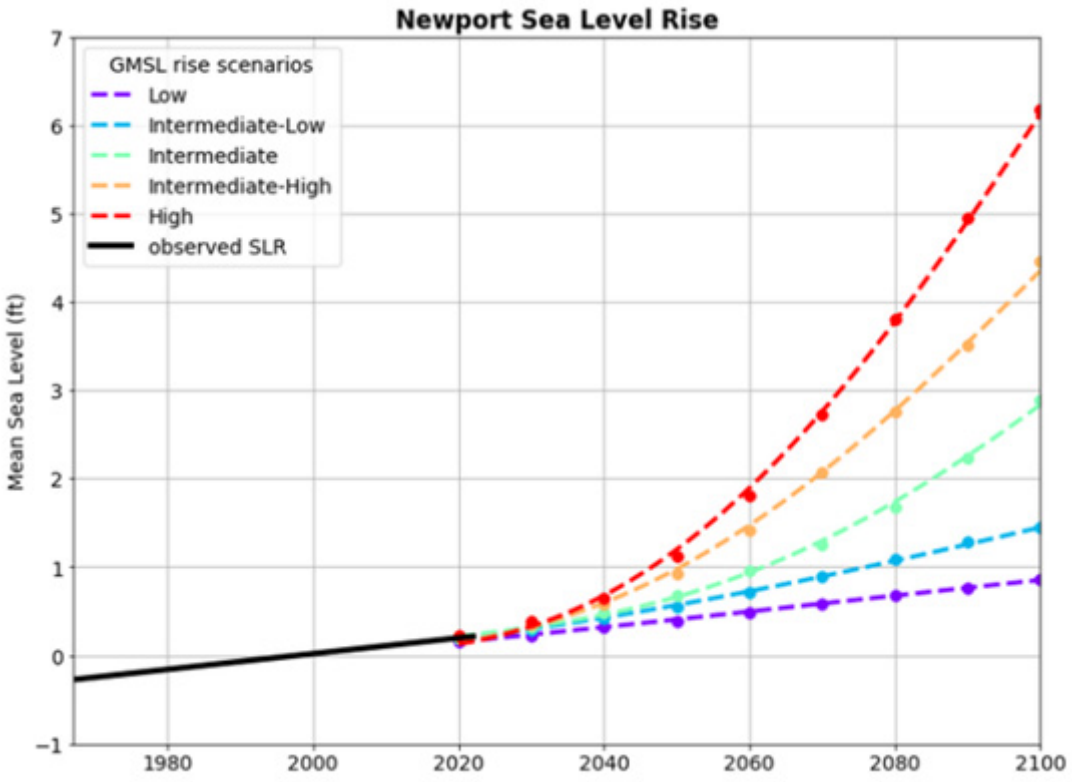


Figure 6. Observed and projected sea level rise for Newport, Oregon, illustrating local variability due to tectonic and hydrodynamic factors. Source: OCMP, 2022.

Coastal Erosion

Rising sea levels and more intense storms will accelerate coastal erosion, leading to the loss of beaches, dunes, and shorelands that serve as natural buffers against storm surges and flooding (Cooper et al., 2018; Ruggiero, 2013). Erosion threatens not only natural habitats but also human infrastructure and cultural resources (USGS, 2011; Patsch & Griggs, 2007). The cumulative effect of sea level rise and erosion is already evident along Lincoln County's shoreline, where critical infrastructure and communities face increased vulnerability (DOGAMI, 2020; Lincoln County 2021). The loss of natural barriers further exposes inland areas to hazards, compounding the risks from other climate-driven changes (USGS, 2011).

Increased Storm Frequency and Intensity

Climate models project an increase in the frequency and intensity of atmospheric rivers and coastal storms in the Pacific Northwest, amplifying the risks of flooding, erosion, and infrastructure damage (Warner et al., 2015; NOAA, 2022; Fleishman, 2023). Higher sea levels combined with stronger storms will result in more frequent overtopping of both natural and engineered defenses, leading to greater inland flooding and saltwater intrusion into freshwater systems (Sweet et al., 2022; Brophy et al., 2019). These impacts threaten water quality,

ecosystem health, and the safety and economic stability of communities, especially those located in low-lying estuarine areas such as Newport (Lincoln County, 2021; OCMP 2024).

Ocean Acidification

Ocean acidification is driven by absorption of excess atmospheric carbon dioxide, leading to a suite of changes to seawater chemistry that often results in a decrease in surface ocean pH (Doney et al., 2009). This process reduces the availability of calcium carbonate, a critical component for the shells of many marine organisms, including commercially important species such as oysters and Dungeness crab (Feely et al., 2004). Aquaculture and fishing industries, which are a vital part of Lincoln County's economy, have already experienced episodes of shellfish mortality, with significant economic consequences (Doney et al., 2009; Orr et al., 2005). The waters off the Oregon Coast are particularly susceptible to acidification due to seasonal upwelling, which brings carbon dioxide-rich waters to the surface (Feely et al., 2016). Continued acidification will further stress marine ecosystems and the communities that depend on them (OWEB, 2020; Lincoln County, 2021).

Precipitation and Drought

Climate change is projected to significantly alter precipitation and drought patterns along the Oregon Coast, particularly in Lincoln County. This will affect both freshwater availability and estuarine ecosystems, which depend on stable river flows and adequate water quality.

The Oregon Coast, including Lincoln County, experiences a maritime climate with wet winters and drier summers. Winter storms often bring heavy rainfall, which increases the risk of flooding in estuaries and low-lying coastal areas, as well as erosion that impacts water quality and habitat stability (NWS, 2023). However, recent trends show increasing variability in precipitation patterns, including periods of unusual dryness and more intense winter storms (OCCRI, 2019). Lincoln County has seen drought declarations in recent years, including three since 2018, a stark shift from the prior 35 years (OPB, 2023). Droughts, such as the particularly severe 2023 summer, have strained water supplies, with record-low rainfall May-July. Statewide, 18 of the last 24 years have experienced below-average precipitation, which is expected to continue (OCCRI, 2019; OCAP, 2020). These changes challenge both municipal water supply systems and the stability of estuarine habitats that rely on predictable river flows.

Climate models predict increased precipitation during winter, which will raise wintertime streamflows and potentially increase flood risks. By mid-century, Lincoln County could experience more frequent and intense winter storms, exacerbating flood risks, especially in areas like the lower Siletz River, which has historically faced damaging floods (OCCRI, 2019; NWRF, 2023). However, summers are expected to become drier and warmer, with summer precipitation projected to decrease by 5-15%, while average summer temperatures may rise by 4-7°F (2-4°C) (OCCRI, 2019). These changes will increase the risk of summer droughts, lowering river flows and impacting freshwater availability for agriculture, drinking water, and natural ecosystems (DEQ, 2022). Reduced summer flows are also expected to strain municipal water

supplies, particularly for those relying on groundwater or self-supplied water sources (MCWP, 2023). Communities such as Newport have already faced summer water use restrictions in response to droughts, underlining the urgency of adaptive water management strategies (OSU, 2025).

Reduced summer flows, in addition to the increased risk of saltwater intrusion, are expected to affect aquatic ecosystems and salmonid populations that are vital to the region's ecology and economy. These changes will diminish cold-water refugia and exacerbate the challenges faced by species such as salmon, which depend on stable water temperatures and streamflows for spawning (OWEB, 2020; Fleishman, 2023). The increased frequency of both flooding and drought underscores the need for more resilient water management strategies and infrastructure that can adapt to changing conditions.

Cumulative and Compounding Effects

The impacts of climate change are not isolated. Rather, they interact and compound, creating cumulative risks that are greater than the sum of their parts (Fleishman, 2023; DLCD, 2020; Lincoln County, 2021). For example, sea level rise and increased storm intensity together exacerbate coastal erosion and flooding, while ocean acidification and higher water temperatures jointly stress marine and estuarine ecosystems (Chan et al., 2017; Doney et al., 2009). These cascading effects threaten critical infrastructure, natural systems, and vulnerable populations, including low-income and Tribal communities, necessitating coordinated adaptation and resilience strategies at local, state, and federal levels (Lincoln County, 2021).

Local, state, and federal agencies, along with non-governmental organizations and watershed councils, are actively collaborating to address these challenges through comprehensive planning, data collection, and restoration projects (DLCD, 2020, NOAA 2022). These efforts are vital for sustaining the ecological and economic vitality of Lincoln County and the broader Oregon Coast in the face of ongoing climate change.

The following sections take a closer look at the key natural hazards Lincoln County is expected to face, including increased flooding, erosion, and wildfires; earthquake and tsunami risk; reduced air and water quality; and increased presence of invasive species. All of these threats warrant strategic adaptation measures to build resilience.

Flooding

Image: Lint Slough Bridge, Hwy 34, Waldport. By Jon French.

Flooding is a persistent hazard for coastal regions, and Lincoln County's estuaries and surrounding communities are especially vulnerable. The county's major estuaries, Siletz, Yaquina, Alsea, and others, contain extensive wetlands, tidal flats, and marshes that provide critical habitat and natural flood protection. These low-lying areas are susceptible to both riverine flooding and coastal storm surge, which can damage infrastructure, threaten public safety, and disrupt key economic activities such as fishing, tourism, and recreation (Lincoln County, 2021).

Communities adjacent to estuaries face heightened flood risks due to the proximity of homes, businesses, and infrastructure to water bodies that rise rapidly during extreme precipitation events or storm surges. Flood events can damage docks, marinas, roadways, and utilities while also degrading water quality through increased runoff and sedimentation (DEQ, 2022). Lincoln County's dependence on coastal infrastructure compounds these challenges, as maintaining and upgrading vulnerable assets in estuarine zones often requires substantial investment (DOGAMI, 2020). Infrastructure and contamination sites along the coast, such as wastewater treatment plants, are particularly vulnerable. Projections suggest 26 such sites could experience twice-yearly flooding by 2050 (Union of Concerned Scientists, 2024).

Riverine Flooding and Storm Surge

Riverine flooding, caused by intense rainfall or snowmelt, and storm surge, driven by coastal storms and low atmospheric pressure, are both major threats to Lincoln County estuaries. These forces often converge in estuarine zones, where upstream river flows and coastal ocean processes interact in complex ways (OCCRI, 2021).

Historical flooding events in Lincoln County demonstrate the region's vulnerability. The December 1964 flood brought record-breaking rainfall, inundating estuarine areas like Canal Creek near the Alsea River and washing out roads and bridges (Oregon Digital, 2022). In

February 1996, the Siletz River reached 28.5 feet, its highest stage in 80 years, damaging homes along Immonen Road and OR Highway 229 (DOGAMI, 2000). In November 1999, over 10 inches of rain in two days triggered widespread flooding in the lower Siletz basin. More recently, the 2007 Great Coastal Gale brought hurricane-force winds and surf that damaged property and prompted emergency declarations across the coast, including at Agate Beach near Yaquina Head (Beach Connection, 2022). Flooding in the winter of 2015-2016 inundated areas in Waldport and along the Siletz River, disrupting transportation and damaging property (MCWC, n.d.; DOGAMI, 2015).

Future projections indicate increased frequency and intensity of flooding due to stronger storms and higher precipitation extremes. In the Alsea and Siletz River estuaries, extreme events that were once considered 100-year floods may become more frequent. For example, a 45,000 cfs flow on the Alsea River near Tidewater is now considered to have a 1% chance of being exceeded in any given year (Vitousek et al., 2017). These shifts will strain infrastructure such as roads, bridges, and wastewater systems, and may displace residents in low-lying areas. As floodplain regulations evolve, including new FEMA guidelines, Lincoln County will need to adapt planning approaches to safeguard both natural systems and community assets (Yachats News, 2024; Lincoln County, 2021).

Saltwater Intrusion

Saltwater intrusion poses another concern, particularly in low-lying estuarine zones where brackish water balances are easily disturbed. While catastrophic saltwater intrusion has not yet been documented in Lincoln County, gradual salinity shifts are already affecting estuarine ecosystems. These changes threaten freshwater-dependent vegetation and wildlife and may also impair drinking water resources drawn from coastal aquifers (OWRD, 2019; Werner et al., 2009). Private wells and irrigation systems in vulnerable zones could be at risk, especially following storm surges that push saltwater upstream. Management responses will need to include the protection of freshwater recharge areas and restoration of natural buffers that slow saltwater intrusion (DEQ, 2022; Lincoln County, 2021).

Landward Migration Zones

Landward migration zones (LMZs) are critical for maintaining the long-term resilience of estuarine habitats. These areas allow marshes and wetlands to shift upslope in response to flooding and other climate-driven changes, helping preserve biodiversity and ecosystem services such as flood protection and water filtration. However, the ability of habitats to migrate naturally is increasingly constrained by steep terrain, roads, and coastal development. In Lincoln County, many estuarine edges that historically supported natural habitat transitions are now cut off by infrastructure, leading to habitat fragmentation and loss (Lincoln County, 2021).

Preserving LMZs through conservation, restoration, and land use planning is essential for sustaining the integrity of estuarine ecosystems. Proactive management of LMZs also provides

co-benefits by reducing flood impacts on adjacent communities and infrastructure, reinforcing the value of integrated coastal resilience strategies. Future projections indicate that without proactive planning and efforts to protect habitat connectivity, the decline in coastal habitats could lead to diminished ecosystem services and increased vulnerability to climate impacts (Brophy, 2018; DLCD, 2021). Sea level rise modeling indicates increasing landward migration zone area up to 4.7 ft SLR, but declines sharply above that level, with 32% of potential tidal wetland area lost across Oregon's 23 largest estuaries (Brophy & Ewald, 2017). This pattern will be particularly evident in Alsea Bay, Beaver Creek, and Salmon River estuaries, while Yaquina Bay stands to lose LMZ area across all sea level rise scenarios (Brophy & Ewald, 2017). Effective land-use policies and conservation efforts will be essential to safeguard these critical areas and ensure the continued functionality of coastal ecosystems.

Table 4. Landward migration zone area by sea level rise scenario for select Lincoln County estuaries.

Estuary Name	Sea Level Rise Scenario (ft)						
	0.0	0.8	1.6	2.5	4.7	8.2	11.5
Yaquina Bay	2037	2018	1827	1549	1101	702	463
Siletz Bay	1017	1120	1224	1349	1301	923	874
Alsea Bay	939	1004	1051	1086	678	331	237
Salmon River	592	628	660	690	597	200	165
Beaver Creek	182	256	343	441	619	413	197
Yachats River	3	4	6	8	16	31	35

Data: Brophy & Ewald (2017)

Table 5. Landward migration zone area loss or gain (-/+) compared to baseline by sea level rise scenario for select Lincoln County estuaries.

Estuary Name	Sea Level Rise Scenario (ft)						
	0.0	0.8	1.6	2.5	4.7	8.2	11.5
Yaquina Bay	0%	-1%	-10%	-24%	-46%	-66%	-77%
Siletz Bay	0%	10%	20%	33%	28%	-9%	-14%
Alsea Bay	0%	7%	12%	16%	-28%	-65%	-75%
Salmon River	0%	6%	11%	17%	1%	-66%	-72%
Beaver Creek	0%	40%	88%	142%	240%	127%	8%
Yachats River	0%	62%	121%	198%	529%	1108%	1285%

Data: Brophy & Ewald (2017)

Erosion

Erosion risks along the Oregon Coast, particularly in Lincoln County and its estuaries, are a significant concern due to natural processes and human activities. The dynamic coastal

environment, characterized by active wave action and storm surges, predisposes the region to ongoing erosion. Areas with sandy beaches and bluffs, such as those found in Lincoln County, face challenges from wave action and shoreline retreat. Estuarine areas, including the Siletz, Yaquina, and Alsea Rivers, also experience sediment loss and shoreline erosion, compounded by human activities like dredging and construction. The construction of seawalls and other coastal armoring measures further disrupts natural sediment transport processes, thereby exacerbating erosion (Komar et al., 1999).

In Lincoln County, ongoing erosion is especially concerning for estuarine areas like Yaquina Bay, Siletz Bay, and Alsea Bay, which provide vital habitats and support local infrastructure. In Yaquina Bay, for example, the erosion of marshlands and shoreline retreat has impacted both habitat quality for fish species and the integrity of infrastructure along the waterfront (Newport, 2021). Dredging activities, which can be essential for maintaining navigability in the bay, have further altered sediment dynamics, contributing to shoreline erosion and loss of critical habitats (DOGAMI, 2021).

Similarly, in the Siletz Bay estuary, erosion along the eastern shore has led to the retreat of marshland. These areas are also vulnerable to property loss, particularly along the fringe of the bay where residential development has expanded. In many cases, local efforts to stabilize the shoreline have included the use of riprap or seawalls, but these measures can exacerbate erosion by interfering with natural sediment transport, reducing the resilience of the shoreline over time.

Recent erosion events have brought attention to the ongoing vulnerability of coastal communities and estuaries in Lincoln County. For instance, in 2015, severe erosion around Yaquina Bay led to shoreline retreat and damage to waterfront properties. This event, fueled by increased wave action and storm surges, revealed the challenges of balancing development with the need to protect natural estuarine processes (DOGAMI, 2016). Similarly, continued development along the Salishan Spit has contributed to increased erosion and property loss, while also impacting public access to the shoreline. As shoreline armoring measures like riprap have been added to protect properties, the resulting acceleration of erosion further threatens coastal ecosystems and complicates public access to the beach (City of Lincoln City, 2021).

Efforts to address erosion in Lincoln County's estuaries are ongoing, with local and regional agencies working together to incorporate erosion risk assessments into long-term planning and adaptive management strategies. These strategies include the use of living shorelines, which promote natural stabilization techniques, and limiting development in high-risk areas to reduce the long-term impacts of erosion on communities and estuarine habitats (DOGAMI, 2021).

Earthquake and Tsunami

The Oregon Coast, particularly Lincoln County, is highly vulnerable to earthquakes and tsunamis due to its location along the Cascadia Subduction Zone (CSZ). This tectonic boundary, where the

Juan de Fuca Plate is being forced beneath the North American Plate, poses significant seismic hazards that can result in powerful earthquakes and tsunamis with devastating effects on coastal communities.

Earthquake Risks

The CSZ is known for producing large megathrust earthquakes, with past events like the 1700 Cascadia earthquake demonstrating the potential magnitude of such activity. This event, estimated to be around magnitude 9.0, caused widespread ground shaking and led to significant geological and hydrological changes along the Pacific Northwest coast (Atwater et al., 1995). The risk of another large earthquake along this fault line is substantial, with scientists predicting a recurrence interval of approximately 300 to 600 years (Goldfinger et al., 2012). Recent studies estimate a 7-15% chance of a magnitude 9.0 earthquake occurring within the next 50 years (Washington County, 2025).

In Lincoln County, the potential for a major earthquake poses severe risks to infrastructure and public safety. Communities such as Newport, Lincoln City, and Depoe Bay are particularly vulnerable due to their proximity to the coastline and underlying geology that may amplify ground shaking. Liquefaction is an additional hazard of concern, especially in estuarine areas where infrastructure has been built on dredge spoils or loose sediments. Liquefaction occurs when saturated soils lose strength during intense shaking, potentially causing buildings and roads to collapse or sink. This risk is particularly pronounced in areas like Newport's South Beach and parts of Yaquina Bay, where estuarine sediments are prevalent (Pacific Northwest Seismic Network, 2025). The rugged terrain and limited access routes in Lincoln County may further hinder evacuation and emergency response efforts in the aftermath of a quake.

Historical earthquake events, such as the 1700 Cascadia earthquake, demonstrate the severe impacts that earthquakes along the CSZ could have on local communities and infrastructure. In addition to the immediate ground shaking, such an event could trigger widespread landslides, further complicating recovery efforts.

Tsunami Risks

Tsunamis generated by subduction zone earthquakes present an additional, significant threat to the Oregon Coast. The 1700 Cascadia event, for example, produced a tsunami that inundated coastal areas from northern California to British Columbia, with evidence of significant sediment deposition and damage to coastal ecosystems and communities (Atwater et al., 1995). Modern tsunami modeling and historical records suggest that the next major subduction zone earthquake could produce a similarly devastating tsunami.

For Lincoln County, the threat of tsunami inundation is pronounced. Coastal communities such as Newport, Lincoln City, and Waldport are at high risk due to their low-lying coastal locations. The Oregon Department of Geology and Mineral Industries (DOGAMI) has identified these areas as particularly vulnerable to tsunami impacts, including potential inundation zones that

could extend several hundred yards inland (DOGAMI, 2020). The risk of a tsunami from a local earthquake produced by the CSZ can cause immediate, catastrophic flooding. A distant tsunami, such as those triggered by earthquakes in Alaska or Japan, may have a delayed impact but still pose a significant threat to coastal communities in Lincoln County. The 1964 Alaska earthquake tsunami and the 2011 Tōhoku tsunami from Japan both reached the Oregon Coast, causing damage and highlighting the vulnerability of the region to waves generated by earthquakes far from the state's shores (NWS, 2021).

Newport, with its significant port infrastructure and busy downtown area, could experience extensive damage and loss of life in the event of a local tsunami. The city's waterfront, which includes critical infrastructure and residential areas, is highly susceptible to tsunami waves. Lincoln City and Waldport, with their similarly vulnerable coastal locations, also face significant risks. The potential for widespread flooding, property damage, and loss of life underscores the urgent need for comprehensive preparedness and mitigation strategies.

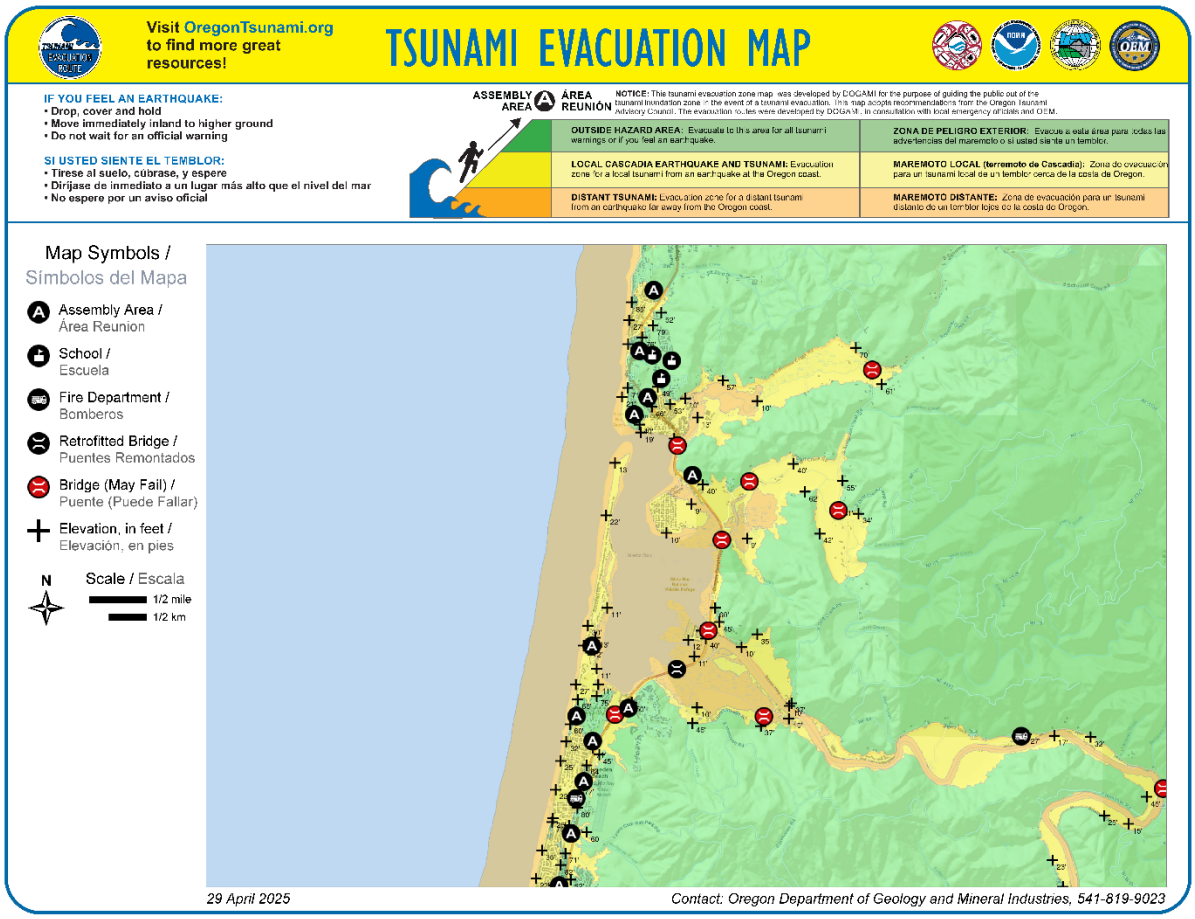


Figure 7. User-generated tsunami evacuation brochure for Siletz Bay area. Visit OregonTsunami.org to view and generate similar maps for other areas of the Oregon Coast.

Current preparedness efforts in Lincoln County involve updating tsunami evacuation plans, improving early warning systems, and conducting public education and preparedness campaigns. For example, the Lincoln County Emergency Management[27] office works to ensure that residents and visitors are aware of evacuation routes and procedures in the event of a tsunami warning. Additionally, community planning initiatives, such as those by the OCMP, aim to enhance resilience by incorporating risk assessments and emergency response strategies into local land-use and development plans. Local organizations like OregonTsunami.org provide valuable resources and information to enhance public awareness and preparedness efforts. The 2011 Tōhoku event reinforced the importance of these efforts, demonstrating that even distant tsunamis can cause significant damage and disruption to Oregon's coastal communities.

Water Quality

In Lincoln County, water quality issues in estuaries, tributaries, and connected wetlands are a growing concern, influenced by both natural processes and human activities. The primary water quality problems are the following:

Increased Temperatures

Rising water temperatures, exacerbated by climate change, are significantly impacting estuarine and tributary environments in Lincoln County. In the Yaquina Bay estuary, water temperature increases of 0.7-1.6°C are projected with a 3°C rise in air temperature, with the upper estuary being most vulnerable to warming. These higher temperatures can stress aquatic species, particularly cold-water fish like salmon, and disrupt ecological balances (DEQ, 2022).

The impacts are not limited to fish; increasing temperatures also affect vegetation patterns and habitat availability. For instance, in the Yaquina Bay estuary, warmer waters may lead to a reduction in eelgrass meadows, which serve as crucial nursery habitats for juvenile fish and invertebrates. Additionally, the number of days exceeding the 18°C temperature criterion for protecting salmon and trout migration and rearing is expected to increase significantly, potentially by up to 40 days in the upstream portions of the estuary (DEQ, 2022). These changes highlight the urgent need for adaptive management strategies.

Turbidity

Turbidity, or the cloudiness of water caused by suspended sediments, remains a significant concern in Lincoln County's waterways. Activities such as logging, construction, and agriculture contribute to sediment runoff, which can degrade water quality by reducing light penetration and harming aquatic plants and animals. In the Yaquina River basin, loss of riparian vegetation on grazed or developed floodplains has led to extensive water quality degradation and subsequent loss of essential fish habitat (NRCS, 2024). The Lincoln Soil and Water Conservation District is actively working to address these issues through riparian restoration and pasture

[27] https://www.co.lincoln.or.us/708/Emergency-Management

improvements in the upper Yaquina watershed, aiming to reduce excessive sediment and improve water quality for salmon spawning habitat. These efforts are part of a broader conservation implementation strategy targeting field sediment, nutrient, and pathogen loss in the region (NRCS, 2024).

Acidification and Hypoxia

Estuaries in Lincoln County are already seasonally experiencing ocean acidification, which affects water chemistry and can harm shellfish and other marine organisms. Hypoxia, or low dissolved oxygen levels in the water, is also a concern. Both acidification and hypoxia are influenced by increased nutrient runoff, which fuels algal growth and subsequent oxygen depletion. Rising temperatures exacerbate these issues by decreasing oxygen solubility in water and increasing microbial respiration rates, potentially leading to more frequent and severe hypoxic events. Alsea Bay has reported instances of low dissolved oxygen levels, particularly during summer months (NOAA, 2023).

Harmful Algal Blooms

Harmful algal blooms (HABs), driven by nutrient pollution from agricultural runoff and wastewater, are becoming more frequent in Lincoln County's estuaries and tributaries. These blooms can produce toxins harmful to aquatic life and pose risks to human health. Rising temperatures are exacerbating this issue, as warmer waters create more favorable conditions for toxic algae growth, potentially leading to earlier and more abundant blooms (EPA, 2016). Yaquina Bay has seen occurrences of HABs that affect water quality and ecosystem health (DEQ, 2023), as well as other places such as Eckman Lake in Waldport.

Nutrient Pollution

Excessive nutrients from agricultural runoff, wastewater discharges, and septic systems contribute to eutrophication in Lincoln County estuaries, leading to algal blooms, oxygen depletion, and degraded water quality. In the Yaquina Bay estuary, elevated nitrate levels during heavy precipitation events increase biochemical oxygen demand, stressing aquatic life (EPA, 2019). Alsea Bay experiences seasonal hypoxia, particularly in summer months, linked to nutrient-driven algal growth and decomposition (NOAA, 2023). Eckman Lake in Waldport suffers from chronic toxic cyanobacteria blooms fueled by stagnant water, septic system leakage, and nutrient-rich sediment (Yachats News, 2022). The use of biosolids as fertilizer adds complexity to nutrient management, potentially introducing per- and polyfluoroalkyl substances (PFAS) into estuarine systems. While PFAS levels in Oregon biosolids are currently low, these "forever chemicals" persist in the environment and have been detected in non-food crops grown in treated soils (OEC, 2024). Climate change intensifies these threats by increasing precipitation-driven nutrient runoff and warming waters, which accelerate microbial respiration and cyanobacteria growth (EPA, 2016).

Pollutants and Contaminants

Pesticides, heavy metals, and other pollutants from urban and agricultural sources can contaminate water sources, impacting both aquatic life and human health (DEQ, 2022). A 2015 statewide assessment found concerning levels of legacy pesticides like DDT, aldrin, and chlordane in several Lincoln County waterbodies, often exceeding human health criteria (DEQ, 2015). Heavy metals such as copper and lead were detected above aquatic life criteria, while arsenic levels in coastal estuaries raised human health concerns. Polycyclic aromatic hydrocarbons, byproducts of waste incineration, were found at levels exceeding human health criteria in multiple locations. Additionally, emerging contaminants like flame retardants were detected in both urban and rural areas, though their long-term impacts remain unclear (DEQ, 2015). In the SW Lincoln County Water District, disinfection byproducts such as haloacetic acids have been detected at levels up to 64 times above health guidelines, highlighting the complexity of maintaining safe drinking water while managing other pollutants (EWG, 2021).

Table 6. Oregon Health Authority recreational-use health advisories related to cyanobacteria outbreaks in Lincoln County water bodies.*

Water Body	Year	Duration (days)	Season
Devils Lake	2008	81	Summer/fall
Devils Lake	2009	39	Summer
Big Creek Reservoir	2012	98	Fall
Devils Lake	2013	113	Summer/fall
Devils Lake	2014	117	Summer/fall
Devils Lake	2024	10	Summer
Eckman Lake	2024	51	Fall

*Oregon Health Authority Harmful Algal Bloom Surveillance program archive data of recreational-use health advisories (OHA, 2022).

Wildfire and Air Quality

Wildfire risks on the Oregon Coast, particularly in Lincoln County, have been a growing concern due to various factors including climate change, land use practices, and historical fire patterns.

Current Wildfire Risks

Vegetation and Terrain

Lincoln County's diverse landscapes, including dense forests, coastal shrublands, and grasslands, are susceptible to wildfires. Climate change is intensifying these risks by creating warmer temperatures and altered precipitation patterns, leading to drier vegetation and extended fire seasons. While the overall probability of a wildfire in the coastal fog belt is

relatively low, extreme conditions, such as preceding drought and east wind events, dramatically heighten fire hazard and risk. The interaction between climate change and invasive species can create additional risks, as changing conditions may favor the spread of fire-promoting invasive plants (ODF, 2023).

Human Activities

The urban-wildland interface, where residential and commercial developments meet natural landscapes, is particularly vulnerable to wildfire ignition. Human activities such as outdoor burning, campfires, and fireworks remain leading causes of wildfires in the region. Increased population density in these areas amplifies the risk. Climate change could exacerbate these risks by creating longer wildfire seasons and increasing wildfire frequency, size, and total area burned. The Lincoln County Community Wildfire Protection Plan[28] addresses these risks and provides strategies for wildfire prevention, protection, response, and recovery, recognizing the need for adaptive management in the face of changing climate conditions (OEM, 2023).

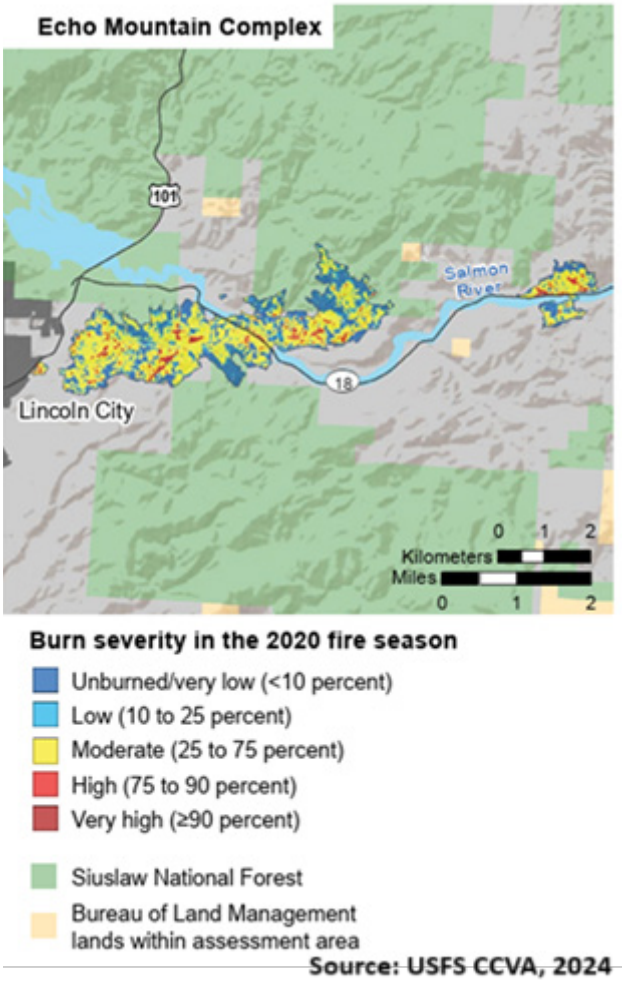


Figure 8. Locations and burn severity of the 2020 Echo Mountain Complex Fire.

2020 Wildfire Season

The 2020 wildfire season was one of the most destructive on record for Oregon, with numerous fires affecting the state, including significant impacts in Lincoln County. While the county experienced less widespread damage compared to some other regions, the local impacts were profound and deeply felt by the community. The Echo Mountain Complex fire (Figure 8) devastated the communities of Otis and parts of Lincoln City. The fire destroyed 288 homes and a total of 1,241 structures, causing extensive damage and displacement. Approximately 15,000 households, representing one-third of the county's population, were placed under evacuation orders during the height of the crisis. This mass evacuation tested the county's emergency response systems and community resilience, with surrounding areas taking in families, pets, and livestock.

[28] https://www.co.lincoln.or.us/401/Community-Wildfire-Protection-Plan

The Echo Mountain fire served as a stark wake-up call for coastal communities, highlighting their vulnerability to wildfire events despite their proximity to the ocean. The severity of the fire's impact is further underscored by a $178 million settlement reached with 402 victims, demonstrating the extensive financial and personal losses suffered by residents (Yachats News, 2025). This event was a real-time test of Lincoln County's emergency preparedness and response capabilities. While challenging, it provided valuable lessons for improving wildfire preparedness, communication systems, and community support networks. The 2020 wildfire season, particularly the Echo Mountain fire, remains a significant event in Lincoln County's recent history, emphasizing the need for continued vigilance and improved wildfire mitigation strategies in coastal Oregon communities.

Increased Fire Risk Due to Climate Change

Climate change is projected to significantly increase wildfire risks on the Oregon Coast, including Lincoln County. Rising temperatures, prolonged droughts, and changing precipitation patterns are likely to create more favorable conditions for wildfires. By mid-century, projections suggest increased frequency, intensity, and size of wildfires in coastal regions (USDA Climate Hubs, 2020). The fire season is expected to lengthen, with a potential shift towards more fires burning at the beginning of fall when extreme weather has the potential to increase fire spread.

Increased fire risk poses significant challenges to fire management and community safety. Large fires exceeding 40,000 hectares may become more frequent, impacting both ecological and economic systems (OSU, 2024). The 2020 fires served as a wake-up call for coastal communities, highlighting vulnerability to wildfire events despite their proximity to the ocean.

Vegetation Changes

Warmer temperatures and changing precipitation patterns are projected to alter vegetation types and densities in coastal Oregon forests. The region may experience a shift from predominantly conifer forests to mixed conifer and hardwood forests (OSU, 2024). This change in forest composition could potentially increase fuel loads and fire hazards. Invasive species that thrive in warmer conditions may replace native vegetation, contributing to higher fire risks. Moreover, these invasive species tend to rapidly colonize areas after disturbances such as wildfires, making post-fire control efforts even more challenging and potentially altering long-term ecosystem dynamics (ODF, 2023).

Impacts to Local Air Quality

Wildfire smoke poses a significant threat to air quality along the Oregon Coast, including Lincoln County. While the coast historically experienced fewer smoke impacts, recent trends show an increase in days with unhealthy air quality due to wildfires. DEQ reports that areas which have historically not seen significant smoke impacts, such as the north coast, are now experiencing more frequent days with air quality index values that are unhealthy for sensitive groups (DEQ, 2023). This trend is expected to continue as climate change intensifies wildfire seasons.

The impact of degraded air quality extends beyond human health to affect coastal ecosystems, including estuaries. Estuaries play a crucial role by providing habitat for diverse species, supporting local economies, and offering natural climate solutions. However, when degraded by factors such as wildfire smoke, estuaries can lose their ability to serve their functions and may even release stored greenhouse gases, potentially exacerbating climate change impacts (Pew Charitable Trusts, 2022). As wildfire seasons intensify due to climate change, the increased frequency and severity of smoke events may pose new challenges for the delicate balance of estuarine ecosystems along the Oregon Coast. To evaluate locally-specific wildfire risks and access other wildfire hazard resources, visit the Oregon Wildfire Risk Explorer[29].

Invasive Species

Invasive species pose a significant threat to the estuaries and waterways of the Oregon Coast, including Lincoln County. These non-native organisms can outcompete native flora and fauna, disrupt local ecosystems, and exacerbate the challenges faced by coastal habitats already under pressure from climate change and human activities. The introduction and spread of invasive species in estuarine and coastal environments could lead to long-term ecological and economic impacts, particularly in areas such as Yaquina Bay and surrounding wetlands. Climate change may further compound these issues by creating more favorable conditions for certain invasive species. Warmer temperatures and altered precipitation patterns could enhance the reproductive rates and survival of non-native organisms, while changes in storm patterns and river flows may facilitate their spread to new areas (NOAA, 2023; USGS, 2022).

The combined effects of invasive species and climate change may result in more pronounced ecological imbalances. For example, the continued spread of species like Japanese knotweed and purple loosestrife could further alter estuarine and riparian ecosystems, affecting native species and ecosystem services such as water filtration and erosion control (DEQ, 2022). These compounding threats highlight the need for continued monitoring, research, and management efforts to protect Lincoln County's estuaries and waterways, including early detection and rapid response programs to control spread and preserve the ecological integrity of these ecosystems.

Invasive Plant Species Risks

Invasive plant species pose significant risks to the health of estuarine ecosystems in Lincoln County. These species can outcompete native vegetation, alter habitat conditions, and disrupt ecosystem processes, leading to long-term ecological and economic consequences.

Table 7 highlights some of the current major invasive plant species in the region, their associated threats, impacts, and supporting references. This list represents the most prominent species at present but is not exhaustive. It is crucial to monitor and detect new invasive species

[29] https://hub.oregonexplorer.info/pages/wildfire

Table 7. Most Concerning Invasive Plant Species Risks

Species	Threat	Impacts	References
European beachgrass (*Ammophila arenaria*)	Extensively planted for erosion control, alters dune ecosystems	Changes dune formation, increases storm surge risk, threatens native species habitats	USDA, 2014
Knotweed species (*Fallopia* spp. And *Polygonum* spp.)	Rapidly spreads in riparian areas, displacing native vegetation, grows up to 2-4 feet per month	Difficult to control, alters riparian habitats, classified as Class B noxious weeds in Oregon	Lincoln SWCD, 2025
Scotch Broom (*Cytisus scoparius*)	Colonizes disturbed areas, forms dense thickets	Causes significant economic damage, alters soil chemistry, displaces native vegetation	OSU Extension, 2025
Old Man's Beard (*Clematis vitalba*)	Invasive in riparian and wetland areas, smothers native vegetation	Disrupts ecological balance, identified as a target for control in Lincoln County	Lincoln County, 2025
Policeman's Helmet (*Impatiens glandulifera*)	Thrives in riparian and wetland areas, displaces native vegetation	Alters ecosystem dynamics, priority for Early Detection and Rapid Response (EDRR) in Lincoln County	Lincoln SWCD, 2025
Yellow Archangel (*Lamium galeobdolon*)	Aggressively spreads in wetland habitats, outcompetes native plants	Reduces biodiversity, alters ecosystem structure	Lincoln SWCD, 2025
False brome (*Brachypodium sylvaticum*)	Rapidly spreads in forest understories and open areas	Reduces biodiversity, alters fire regimes, priority for EDRR programs in Lincoln County	Lincoln SWCD, 2025
Yellow Flag Iris (*Iris pseudacorus*)	Forms dense stands that displace native plants and disrupt wetland ecosystems	Impacts biodiversity and habitat by reducing available food and nesting sites	Hager & McCoy, 2007
Reed Canary Grass (*Phalaris arundinacea*)	Invades wetlands and riparian zones forming dense stands	Crowds out native vegetation and reduces biodiversity, exacerbates erosion	Hilty, 2008
Himalayan blackberry (*Rubus armeniacus*)	Aggressive growth, forms dense thickets	Outcompetes native plants, alters habitats, target for invasive plant management efforts in Oregon	Lincoln County, 2025
Spurge Laurel (*Daphne laureola*)	Toxic, dominates understory habitats	Impacts native plant diversity in coastal wetlands and estuarine areas	Lincoln County, 2025
Purple Loosestrife (*Lythrum salicaria*)	Invades wetlands, displaces native plant species	Alters wetland habitats, negatively affects bird and insect populations that rely on these ecosystems	OSU, 2022
Japanese Eelgrass (*Zostera japonica*)	Outcompetes native eelgrass (*Zostera marina*), alters habitat structure	Impacts habitat structure, affects local fisheries and biodiversity, poses challenges for managing native eelgrass populations	Bando, 2006; Vaudrey, 2008

early to prevent further ecological damage, as seen with species like gorse, which has caused considerable harm in other coastal areas both ecologically and financially. Early intervention is key to safeguarding the resilience of these delicate ecosystems.

Invasive Wildlife Species Risks

Invasive wildlife species can pose significant threats to the ecological balance of estuarine and coastal habitats. While the focus here is on a few of the most prominent invasive species, this list is not exhaustive. The introduction and spread of non-native wildlife can disrupt local ecosystems by outcompeting native species, altering habitats, and introducing diseases. Effective management strategies are crucial, particularly for early detection and rapid response, to prevent new invaders from establishing themselves.

European Green Crab (*Carcinus maenas*): This aggressive, adaptable species has established populations in Oregon's estuaries, including in Lincoln County. European green crabs may outcompete native species for food and habitat, potentially affecting shellfish populations and disrupting estuarine ecosystems. Their presence has been documented in all of Oregon's major estuaries (OSU, 2021), with ongoing monitoring by ODFW. A population surge in the early 2000s raised concerns about possible ecological impacts, such as declines in native clams and altered estuarine communities (ODFW, 2019). However, no specific research has yet confirmed measurable impacts on native species in Oregon's estuaries.

Griffen's Isopod (*Orthione griffenis*): This parasitic crustacean has significantly impacted mud shrimp populations in West Coast estuaries, including those in Oregon. It infests mud shrimp, reducing their reproductive capacity by sucking their blood or nutrients, which can lead to population declines (OSU, 2017).

New Zealand Mudsnail (*Potamopyrgus antipodarum*): This small snail has been observed in some coastal streams and estuaries near Lincoln County. It can form dense populations in freshwater and brackish habitats, potentially affecting food webs. However, its full ecological impact in Oregon estuaries is still being assessed (Oregon Conservation Strategy, 2022).

Purple Varnish Clam (*Nuttallia obscurata*): First found in Oregon estuaries in the 1990s, this non-native clam has established populations in several bays. While it competes with native clams for space and resources, it has also become a target for recreational harvesting. Its overall impact on estuarine ecosystems is still being studied (Shane's Outdoor Fun, 2019).

Japanese Oyster Drill (*Ocinebrellus inornatus*): This predatory snail has been reported in some Oregon estuaries. It is known to prey on shellfish, particularly oysters, which could have implications for aquaculture operations. However, the extent of its presence and impact in Lincoln County specifically requires further investigation.

Colonial Tunicates (e.g., *Didemnum vexillum*): These marine organisms have been observed forming colonies on submerged surfaces in some Oregon estuaries, including Yaquina Bay. While they can potentially affect habitat structure, their specific impacts in Lincoln County estuaries are not yet fully understood.

Image: Alsea Bay. By Jeff & Linda Hildreth.

III. Vulnerability Summary

Image: Lincoln City Wastewater Treatment Plant on Schooner Creek, Siletz Bay. Courtesy of Oregon ShoreZone.

Lincoln County

This chapter introduces broad themes of vulnerability that affect Lincoln County's estuaries and coastal communities. It highlights patterns, such as infrastructure risks, water quality concerns, and climate change impacts, that recur across the region and shape both present challenges and future risks. These cross-cutting themes reflect issues that span multiple watersheds and communities, offering a regional perspective on the factors influencing resilience. They also illustrate how interconnected systems, natural, built, and social, contribute to both vulnerabilities and opportunities for adaptation. Together, these themes provide important context for understanding the challenges ahead and frame the more detailed, estuary-specific vulnerability assessments that follow.

Key Themes for Vulnerability

Infrastructure Vulnerability: Key infrastructure in Lincoln County faces increasing risks from climate change impacts. US Highway 101, a critical coastal route, is particularly vulnerable to erosion and landslides, especially in areas like Beverly Beach. The Yaquina Bay Bridge in Newport, while historically significant, may require adaptation measures to withstand more frequent storm surges and sea level rise. Aging tide gates and undersized culverts throughout the county's estuaries, such as those in the Siletz and Alsea watersheds, are struggling to manage increased water flows, leading to more frequent flooding of low-lying areas.

Water Quality and Monitoring: Lincoln County's estuaries face water quality challenges exacerbated by climate change. Rising temperatures and altered precipitation patterns are increasing the risk of harmful algal blooms and low dissolved oxygen events. The county lacks comprehensive, real-time monitoring systems to track these changes across watersheds, hindering effective management responses. Additionally, septic systems near coastal areas, such as those in Cutler City, are becoming more vulnerable to saltwater intrusion as sea levels rise. There is an urgent need for sediment budget studies and tidal gauge installations, particularly in the Siletz and Yaquina estuaries.

Climate Change Impacts: Sea level rise poses a significant threat to Lincoln County's coastal communities. Areas like Taft in Lincoln City and parts of Waldport are at increased risk of flooding during storm events. The Salmon River estuary is experiencing saltwater intrusion further upstream, altering habitats and potentially affecting water supplies. Coastal erosion is accelerating in areas like Seal Rock, threatening both natural habitats and built infrastructure.

Land Use and Development: Pressure for development in flood-prone areas continues, particularly in desirable coastal locations. The South Beach area of Newport, for example, faces challenges in balancing growth with flood risks. The county's efforts to update zoning laws and building codes are crucial for reducing future vulnerabilities, but face obstacles such as existing property rights and economic pressures. There is a growing need to align Goal 16 (estuaries) and Goal 17 (shorelands) planning to address cumulative impacts of development and climate change.

Funding and Resource Limitations: Lincoln County, like many rural coastal counties, struggles with limited financial resources to address climate resilience. The backlog of bridge maintenance in Lincoln City exemplifies this challenge. Innovative funding mechanisms, such as reallocating a portion of tourism revenue for resilience projects or creating a coastal resilience fund using state bonds, are being explored but face political and practical hurdles.

Community Engagement and Education: While there is growing awareness of climate risks, many residents and property owners, especially non-resident owners, remain uninformed

about specific local vulnerabilities. Efforts like the Oregon King Tides Project[30] help visualize future flooding risks, but more comprehensive education programs are needed to build community support for adaptation measures. Developing a centralized estuary data portal, possibly through OSU's Guin Library, could improve public access to critical information.

Nature-Based Solutions: There is increasing recognition of the potential for nature-based solutions to address multiple challenges. Prioritizing living shorelines, wetland restoration, and urban bioswales can help reduce erosion and filter pollutants. Expanding partnerships with tribes, land trusts (e.g., Central Coast Conservation Opportunity Team), and federal agencies (e.g., USFWS) can facilitate the implementation of scalable projects. Beaver-assisted restoration and invasive species management are emerging as key strategies for enhancing ecosystem resilience.

Equity and Managed Retreat: Low-income communities in flood-prone areas face disproportionate risks from climate change impacts. There is a growing need to develop equitable managed retreat programs, potentially modeled after successful initiatives in other regions. Real estate disclosures for hazard risks could help reduce development in vulnerable areas and inform property buyers of potential future challenges.

By addressing these interconnected themes, Lincoln County can work towards a more resilient and sustainable future for its estuaries and coastal communities.

Overview of Community Concerns

This section summarizes key concerns surfaced through Lincoln County's community engagement efforts, which included a public survey, community listening sessions, adaptation action workshops, and individual interviews. Reflecting the experiences and perspectives of participants, the summaries highlight vulnerabilities across built infrastructure, critical and environmental infrastructure, social factors, and vulnerable populations. While not intended as an exhaustive assessment, this overview captures many of the local priorities and challenges that emerged most prominently during community engagement efforts.

Built Infrastructure: Community members in Lincoln County identified a variety of built infrastructure assets as particularly vulnerable to natural hazards and climate change impacts. Major transportation routes such as US Highway 101 and key east-west highways are essential for regional connectivity but are at significant risk from flooding, erosion, and seismic events. Vulnerable assets also include buildings, bridges, docks, agricultural facilities, and residential areas located in low-lying, flood-prone zones. Specific concerns were raised about the resilience of critical facilities like the Hatfield Marine Science Center (HMSC), as well as the structural

[30] https://www.oregonkingtides.net/

integrity of tide gates, culverts, and communication systems. Failing septic systems in certain areas further heighten public health and environmental risks.

The potential destruction of this infrastructure could severely disrupt community connectivity, emergency response, and access to essential goods and services. Crumbling roadways, collapsed bridges, and damaged docks could isolate communities, cut off supply chains, and hinder evacuation and recovery efforts. These disruptions would exacerbate the vulnerabilities of already at-risk populations, especially during extreme weather events or other hazards. The loss of access to food, medical care, and critical resources is a major concern, along with the cascading economic and social consequences that accompany such infrastructure failures.

Critical/Environmental Infrastructure: Environmental infrastructure is deeply intertwined with the health, safety, and economy of Lincoln County. Estuarine and intertidal habitats, tidal and freshwater wetlands, and coastal forest ecosystems are all highly vulnerable to habitat degradation and loss driven by sea level rise, saltwater intrusion, pollution, invasive species, and temperature increases. Key species such as salmonids (especially juveniles), oysters, and Dungeness crabs face multiple threats from deteriorating water quality and ecological disruption. Potable water sources like the Big Creek Reservoir are also at risk from drought, contamination, and infrastructure damage. Protecting eelgrass beds and maintaining the ecological health of Devils Lake are seen as critical priorities for sustaining biodiversity and local fisheries.

Anticipated impacts include increased water scarcity, a loss of habitat diversity, and diminished ecosystem productivity. Pollution, erosion, and invasive species could further destabilize these fragile systems, leading to the potential collapse of key estuarine and nearshore ecosystems. Such collapses would threaten not only biodiversity but also vital food resources and local industries dependent on healthy ecosystems. Declines in species like shellfish could severely impact local fisheries and aquaculture operations, while degraded drinking water supplies would endanger human health. These environmental changes pose risks not just to natural systems but also to the economic and social fabric of Lincoln County communities.

Social Factors: The social fabric of Lincoln County is closely tied to its natural resources, and community members expressed deep concern about vulnerabilities linked to economic, cultural, and emergency response capacities. The fishing and seafood industry, cornerstones of the regional economy, are particularly threatened by climate-related changes impacting aquaculture, fish species availability, and habitat conditions. In parallel, emergency response organizations are strained by existing challenges and may be overwhelmed during future disasters, especially if infrastructure failures limit access and mobility.

Potential impacts include the loss of life, cultural resources, and critical social connections. Economic disruption could manifest in widespread job losses within industries such as fishing and tourism, significantly affecting livelihoods and exacerbating existing inequities. Community members also fear increased costs of living, reduced food availability, and broader declines in

quality of life. Health outcomes may worsen as access to nutritious food, clean water, and healthcare services becomes less reliable during and after disasters. Inappropriate or inequitable responses to emergencies could further exacerbate vulnerabilities, making it critical to center social equity in resilience planning.

Vulnerable Populations: Several communities and populations in Lincoln County are especially vulnerable to natural hazards and climate change impacts. Low-lying areas such as Nye Beach, South Beach, and Cutler City are particularly susceptible to flooding, storm surge, and coastal erosion. Elderly and non-ambulatory individuals in these neighborhoods and beyond face additional risks due to mobility challenges during emergencies and evacuations. Tourists and seasonal visitors, often unfamiliar with local hazards and emergency protocols, represent another vulnerable group, especially during sudden disasters. Rural and isolated residents confront heightened risks stemming from limited access to healthcare, emergency response, and critical services, particularly during periods of extreme weather or water scarcity.

These vulnerabilities translate into serious concerns about displacement and forced migration, particularly for low-lying and coastal populations. Flooding, erosion, and sea level rise threaten homes, livelihoods, and cultural continuity, especially for Indigenous communities like the Confederated Tribes of Siletz Indians, whose cultural identity and subsistence practices are closely tied to coastal ecosystems. The Tribe's lands are distributed across the Coast Range, the Pacific shoreline, and the estuaries, and are particularly vulnerable to climate impacts on fisheries, as well as to the physical impacts of sea level rise and flooding. Displacement can disrupt social networks and lead to profound economic and psychological hardship. Health crises are another major fear, particularly given the limited medical response capacity in remote areas; elderly, disabled, and low-income residents are especially vulnerable to adverse outcomes during disasters.

Economic hardship is expected to deepen following natural hazard events, as many vulnerable populations lack insurance, savings, or other financial safety nets. The loss of culturally significant resources, such as key fisheries, would threaten both the economic and cultural resilience of Indigenous and traditional communities. Persistent barriers to emergency preparedness such as language differences, transportation challenges, and insufficient outreach, leave many residents underprepared and disproportionately at risk when disasters strike, further underscoring the need for equitable and accessible resilience strategies.

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The community feedback highlights a broad range of vulnerabilities across built, natural, and social infrastructures in Lincoln County. The concerns emphasize the interconnectedness of these assets and the need for comprehensive, community-driven planning to address the diverse impacts of climate change. Protecting infrastructure, enhancing emergency response capabilities, and prioritizing the needs of vulnerable populations will be essential steps in building resilience against the anticipated climate threats of the 21st century.

Salmon River

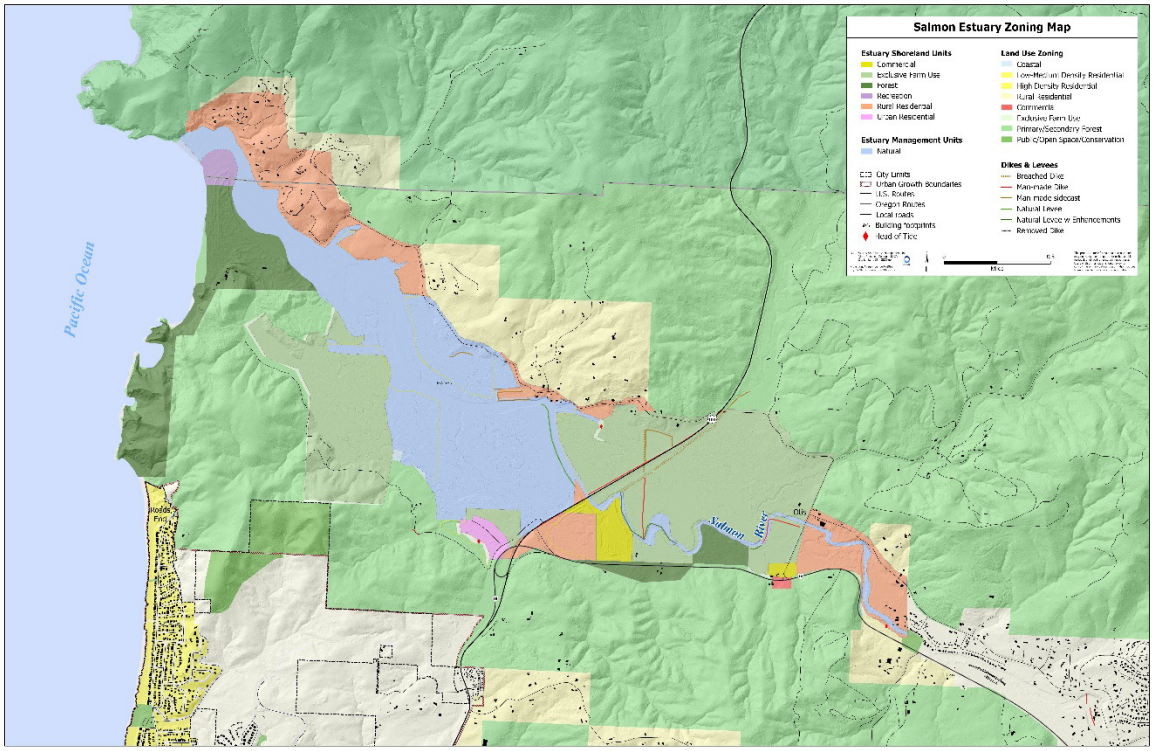

Figure 9. Salmon River estuary zoning map.

The Salmon River estuary is a small yet ecologically significant estuary that flows into the Pacific Ocean near Cascade Head. This estuary is characterized by its meandering channels, expansive tidal marshes, and rich biodiversity. It serves as a crucial habitat for a variety of species, including endangered salmonid populations such as Chinook and coho salmon, which rely on its waters for spawning and rearing.

The estuary's landscape includes a mix of salt marshes, mudflats, and forested wetlands, providing vital feeding and nesting grounds for numerous bird species. The estuary has also been the focus of extensive restoration efforts, particularly in the late 20th and early 21st centuries, aimed at reversing the impacts of historical diking and draining activities that had significantly altered its natural state. These restoration projects have successfully re-established natural tidal flows and reconnected the estuary with its floodplain, promoting the recovery of native vegetation and wildlife.

The surrounding communities, such as Otis, are small and largely rural, with limited infrastructure near the estuary itself. Part of the Salmon River estuary is also within the USFS Cascade Head Scenic Research Area, a federally designated area that underscores the region's ecological and scenic importance.

Hazard Risk

Flooding is a concern for the Salmon River estuary and surrounding areas. In particular, the community of Otis and adjacent agricultural lands may be susceptible to inundation during heavy rainfall, storm surges, and high tides. The US Highway 101 crossing over the estuary may experience periodic impacts from these events, potentially affecting transportation and local connectivity. Additionally, the Knight Park boat launch area could see occasional flooding, which might influence local recreation and tourism. The increasing threat of **wildfire**, exemplified by the Echo Mountain Complex Fire in 2020, also poses a risk to nearby forests and residential areas. This hazard underscores the need to consider potential damage to infrastructure and long-term ecological impacts, including soil erosion and habitat loss.

Coastal **erosion** is a significant threat along the lower reaches of the Salmon River estuary, particularly near the Cascade Head Scenic Research Area and the mouth of the river. Rising sea levels and increased storm intensity are accelerating shoreline retreat, which endangers the salt marshes and tidal flats that provide critical habitats for species such as coho salmon, Bald Eagles, and the threatened Oregon silverspot butterfly. These areas are also vital for supporting the biodiversity of the estuary and surrounding lands. Additionally, erosion threatens the stability of the Cascade Head Preserve, which could impact the area's ecological integrity and biodiversity.

Key Themes for Vulnerability

Key Challenges

Habitat Loss: Historical diking around marshes, loss of off-channel habitat, and decreased water quality have contributed to the decline of salmon populations in the Salmon River estuary.

Restoration Challenges: Past restoration efforts faced difficulties, including challenges with berm construction and maintenance to protect adjacent private lands, as well as conflicts between regulatory requirements and landowner wishes.

Infrastructure Impacts: Human alterations, such as the rerouting of US Highway 101 in 1961, have constricted tidal flows and cut off migrating fish from tidal channels and hydrologic connectivity.

Opportunities for Resilience

Continued Restoration Successes: Building on past projects like those from 2007-2014, which restored tidal influence to 108 acres and over two miles of stream channel and floodplain in the Salmon River estuary, to enhance future restoration efforts.

Collaborative Conservation: The implementation of complex restoration projects in the Salmon River estuary has been facilitated by partnerships between multiple agencies and organizations.

Adaptive Management: Updating Oregon's estuary management plans to provide new opportunities to protect habitats and species, address climate change issues, and encourage restoration efforts.

Specific Vulnerability Concerns

US Highway 101: The US Highway 101 crossing over the Salmon River estuary faces several long-term vulnerabilities related to flooding, sea level rise, and seismic hazards. The culverts beneath the highway, while currently sufficient, may be at risk during high water events such as king tides, especially considering future sea level rise projections. During these events, water levels can reach the top of the culverts, potentially leading to roadway flooding and compromised transportation routes.

The highway's construction has significantly altered the estuary's hydrology. As noted in the 2014 Salmon River estuary restoration report, "The highway roadbed across the estuary is nine feet higher than the estuary surface. As a result, the highway functions as a large dike. It cuts the estuary into two ecologically separate parts, constricting the flow of the tides and the river" (Ellingson & Ellis-Sugai, 2014). This alteration has implications for both flood risk and ecological function.

While the installation of a culvert at Frazer Creek has provided additional storm surge relief, the overall infrastructure is projected to be sufficient only for the next 25-30 years. This timeframe does not fully account for potential future sea level rise impacts. Mid-century (2050) projections indicate a high risk for coastal flooding due to sea level rise and storm surge along the Oregon Coast (ODOT, 2023).

The highway's vulnerability extends beyond flooding concerns. According to DOGAMI's tsunami hazard assessment, Highway 101 is vulnerable to exposure on the west side in a distant tsunami scenario and on both sides in a local tsunami scenario (DOGAMI, 2019). Furthermore, shaking

from a 9.0 CSZ earthquake is expected to be most severe in the areas immediately surrounding Highway 101 along its entire length crossing the estuary (DOGAMI NHRR, 2020).

N 3 Rocks Rd: The bridge near Knight Park on N 3 Rocks Rd, which spans Crowley Creek, is vulnerable due to an undersized culvert that is currently blocked and non-functional. This culvert poses a risk to the bridge during high water events, increasing the likelihood of flood damage and compromising access for the community. In addition to its structural concerns, the culvert limits estuarine function in adjacent wetlands, restricting natural hydrological processes (Salmon River Site Conservation Action Plan, 2008).

This section of N 3 Rocks Rd is also highly vulnerable to seismic activity. Shaking from a 9.0 CSZ earthquake is expected to be most severe near Knight Park (DOGAMI, 2020). Given the area's proximity to tidal waters and low elevation, additional hazards such as subsidence may further compound risks during seismic events (DOGAMI, 2019).

Image: Salmon River. By Duncan Berry.

Otis: The community of Otis faces ongoing vulnerabilities related to both infrastructure and wildfire risks. The bridge on N Old Scenic Hwy 101 in Otis is in need of upgrades to address its susceptibility to natural hazards. While ODOT is aware that the bridge needs improvements, there are currently no plans for upgrades. The bridge's condition poses potential risks to transportation routes and local residents during flooding and other extreme weather events.

The 2020 Echo Mountain Complex Fire significantly impacted Otis, burning over 2,500 acres and destroying 288 homes and 339 structures in the area (Explore Lincoln City, 2021). This devastating event left lasting effects on the landscape and community. Post-2020 fires, Otis continues to face elevated wildfire concerns. The loss of vegetation and changes to soil composition following intense wildfires can alter watershed hydrology, potentially increasing the risk of flash floods and debris flows even during modest rainstorms (DOGAMI, n.d.). This heightened vulnerability underscores the need for ongoing mitigation efforts and community preparedness.

The Echo Mountain Fire highlighted pre-existing socioeconomic challenges in Otis, including issues related to housing insecurity, poverty, and limited resources (Open Oregon, 2023). For example, manufactured homes and temporary housing setup for wildfire victims near Highway 101 are at increased landslide and erosion risk from the hillsides above denuded as a result of the fire. These underlying factors may compound the community's vulnerability to future wildfire events and complicate long-term recovery efforts.

Siletz Bay

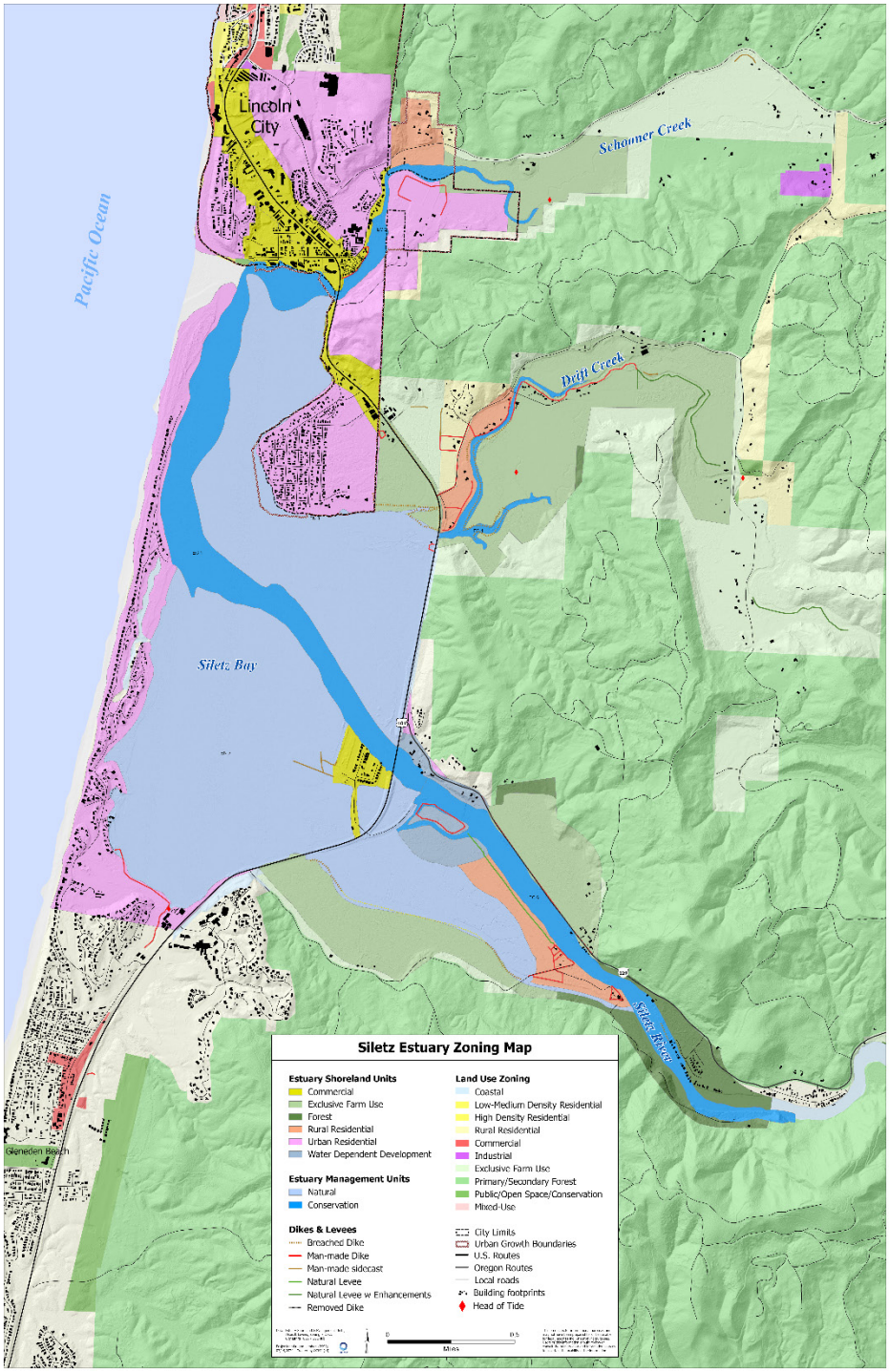

Figure 10. Siletz Bay estuary zoning map.

Siletz Bay, located near the city of Lincoln City, is a shallow estuary bordered by sandy beaches and dunes and bounded to the west by the narrow Salishan Spit. The bay is formed by the confluence of the Siletz River and Drift Creek, creating a diverse habitat that includes tidal marshes, mudflats, and eelgrass beds. These habitats are crucial for a variety of species, including Dungeness crab, bay clams, salmonids, migratory waterfowl and shorebirds. Historically, the bay was significantly altered by human activities, such as the construction of dikes and levees, which impacted its natural tidal flow. Recent restoration efforts have aimed to restore these natural processes, enhancing habitat quality for native species.

The estuary is also notable for its proximity to Lincoln City, a popular tourist destination, which has influenced both the development and conservation efforts in the area. The Siletz Bay National Wildlife Refuge, established to protect the estuary's diverse ecosystems, offers a sanctuary for wildlife and a place for the public to engage in birdwatching and other recreational activities.

Drift Creek is a major tributary that flows into Siletz Bay, adding to the estuary's rich tidal marshes and mudflats that are vital for various aquatic species and migratory birds. This part of the estuary serves as a critical habitat for fish, including salmon and trout, which use the creek for spawning and rearing. The surrounding area is characterized by lowland forests and wetlands, providing a scenic and ecologically important buffer between the creek and the developed areas around Siletz Bay.

Hazard Risk

The Siletz Bay estuary faces several natural hazard threats that could impact both its ecological health and the surrounding communities. Coastal **flooding** is a significant concern, particularly affecting areas such Taft and Cutler City, and the nearby residential zones. During heavy rainfall, storm surges, or high tides, parts of Siletz Bay and adjacent low-lying areas may experience occasional inundation, potentially affecting local infrastructure and land use.

The Siletz River's mouth and the nearby roadways, as well as portions of Highway 101 and OR 229, are at risk of occasional flooding, which can disrupt transportation and access to local resources. Additionally, the estuarine wetlands and habitats around Siletz Bay are vulnerable to **erosion** and **sedimentation** impacts, which can threaten critical fish and wildlife habitats and alter the estuarine balance. Erosion on the Salishan Spit threatens residences there and has led to occasional breaching of the spit during storm surge. **Earthquake** liquefaction (soft soil) hazard is high in Siletz Bay, as well as Devils Lake. Buildings and infrastructure are likely to be severely damaged. Lincoln City is rated as having “high” vulnerability to CSZ, meaning >10% of the unincorporated population or property could be affected, with up to 30% of the unincorporated population potentially displaced by 9.0 CSZ (DOGAMI NHRR, 2020).

Wildfire poses another increasing threat, particularly during the dry summer months. The 2020 wildfires in nearby areas highlighted vulnerabilities to both forested regions and residential

zones around Siletz Bay, emphasizing potential impacts on infrastructure and natural ecosystems.

Key Themes for Vulnerability

Sediment & Flooding: The Siletz estuary lacks crucial tidal flood gauges near the head of tide, limiting understanding of seasonal fluctuations and tidal dynamics. This data gap exacerbates flooding risks in low-lying areas like Ebb Road and 50th Street. The complex interaction of the estuary's tidal prism interacts with river discharge influences flood patterns and habitat conditions. Climate change projections suggest increased winter precipitation, further heightening flood risks for vulnerable communities like Taft and Cutler City.

Managed Retreat & Equity: Low-income communities in Taft and Cutler City face repeated flooding but lack resources for relocation. These areas represent prime candidates for managed retreat programs, similar to successful initiatives in Hamilton, WA. However, implementing such programs requires careful consideration of equity issues and substantial funding mechanisms to support vulnerable populations in the transition process.

Habitat Connectivity: The Siletz River watershed has experienced a significant loss of woody debris connectivity from forests to the estuary, reducing habitat complexity for salmon and other aquatic species. Restoration efforts should focus on enhancing off-channel habitats for fish recovery and expanding protected areas like the Siletz Bay National Wildlife Refuge. These efforts can provide critical habitat and serve as natural buffers against sea level rise, benefiting both wildlife and local communities.

Key Challenges

Climate Change Impacts: Sea level rise, increased storm intensity, and altered precipitation patterns threaten infrastructure and habitats.

Water Quality Degradation: Agricultural runoff, urban stormwater, and legacy pollutants impair water quality, impacting aquatic life and recreational opportunities.

Habitat Loss and Fragmentation: Development, dredging, and invasive species contribute to the loss of critical habitats such as eelgrass beds and tidal wetlands.

Opportunities for Resilience

Implement Green Infrastructure: Utilize nature-based solutions to manage stormwater, reduce erosion, and enhance habitat connectivity.

Restore Tidal Wetlands: Restore tidal wetlands to provide flood protection, improve water quality, and create habitat for fish and wildlife.

Engage Stakeholders: Foster collaboration among government agencies, local communities, and private landowners to develop and implement effective resilience strategies.

Specific Vulnerability Concerns

US Highway 101 Bridge over Drift Creek: The Highway 101 bridge over Drift Creek is a critical transportation link in the region, and its current condition poses potential risks to public safety and regional connectivity. ODOT has classified this bridge as "structurally deficient," indicating that it requires upgrades to meet current safety and structural standards. The bridge has not been retrofitted to withstand significant seismic events, which is a concern given its location in a seismically active coastal area where a CSZ earthquake could trigger both severe ground motion and a subsequent tsunami (Yim & Boon-intra, 2023).

Tsunami modeling has revealed the bridge's vulnerability to inundation. Even in a distant tsunami scenario, both approaches to the bridge are at risk of exposure. Furthermore, in an XXL tsunami event, sections of Highway 101 immediately north of the bridge would also be vulnerable to inundation (DOGAMI, 2019, 2021). This combination of seismic and tsunami risks highlights the need for comprehensive resilience measures.

The bridge's role in the larger Highway 101 corridor means that any damage or closure could affect regional access and emergency response capabilities during a disaster (ODOT, 2023). The potential for isolation of communities and disruption of evacuation routes underscores the broader implications of the bridge's current deficiencies. Addressing these vulnerabilities will likely require a multi-faceted approach, potentially including seismic retrofitting techniques such as column jacketing, seat extensions, and the installation of seismic isolation bearings (FHWA, 2006). Additionally, considerations for tsunami loads and potential scour effects should be incorporated into any retrofit design, given the bridge's exposure to both seismic and tsunami hazards (Yim & Boon-intra, 2023).

US Highway 101 Along the East Side of Siletz Bay: Highway 101 along the east side of Siletz Bay faces significant vulnerabilities due to its low-lying position in places and proximity to coastal hazards. This critical transportation route is susceptible to inundation from multiple sources,

including storm surge, high rainfall events, and tsunamis. Even in a distant tsunami scenario, much of this stretch is at risk of flooding (DOGAMI, 2019), highlighting its extreme vulnerability to coastal hazards.

The highway's susceptibility to flooding poses a serious threat to both local and through traffic, potentially disrupting emergency services, commerce, and daily commutes. This vulnerability is compounded by the increasing risks associated with climate change, including sea level rise and more frequent intense storms, which could exacerbate flooding issues in the future (ODOT, 2023). Additionally, the area faces a high wildfire risk (DOGAMI NHRR, 2020), creating a complex hazard landscape that could potentially isolate communities or complicate evacuation efforts during emergencies.

These overlapping hazards underscore the critical need for proactive planning and mitigation strategies to ensure the resilience of this vital transportation link. As part of the larger Highway 101 corridor, this section's vulnerability contributes to the overall fragility of Oregon's coastal transportation network, which is increasingly susceptible to erosion, flooding, and other climate-related impacts (Olsen et al., 2023).

Salishan Spit: The Salishan Spit, a narrow sandy barrier separating Siletz Bay from the Pacific Ocean, is a dynamic and vulnerable coastal feature facing multiple natural hazards. Erosion is one of the most pressing concerns, with significant episodes periodically threatening properties and infrastructure. The ocean-facing side of the spit is particularly unstable, with erosion occurring from both the ocean and estuary sides near its end. This instability has been exacerbated by environmental changes, including altered circulation patterns in Siletz Bay and the deflection of the Siletz River flow caused by the prograding Drift Creek delta (DOGAMI, 1997; DLCD, 2023). Additionally, older riprap installations have collapsed in some areas, leaving homes unprotected and highlighting that riprap is not a long-term solution (OPRD, 2021; Sea Grant Scholars, 2021). Riprap here has also redistributed incoming wave energy, contributing to the narrowing of public beach areas, reducing the natural storm buffer that beaches provide, and hindering public access to and along the shore.

Flooding and tsunami hazards further compound the spit’s vulnerabilities. High tides and storm surges frequently inundate low-lying areas, while long-period waves during winter storms have caused significant damage (Sea Grant Scholars, 2021). In a tsunami scenario triggered by a CSZ earthquake, the majority of Salishan Spit would be inundated. Under an XXL event, nearly complete inundation is anticipated, with a high likelihood of fatalities north of Salishan Middle due to limited evacuation options and rapid inundation times (DOGAMI, 2019; DOGAMI, 2021). Historical tsunami deposits suggest that prehistoric events reached elevations of up to 39 feet at Salishan Spit, underscoring its susceptibility to catastrophic inundation (DOGAMI Clearinghouse, 1995; Priest et al., 2001).

The long-term sustainability of Salishan Spit is also threatened by climate change impacts such as rising sea levels and increased storm intensity. These factors are likely to accelerate erosion

rates and heighten flood risks over time. The spit's dynamic nature places development in direct conflict with natural processes, creating ongoing challenges for infrastructure stability and community safety (OCCRI, 2021; Ruggiero et al., 2005).

Lincoln City Wastewater Treatment Plant: The Lincoln City Wastewater Treatment Plant (WWTP) is an essential facility providing wastewater services to the community. However, its coastal location and reliance on aging infrastructure, make it susceptible to a range of natural hazard threats. The freshwater intake in Siletz Bay, which is critical to the plant's operations, is increasingly experiencing saltwater intrusion - a challenge also affecting Beaver Creek and Depoe Bay. In addition to the saltwater intrusion at the plant's intake, the dikes surrounding the treatment ponds are considered vulnerable, and present a risk to operations. Gleneden Beach currently pumps its wastewater to Depoe Bay, but the system is already strained, necessitating planned upgrades to enhance capacity and resilience. The location of the WWTP means that the building facilities are vulnerable to exposure in a large local tsunami scenario, and the impoundment ponds are vulnerable even in a small distant tsunami scenario (DOGAMI 2019, 2021). This combination of factors poses a significant risk to the facility's operations and the environment, requiring proactive measures to enhance its resilience.

Low-Lying Areas Such as Taft and Cutler City: These low-lying communities situated along the estuary are particularly susceptible to a range of hazards. In addition to the ongoing threat of flooding, these neighborhoods face significant risks from tsunamis, earthquakes, and even wildfires, requiring comprehensive resilience strategies.

Given their proximity to the estuary, Taft and Cutler City are inherently susceptible to flooding, a risk amplified by sea level rise projections for the Oregon Coast (Sweet et al., 2017). Specific threats to the areas are associated with filled wetlands near water areas and infrastructure, which reduces resilience during flood events.

DOGAMI data confirms the high tsunami risk in these areas (Witter et al., 2013). The majority of Taft west and east of Highway 101 are vulnerable to exposure in a medium local tsunami scenario. A high likelihood of fatalities is anticipated in such a scenario for the majority of residents south of SW 65th Street in Cutler City. All of Cutler City is likely vulnerable even in a distant tsunami scenario.

Earthquake shaking in Lincoln City is expected to be most severe in Taft and Cutler City (DOGAMI *HazVu*, n.d.). Portions of Cutler City, particularly east of Highway 101, are highly vulnerable to wildfire. Highway 101 and other local roads in the Siletz Bay area are critical transportation corridors but may also be vulnerable to these hazards (ODOT, 2014). Disruptions to this route could hinder evacuation efforts and impede emergency response operations.

Siletz Keys: The Siletz Keys residential area is highly vulnerable to natural hazards due to its low-lying location and reliance on protective dikes. While there are currently no known structural concerns with the dikes, their failure would result in severe flooding, with potentially

devastating consequences for homes and infrastructure within the community. The surrounding lowlands are also at risk of inundation in a distant tsunami scenario, and residential structures are particularly vulnerable to exposure during a local CSZ earthquake and tsunami (DOGAMI, 2019).

The construction of Siletz Keys has significantly altered the hydrology of the bay. The landfill created for the development, along with the dike on Millport Slough, has disrupted natural flood discharge patterns. These modifications prevent floodwaters from dispersing into the south bay, instead channeling the full force of the Siletz River's flood discharge toward the back of Salishan Spit. This alteration has not only contributed to erosion concerns elsewhere in the bay but also heightened flood risks for nearby areas (Komar & Rea, 1975). Historical flood events in the lower Siletz River basin, such as those in 1996, 1998, and 1999, illustrate the persistent threat of riverine flooding in this region (Lower Siletz Basin Flood Mitigation Action Plan, 2000).

In addition to flooding risks, subsidence during a major CSZ earthquake could further exacerbate inundation hazards. Even smaller tsunami scenarios pose a risk to this low-lying area due to its elevation and proximity to tidal waters. These overlapping vulnerabilities underscore the importance of maintaining and monitoring flood protection infrastructure while preparing for potential earthquake and tsunami impacts (DOGAMI, 2021).

Image: Siletz Bay at SW 68th. By MKeane.

Depoe Bay

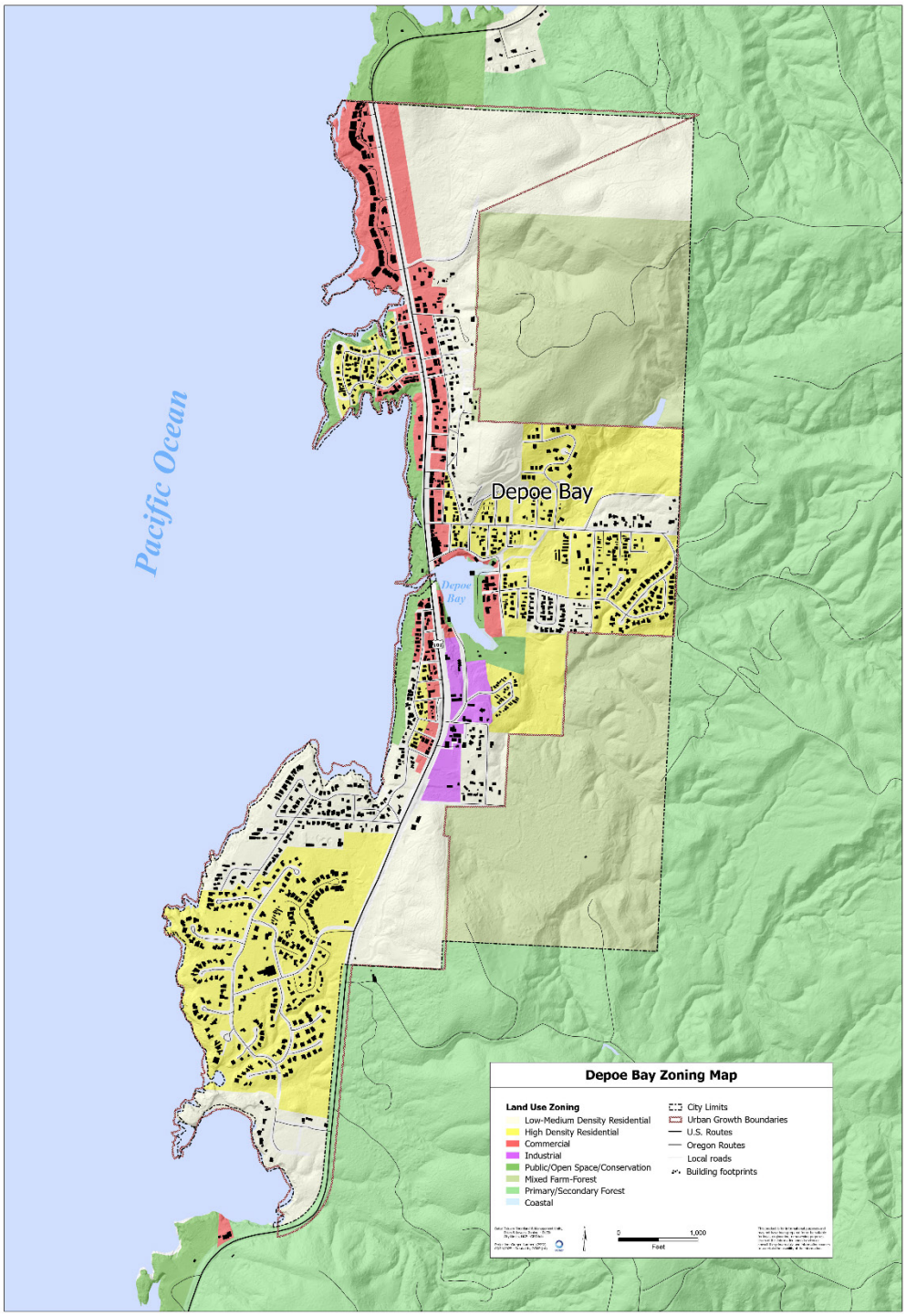

Figure 11. Depoe Bay estuary zoning map.

Depoe Bay, often referred to as the “world’s smallest navigable harbor,” is a unique estuarine environment. Unlike other estuaries along the coast, Depoe Bay is characterized by its small, enclosed harbor that opens directly into the Pacific Ocean through a narrow channel. The bay is fed by a small watershed, and its sheltered waters are surrounded by rugged cliffs and dense coastal forests.

Depoe Bay is renowned for its whale-watching opportunities, as gray whales are frequently spotted just offshore. The town of Depoe Bay, perched above the harbor, is a popular tourist destination, known for its scenic views and maritime heritage. The bay's unique geography and ocean access have made it a hub for recreational and commercial boating, as well as a center for marine research and education.

While Depoe Bay's estuarine features are less extensive than those of larger bays, it plays a vital role in the local ecosystem, providing habitat for a variety of marine and bird species. The estuary's small size and unique characteristics make it a distinctive feature of the Oregon Coast, blending natural beauty with cultural and economic activity. Efforts to manage and protect this delicate environment are essential to preserving its ecological integrity and supporting the local community.

Hazard Risk

Depoe Bay, known for its rugged coastline and small but active harbor, faces several significant natural hazard threats that pose risks to both the community and the local environment. **Tsunami** risk is a paramount concern due to the town's proximity to the CSZ. In the event of a major earthquake, Depoe Bay could experience devastating tsunamis, leading to widespread flooding, particularly in the low-lying areas near the harbor and along US Highway 101. The small, narrow harbor, while protected from minor coastal events, is especially vulnerable to damage from a tsunami, potentially disrupting marine activities and local economies.

Coastal erosion and landslides are also pressing issues, exacerbated by the area's steep cliffs and ongoing wave action. Sections of the highway and residential areas perched along these cliffs are at risk, particularly during heavy rains, which can trigger landslides that threaten infrastructure and property. Shaking from a 9.0 CSZ earthquake is projected to be most severe on the hillsides east of Highway 101. Infrastructure vulnerabilities are a significant concern, particularly the Depoe Bay Bridge and sections of Highway 101, which are vital for transportation and emergency access. Erosion and potential earthquake damage could severely impact these critical links, isolating the community.

While **wildfire** risk is less prominent than in more forested areas, the surrounding forested regions still pose a potential threat during dry summer months. Additionally, **flooding** during severe storms or extreme tides could impact low-lying areas near the harbor and along the shoreline, causing damage to homes, businesses, and local infrastructure.

Key Themes for Vulnerability

Harbor Infrastructure & Boating Community: The Depoe Bay harbor, a vital asset for the local economy and community, faces a range of challenges. The existing docks, some over 60 years old, have recently been replaced to improve accessibility and environmental sustainability, reflecting a proactive approach to modernization. However, king tides and potential sea level rise pose ongoing concerns about boat access to the fuel dock and unloading areas. The charter fishing fleet and fishing community, key stakeholders in Depoe Bay, are particularly sensitive to impacts on harbor infrastructure and access. While dredging of the harbor hasn't occurred in several years and is not currently scheduled, its importance necessitates future planning to address sediment accumulation and planning for the responsible placement of spoils.

Salmon Habitat and Water Quality: North Depoe Bay Creek and South Depoe Bay Creek are crucial for salmon spawning and migration, prompting ongoing restoration and maintenance efforts by the city's Salmon Enhancement Commission. The city's primary drinking water source, North Depoe Bay Creek, underscores the importance of protecting the entire drainage system. Water quality within the harbor is managed by the Harbor Commission.

Coastal Hazards and Infrastructure Vulnerability: While coastal bluff erosion is more of a concern outside the harbor, the 2011 tsunami highlighted the area's vulnerability to natural disasters. The replacement of damaged docks after the tsunami demonstrates a commitment to rebuilding and improving infrastructure. The main north-south roadway, Highway 101, and its aging bridge are also potential vulnerabilities that could impact emergency access and community connectivity, particularly affecting access to both creeks. There is a need to evaluate potential options to ensure the community continues to have access to transportation and access to services, especially emergency support.

Economic Sustainability and Funding: Depoe Bay faces significant financial challenges due to a limited local tax base. The city heavily relies on transient lodging taxes and system development charges to fund infrastructure improvements. Grant funding is essential for many projects, and the city is actively seeking additional funding sources for water, sewer, and housing initiatives. Although vacation rentals are limited, there is a continuing conversation around potentially zoning more areas for them and the city's reliance on tourism revenue. Efforts to acquire land and place it in public ownership are favored to protect it from development, signaling a shift towards prioritizing conservation and ecosystem services.

Emergency Preparedness and Water Interdependencies: Emergency preparedness is a critical issue, highlighted by the 2024 ice storm that left the community without power for several days. While a formal plan may be lacking, the Emergency Preparedness Committee is working to purchase supplies and improve logistics. Depoe Bay also provides potable water to the Rocky Creek area to the south, highlighting the interdependence of water systems in the region. Securing the watershed that feeds these critical drinking water supplies is of vital concern.

By addressing these challenges and concerns in a holistic manner, Depoe Bay can strengthen its resilience and ensure a sustainable future for its harbor, community, and natural environment.

Key Challenges

Water Quality Impairments: High temperatures, bacteria, and nutrients impair water quality, impacting aquatic life and human health.

Invasive Species: European green crab, *Spartina*, and other invasive species threaten native ecosystems and economic activities.

Habitat Degradation: Loss of tidal wetlands, eelgrass beds, and other critical habitats reduces biodiversity and ecosystem services.

Opportunities for Resilience

Improve Wastewater Treatment: Upgrade wastewater treatment facilities to reduce nutrient pollution and improve water quality.

Control Invasive Species: Implement targeted control measures to reduce the impacts of invasive species on native ecosystems and economic activities.

Restore Tidal Wetlands: Restore tidal wetlands to provide flood protection, improve water quality, and create habitat for fish and wildlife.

Specific Vulnerability Concerns

Boating and Waterfront Facilities: Depoe Bay's harbor, which serves both commercial and recreational fishing, faces several natural hazard vulnerabilities. The harbor's older docks are currently being replaced, highlighting ongoing concerns about their resilience. Waterfront facilities, including moorage areas, are susceptible to impacts from high water levels, such as king tides and sea level rise, which can affect accessibility and safety, particularly during challenging conditions like bar crossings. The fleet of charter fishing boats and recreational fishermen in the harbor are sensitive to these disruptions, which can impact their operations and the local economy. The harbor's vulnerability extends to tsunami risks, with waterfront facilities exposed even in a medium tsunami scenario, including areas upstream on South Depoe Bay Creek (DOGAMI, 2021), where there is a USACE check dam built in the 1950s/60s. Sea level rise poses an additional threat, with potential impacts on critical infrastructure along the Oregon Coast by 2050.

Silt buildup is rendering the fuel dock inaccessible at low tide and making it difficult to launch boats that draw more than two feet of water. This issue is exacerbated by recent clear-cut logging in nearby hills, which is likely increasing silt deposition in the harbor.

Salmon and Riparian Restoration: The City of Depoe Bay oversees a Salmon Enhancement Commission, which has identified restoration and maintenance of North Depoe Bay Creek as a priority. This creek is a crucial habitat for spawning salmon that migrate to and from a reservoir which serves as the primary source of local drinking water. Efforts to support salmon populations are vital for maintaining both ecological balance and the community's water supply.

Harbor Maintenance: The Depoe Bay harbor is in need of dredging, which has not been performed in several years. This maintenance is not currently scheduled by USACE, but it is essential for maintaining navigability.

Wastewater Management: The City's wastewater infrastructure is facing several challenges. The treatment plant, which temporarily processes wastewater from the Gleneden Beach area, is undergoing updates but still requires significant improvements. The sewer system is aging and in need of further upgrades, with a full separation of the wastewater systems projected to take over five years. Ensuring the resilience and efficiency of wastewater management is crucial for protecting public health and environmental quality.

Stanley Property: A 12-acre parcel off NE Stanley Street presents both opportunities and challenges. This steeply sloped land, zoned for residential use, has limited access but could be developed for residential purposes or nature-based solutions such as a multi-use green space. Effective planning and development could leverage this area to enhance local resilience and contribute to community growth and resilience.

Estuary Management Plan: The City's 1991 Estuary Management Plan needs updating to reflect current conditions and emerging challenges. An updated plan will better address contemporary issues such as climate change and sea level rise, and guide future management practices to ensure the estuary's health and the community's well-being.

Yaquina Bay

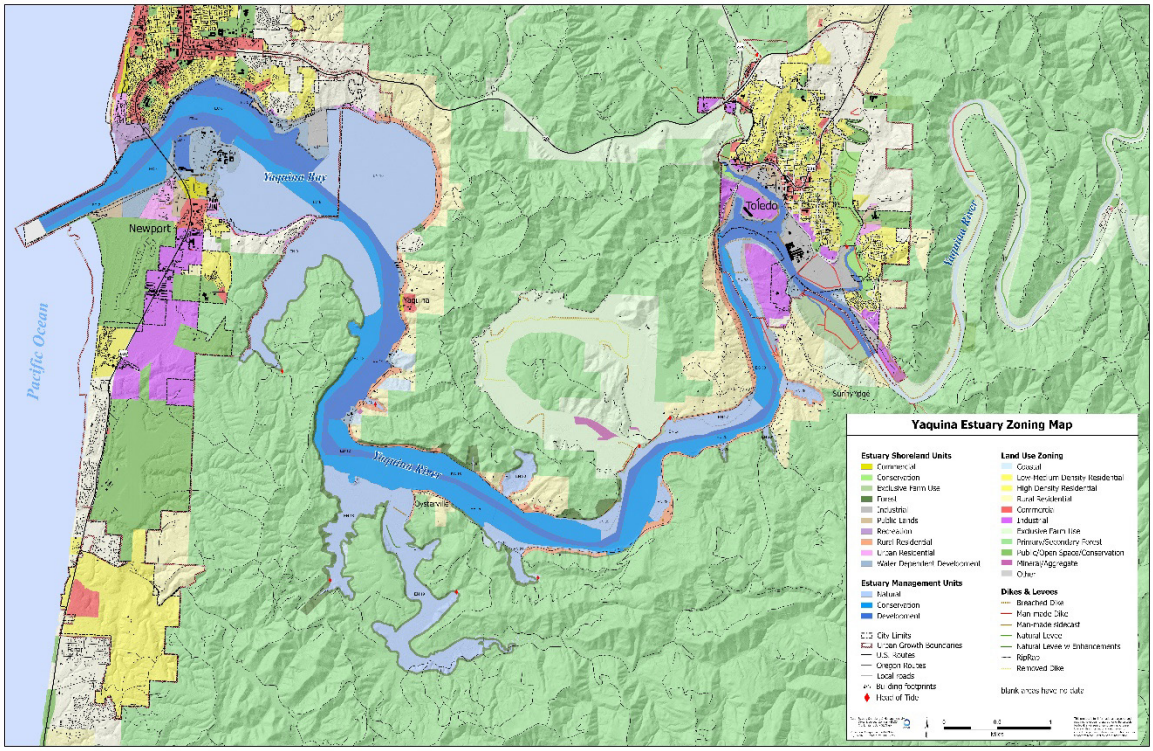

Figure 12. Yaquina Bay estuary zoning map.

Yaquina Bay is one of the larger and more developed estuaries on the Oregon Coast, centered around the city of Newport. The estuary is characterized by its deep-water port, extensive tidal flats, and salt marshes, which support a rich array of marine life, including commercially important species like Dungeness crab and salmon. Covering approximately 2,048 acres, the bay is fed by the Yaquina River and several smaller tributaries, and its waters mix with the Pacific Ocean through a narrow inlet protected by navigational jetties. The estuary is maintained at a depth of 22 ft through dredging, with depth decreasing upstream due to shoals, tidal flats, and other shallow zones.

The estuary is home to a diverse array of fish and shellfish, including Chinook and coho salmon, Pacific herring, ghost shrimp, and various clam species. Over 56 species of fish have been identified in Yaquina Bay, highlighting its ecological significance. The estuary also supports over 30 species of conservation concern including threatened coho salmon. The estuary serves as a critical nursery ground for juvenile fish, crabs, and migratory shorebirds, with its tidal wetlands, eelgrass beds, and mud flats providing essential habitat. The estuary's diverse habitats also provide crucial environments for species like perch, rockfish, greenling, and cabezon. Many of

these species play important roles in the ecosystem and support both recreational and commercial fisheries.

The estuary's rich ecosystem supports a wide variety of wildlife. Millions of birds migrate annually along the Pacific Coast, using Yaquina Bay as a vital rest stop. Common species include Black Brant, Brandt's Cormorant, Great Blue Heron, Dunlin, and various duck species such as American Widgeon and Bufflehead. Less common species like the Long-tailed Duck and Harlequin Duck can also be spotted. Birds of prey, including Bald Eagles, Osprey, and Peregrine Falcons, frequent the area. Marine mammals, such as harbor seals and California sea lions, are also often seen resting along the shore or feeding in the open-water habitat.

The surrounding habitats, including the estuarine wetlands and adjacent upland forests, provide critical ecosystem services, such as nutrient cycling and storm protection. Yaquina Bay has faced environmental challenges, including pollution from industrial and urban runoff, invasive species, and habitat loss. Ongoing conservation and restoration initiatives aim to address these issues, ensuring the bay remains a vibrant and productive ecosystem.

Historically, Yaquina Bay has been a hub of economic activity, from Native American settlements to modern commercial fishing, shipping, and tourism industries. The bay is named after the Yaquina people, who now belong to the Confederated Tribes of Siletz Indians. The estuary's importance grew with the completion of a road connecting it to the Willamette Valley in 1873, followed by a railroad in 1884 (CoastView, 2024).

Today, Yaquina Bay is home to several significant marine research and educational institutions. HMSC, operated by OSU, is a leading coastal and marine research facility. Adjacent to HMSC is the NOAA Marine Operations Center - Pacific (MOC-P), which serves as the homeport for two NOAA ships and provides support to the entire NOAA Pacific fleet (NOAA, 2023). These facilities contribute to Newport's reputation as a hub for marine science and research. The Newport marina, located in the historic bayfront area, is a focal point for both commercial and recreational boating activities. It supports one of Oregon's largest commercial fishing fleets, which plays a crucial role in the local economy and contributes to Newport's identity as a working waterfront (Port of Newport, n.d.). Another major attraction in Newport is the Oregon Coast Aquarium, a world-class facility that showcases the diverse marine life of the Pacific Northwest. The aquarium, which opened in 1992, attracts around 450,000 visitors annually and is consistently ranked among the top aquariums in North America.

The Yaquina Bay Bridge, built in 1936 to replace a ferry, has become an iconic landmark and a testament to the area's development. Today, Newport, with its population of approximately 10,000, serves as a popular tourist destination along US Highway 101, while the smaller town of Toledo upriver maintains a pulp mill industry. The estuary extends approximately 26 miles upstream from Newport to Toledo, with tidal influence reaching as far as Elk City, showcasing the extensive reach of this important coastal ecosystem.

The combination of these marine-focused institutions, along with Newport's natural beauty and coastal charm, has made the city a popular tourist destination. Visitors are drawn to attractions such as the historic lighthouses, scenic beaches, and the bustling bayfront area with its mix of seafood restaurants, shops, and art galleries. This thriving tourism industry, alongside the commercial fishing sector and marine research facilities, forms the backbone of Newport's diverse and vibrant coastal economy.

Hazard Risk

Yaquina Bay faces several significant natural hazard risks that could impact both its ecological health and surrounding communities. Coastal **flooding** is a major concern, particularly affecting low-lying areas such as the Newport Historic Bayfront and the residential neighborhoods along the bay. High tides, storm surges, and sea level rise can lead to occasional inundation of these areas, potentially disrupting local infrastructure like the Yaquina Bay Bridge and nearby roads, including Highway 101, which are critical for transportation and emergency services. Rising sea levels are likely to exacerbate coastal flooding, particularly in low-lying areas such as the Newport waterfront, potentially leading to more frequent and severe inundation events. Yaquina Bay's confined topography is likely to result in losses of tidal land area across all sea level rise scenarios. Further up the estuary, locations like Boone-Nute Slough are at risk of increased flooding and saltwater intrusion. These impacts could undermine flood protection infrastructure, disrupt local communities, and damage residential, commercial, and public properties. Additionally, sea level rise could lead to the loss of critical habitats and affect local ecosystems, compounding challenges faced by both natural systems and human infrastructure.

Tsunami risk poses a significant threat to the Yaquina Bay area, including its more inland reaches. In the event of a major seismic event along the CSZ, the Newport waterfront and Yaquina Bay Bridge could face severe damage and inundation. This risk extends further up the estuary, impacting areas such as Boone-Nute Slough and the City of Toledo. In these locations, a tsunami could lead to substantial flooding, potentially overwhelming flood protection systems and causing extensive damage to infrastructure. The inundation could disrupt local communities, damage residential and commercial properties, and impact critical services, including transportation routes and utilities.

Erosion is another pressing issue, with potential for impacts along waterfront areas, such as those around the Newport Marina and the South Beach area, which are vulnerable to shoreline retreat and sediment loss. This erosion threatens both natural habitats and built infrastructure, potentially leading to the destabilization of waterfront properties and recreational facilities.

The Yaquina Bay Bridge, an essential transportation link, is at elevated risk from seismic activity due to its location along the CSZ. A **major earthquake** could severely impact the bridge's structural integrity, disrupting access and emergency response capabilities in the region.

Saltwater intrusion poses an additional risk, affecting freshwater resources and agricultural lands around Yaquina Bay. Rising sea levels and increased storm surge exacerbate this issue, compromising water quality and soil health.

Key Themes for Vulnerability

Climate-Ready Planning: Yaquina Bay's Estuary Management Plan recently went through an update process and incorporated more climate-ready policies, but other local plans and policies frequently lack actionable thresholds for climate risks such as sea level rise and flooding, leaving critical areas like South Beach exposed to future hazards. The Newport Municipal Airport, while situated above the tsunami inundation zone, faces potential instability due to its construction on fill material, highlighting the need for comprehensive infrastructure assessments in climate adaptation planning.

Habitat & Water Quality: Eelgrass beds in Yaquina Bay are under threat from rising temperatures and sedimentation, jeopardizing critical fish spawning habitats. These changes can severely impact aquatic ecosystems, including nursery areas for juvenile fish and invertebrates. Dredging activities, while necessary for maintaining navigation channels, have altered benthic habitats and tidal exchange patterns. OSU Fisheries studies have documented these changes, underscoring the delicate balance between economic needs and ecological health.

Economic & Social Values: Yaquina Bay's economy relies heavily on its estuary health, supporting commercial fishing, aquaculture, and tourism. Recent initiatives, such as oyster restoration projects in Poole Slough, demonstrate efforts to integrate ecological resilience with economic stability. However, balancing these interests requires careful planning and innovative approaches to ensure long-term sustainability of both natural resources and local livelihoods.

Key Challenges

Climate Change Impacts: Sea level rise, increased storm intensity, and altered precipitation patterns threaten infrastructure and habitats.

Water Quality Degradation: Agricultural runoff, urban stormwater, and legacy pollutants impair water quality, impacting aquatic life and recreational opportunities.

Habitat Loss and Fragmentation: Development, dredging, and invasive species contribute to the loss of critical habitats such as eelgrass beds and tidal wetlands.

Opportunities for Resilience

Implement Green Infrastructure: Utilize nature-based solutions to manage stormwater, reduce erosion, and enhance habitat connectivity.

Restore Tidal Wetlands: Restore tidal wetlands to provide flood protection, improve water quality, and create habitat for fish and wildlife.

Engage Stakeholders: Foster collaboration among government agencies, local communities, and private landowners to develop and implement effective resilience strategies.

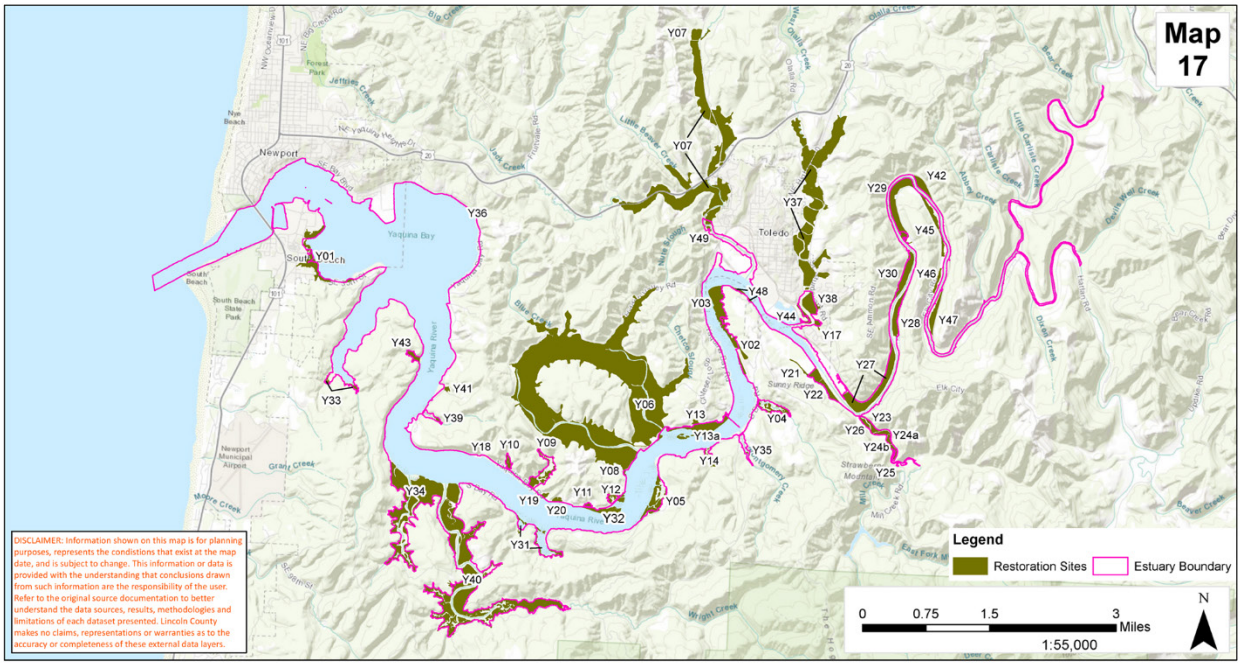

Figure 13. Priority restoration sites identified in the Yaquina Bay Estuary Management Plan (2025).

Specific Vulnerability Concerns

South Beach Area: The South Beach area of Newport, including HMSC, Port of Newport, Oregon Coast Aquarium, and NOAA facilities, faces significant vulnerabilities to natural hazards. This area is particularly susceptible to tsunamis, sea level rise, and storm surges due to its low-lying coastal location.

The risk of a tsunami striking South Beach is substantial, with the area being highly vulnerable even in a medium tsunami scenario. South Beach State Park faces a high likelihood of fatalities in an XXL scenario (DOGAMI, 2021). Tsunamis pose a significant threat to coastal communities, with the risk of a tsunami being approximately 100 times greater than the risk of a tornado occurring anywhere in the United States (FEMA, 2006). Seismic activity poses another significant threat. Shaking from a 9.0 CSZ earthquake is expected to be most severe in the central South Beach area (DOGAMI NHRR, 2020). Following such an earthquake, a major tsunami could reach the area in as little as fifteen minutes (NOAA Teacher at Sea Blog, n.d.).

HMSC and other marine research facilities rely heavily on sophisticated seawater distribution systems. The seawater intake system at HMSC, crucial for marine research, could be compromised during a disaster. In August 2021, $5 million was approved to improve this system, including replacing the causeway and pump portions that take seawater from Yaquina Bay (HMSC, 2021).

Climate change impacts are expected to exacerbate these risks, potentially increasing the frequency and extent of storm surge flooding due to sea level rise. This could threaten the integrity of critical infrastructure and hinder its use (City of Newport Comprehensive Plan, 2019).

The local sewer systems in the area are also at risk of being compromised during a disaster, which could lead to pollution events.

To address these vulnerabilities, efforts have been made to improve evacuation routes and assembly areas. The Safe Haven Hill project has created an easily identifiable evacuation route and short-term assembly area that people can reach quickly, which is critical for ensuring the safety and resilience of the South Beach community (FEMA, 2020).

35th Street and Idaho Point Area: The 35th Street area in Newport faces multiple vulnerabilities related to flooding, infrastructure, and ecological concerns. The culvert at 35th Street requires upgrading to address current and future flooding risks, and the City of Newport has identified this site in their Capital Improvement Plan. The culvert upgrade could be coupled with salt marsh restoration, which would provide additional benefits as natural buffers against storm surges and offer essential wildlife habitat. Salt marsh restoration through measures like dike removal has been considered for coastal protection and ecosystem services along the Oregon Coast.

Idaho Flats, recognized as an important habitat for numerous species, is ecologically significant, and any vulnerabilities in this area could have substantial environmental impacts. The adjacent residential area of Idaho Point is low-lying and particularly susceptible to flooding and sea level rise. Residents in this area rely on 35th Street, which is itself vulnerable, raising concerns about access and evacuation during emergencies.

The combination of infrastructure upgrades, habitat restoration, and addressing the vulnerabilities of low-lying residential areas presents a complex challenge for Newport's resilience planning. These issues highlight the interconnected nature of infrastructure, ecology, and community safety in coastal areas facing increasing climate-related risks.

King Slough: King Slough and the adjacent Yakona Nature Preserve present interconnected ecological and infrastructural vulnerabilities. King Slough's high water quality supports critical habitat and aquaculture potential, including an oyster bluff on its eastern shore with an aquaculture operation in development. However, two vulnerable dikes protecting SE Harborton Street, a key access route crossing the backend of the slough, pose risks to both infrastructure and ecological integrity. These dikes are essential for maintaining connectivity to the Yakona Nature Preserve & Learning Center, a 439-acre protected Sitka spruce forest on the eastern peninsula that serves as an educational and cultural resource while supporting wildlife such as black bears, elk, and Bald Eagles (Yakona Nature Preserve, 2024). The Yakona peninsula faces elevated landslide risks, with susceptibility rated high to very high on both slopes (DOGAMI NHRR, 2020). The combination of steep topography and the preserve's location along Yaquina Bay increases exposure to compound hazards, including seismic activity and erosion. SE Harborton Street's vulnerability underscores broader challenges: its failure could isolate the preserve, disrupt aquaculture operations in King Slough, and compromise emergency access.

Sally's Bend: Sally's Bend, located on the north side of Yaquina Bay, contains tidal flats that provide critical habitat for a wide variety of species. This area features extensive native eelgrass (*Zostera marina*) meadows, which are vital to the ecological health of the estuary (ODFW, 2021). Eelgrass beds at Sally's Bend form dense underwater meadows that serve as nurseries for juvenile fish and shellfish, including commercially important species such as salmon, Dungeness crab, and Pacific herring. These meadows contribute to water quality by filtering pollutants and absorbing excess nutrients, while their root systems stabilize sediments and reduce erosion. The ecological importance of Sally's Bend is further underscored by its role in carbon sequestration. Eelgrass meadows are highly efficient at capturing and storing carbon, helping to mitigate climate change impacts.

The area surrounding Sally's Bend faces multiple considerations. A liquefied natural gas (LNG) plant is located in this low-lying area, which is subject to potential impacts from sea level rise, storm surges, and other climate-related changes. Landslide susceptibility is rated very high along the surrounding hillsides (DOGAMI NHRR, 2020), and the low-lying nature of Sally's Bend makes it susceptible to tsunami inundation (DOGAMI, 2019). These factors highlight the complex interplay between industrial infrastructure, natural hazards, and ecological resources in this area.

Yaquina Bay Road Area: The Yaquina Bay Road area faces multiple natural hazards that threaten infrastructure, water quality, and local communities. Sawyer's Landing RV Park, located in a low-lying area along Yaquina Bay Road, is particularly vulnerable to flooding, sea

level rise, and potential tsunami inundation (DOGAMI, 2012). Several low crossings along Yaquina Bay Road are also at risk, which could hinder access and evacuation during emergencies.

The tide gates at the entrance to Boone-Nute Slough are critical for managing water levels and preventing saltwater intrusion. However, there is concern about the effectiveness of these tide gates and local partners are considering removing them and weighing potential options for regulating tidal exchange. Saltwater intrusion has already begun to affect water quality further up the sloughs, impacting local farming activities. These sloughs, important habitats for various species, face water quality challenges from agricultural runoff and other sources (DEQ, 2021).

Landslide susceptibility is rated high to very high along portions of Yaquina Bay Road, including at Boone-Nute Slough (DOGAMI NHRR, 2020). The area's steep slopes and geologic conditions contribute to instability, particularly during heavy rainfall or seismic events. Additionally, the shoreline along Yaquina Bay Road is subject to erosion, especially during storm events.

Wildfire risk is also rated high throughout Boone-Nute Slough and other portions of Yaquina Bay Road (DOGAMI NHRR, 2020). The combination of wildfire hazards, landslide susceptibility, flooding risks, and long-term sea level rise projections creates a complex hazard landscape for this area.

Upper portions of the estuary, particularly around Boone-Nute Slough, have been identified as critical zones for landward migration. These areas offer relatively undeveloped uplands that could allow tidal wetlands to migrate inland as sea levels rise. The area around Sawyer's Landing and the tidal flats near Sally's Bend also presents opportunities for habitat migration and restoration.

South Bay Road: South Bay Road, connecting Oysterville and Sunnyridge, faces multiple vulnerabilities related to flooding, sea level rise, and landslides. The road includes several low-lying crossings over tidal wetlands that are at risk, including those at Flescher Slough, Alexander Creek, Montgomery Creek, and Babcock Creek. These areas are particularly susceptible to inundation during high tides and storm events. ODOT has identified several of these bridges and crossings as vulnerable to climate change impacts, including increased flooding and erosion. Portions of South Bay Road near these crossings could experience regular flooding with just 1-2 feet of sea level rise, which is projected to occur by mid-century under moderate emissions scenarios (NOAA, 2025). ODOT's Climate Change Adaptation Strategy Report highlights the need for infrastructure upgrades to improve resilience (ODOT, 2021).

Landslide risk is also a significant concern along South Bay Road. Landslide susceptibility is high to very high in many spots along South Bay Rd, particularly in the reach from Alexander Creek to Toledo (DOGAMI NHRR, 2020).

Toledo Waterfront: The Georgia-Pacific Mill on the Toledo waterfront may be at risk due to its proximity to water and vulnerability to natural hazards. The mill's settling ponds are particularly

susceptible to sea level rise, earthquakes, and tsunamis, posing potential threats to downstream ecosystems and communities. Some of the waterfront industrial areas in Toledo, including the mill property adjacent to Tokyo Slough, are vulnerable to inundation in a medium tsunami scenario (DOGAMI, 2021). In an XXL tsunami event, nearly all of the low elevation waterfront areas, including downtown around A Street, would be at risk. While there are no current issues with their integrity, the settling ponds at the Georgia-Pacific mill are a focal concern for hazard impacts. These ponds, which hold wastewater from the pulp and paper production process, could be compromised by seismic activity or extreme flooding events. A breach in the levees for these ponds could have significant environmental impacts on the Yaquina River and surrounding areas.

Tokyo Slough, a manmade feature constructed to expand the industrial waterfront north from the Yaquina River, presents additional challenges. As a designated wetland and Brownfield site, it faces complex environmental and regulatory issues (OCWCOG, 2022). The property line is split between the Port of Toledo and Georgia-Pacific, complicating management and mitigation efforts. The OCMP Regional Solutions Team has noted that addressing the challenges at Tokyo Slough will be difficult due to planning and code issues. These complexities, combined with the site's vulnerability to inundation, create a significant hazard threat that requires careful consideration and potentially extensive mitigation efforts. As a result, the property owners plan to no longer utilize the slough, and allow natural estuarine conditions to prevail.

Yaquina Bay Bridge: The Yaquina Bay Bridge, a critical transportation link in Newport, Oregon, faces significant seismic vulnerabilities. According to ODOT’s Seismic Vulnerability of Oregon State Highway Bridges report, bridges built before 1970 have no seismic design considerations, making them highly susceptible to damage or collapse in a major earthquake (ODOT, 2009). The Yaquina Bay Bridge, constructed in 1936, falls into this category.

ODOT's Bridge Condition Report indicates that while a major cathodic protection project on the Yaquina Bay Bridge was completed in 2023, seismic retrofits remain a pressing concern (ODOT, 2023). The Oregon Seismic Plus Report outlines a comprehensive program to address seismic vulnerability and mitigate structural deficiencies in Oregon's highway system. This report emphasizes the importance of retrofitting or replacing key bridges like the Yaquina Bay Bridge to ensure post-earthquake functionality (ODOT, 2014). DOGAMI's Tsunami Hazard Map of the Yaquina Bay Area warns that bridges may fail in the event of an earthquake and advises consulting with government transportation authorities about the seismic stability of bridges used for evacuation (DOGAMI, 2013). This is particularly relevant for the Yaquina Bay Bridge, which serves as a crucial evacuation route.

The bridge's vulnerability extends beyond seismic risks. Its coastal location exposes it to potential erosion and flooding, exacerbated by sea level rise and increasing storm surges. These factors could compromise the bridge's foundations and structural integrity over time. The potential failure of the Yaquina Bay Bridge during a disaster would have severe implications for

emergency response, evacuation efforts, and long-term economic recovery in the Newport and central coast area.

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These site-specific concerns highlight the need for targeted interventions in critical areas along this highly-trafficked part of the Oregon Coast. Upgrading infrastructure, restoring natural habitats, and implementing mitigation strategies are essential steps in protecting these vulnerable estuaries and surrounding communities from the impacts of climate change.

Image: Yaquina River. By Cinamon Moffett.

Alsea Bay

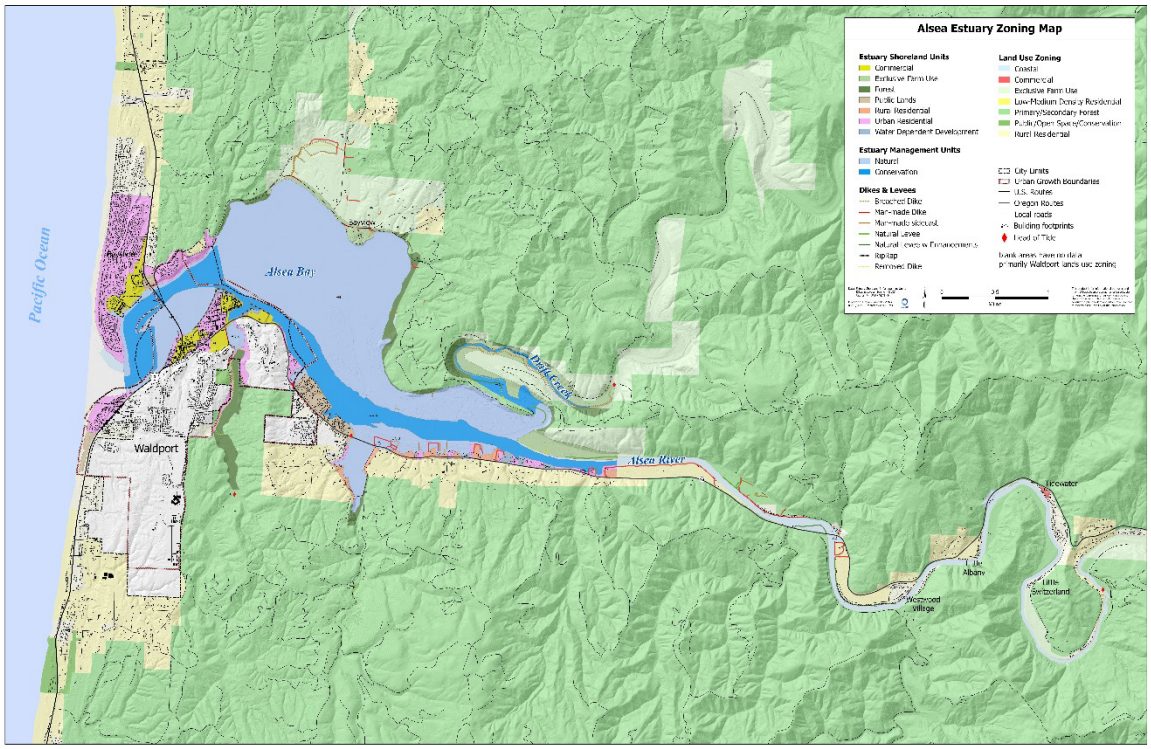


Figure 14. Alsea Bay estuary zoning map.

Alsea Bay, located near the town of Waldport, is known for its wide sandy beaches, salt marshes, and eelgrass beds. The bay is formed by the Alsea River, which flows into the Pacific Ocean, creating a dynamic environment influenced by tidal and riverine processes. This estuary is an important habitat for salmon, crabs, clams, and a variety of bird species, making it a popular spot for fishing, birdwatching, and other recreational activities. The physical features of Alsea Bay, including its tidal flats and surrounding forested hills, provide a scenic backdrop to the small, close-knit community of Waldport. The estuary is noted for its meandering tidal channels that weave through extensive mudflats and marshes before opening into the broad mouth of the bay at the Pacific Ocean. Additionally, the Alsea River's North Fork/Drift Creek contributes to the estuary's diverse hydrology, supporting a range of habitats that are essential for local wildlife.

The ecological diversity of Alsea Bay has supported human communities for thousands of years. Prior to European settlement, the Alsea band of the Confederated Tribes of the Siletz Indians historically populated the area, with over 50 villages and fishing, hunting, and gathering sites located throughout the lower estuary. The Alsea people were skilled seal and sea lion hunters, using canoes to navigate the estuary while collecting shellfish, anadromous fish, and various plants for food, medicine, and cultural practices.

Historically, Alsea Bay has been shaped by both natural processes and human activities. The construction of the Alsea Bay Bridge, a notable landmark on US Highway 101, has had a lasting impact on the area's infrastructure and accessibility. The estuary has also been affected by logging, agriculture, and urban development, which have contributed to changes in water quality and habitat conditions. During the height of industrial activity, five canneries operated on the bay, reflecting its economic importance to the region.

In recent years, efforts have been made to restore and protect the estuary, focusing on enhancing fish habitat and improving water quality. These conservation efforts align with the area's longstanding importance to Indigenous communities and its vital role in supporting wildlife. For over 25 years, the Tribe and conservation groups have prioritized the preservation of this ecologically and culturally significant area.

Hazard Risk

The Alsea Bay estuary faces several pressing natural hazard risks that impact its ecological health and surrounding communities. These risks include flooding, erosion, tsunami threats, and water quality issues, among others.

Heavy rainfall and **storm surges** can lead to significant inundation of the estuary and its surrounding lands. Low-lying areas of US Highway 101 and OR 34 are vulnerable to **flooding**, which could disrupt transportation and access to essential services in the region. Residential areas and commercial properties in Waldport, including waterfront businesses, are also at risk of damage from floodwaters, which can lead to substantial economic losses and disruptions in daily life. Residential areas along OR 34 in the back bay are also vulnerable.

Erosion threatens the western shorelines of Alsea Bay, where active coastal and riverbank erosion can undermine natural habitats and infrastructure. For example, the loss of wetlands along the bay's western edge reduces critical fish spawning and nursery areas, impacting local salmon populations. Erosion also affects nearby infrastructure, including sections of OR 34 and properties along the shoreline, leading to potential structural damage and increased maintenance costs. The continual erosion contributes to sedimentation in the estuary, which can degrade water quality and disrupt ecological functions.

Alsea Bay is also at risk from potential **tsunami** events, which could cause severe inundation of coastal areas. A significant tsunami could lead to widespread damage to infrastructure such as the OR 34 bridge over McKinney Slough, which ODOT has identified as structurally deficient, as well as impacts to other waterfront properties.

Projected **increases in sea levels** could lead to more frequent and severe flooding events, impacting low-lying areas such as downtown Waldport and tidal wetlands. Rising sea levels can accelerate shoreline erosion, threatening infrastructure and increasing the risk of damage to coastal properties. Additionally, **saltwater intrusion** into freshwater systems due to sea level

rise can affect water quality and disrupt habitats for species such as salmon and other fish, leading to ecological imbalances.

Local **water quality** is challenged in numerous ways. Agricultural runoff and leaking septics throughout the area are likely resulting in eutrophication and harmful algal blooms, affecting marine life and degrading local water quality.

Key Themes for Vulnerability

Water Quality & Invasives: Alsea Bay is grappling with persistent water quality issues, being listed as an impaired water body under Section 303(d) of the Clean Water Act. Temperature and sedimentation are primary concerns, with TMDL development delayed until 2030 or beyond. This delay hinders effective management of water quality challenges. Additionally, invasive species such as European green crab and nutria are degrading marsh habitats and competing with native species, further compromising the estuary's ecological integrity.

Tide Gate & Infrastructure Challenges: Aging tide gates, such as those at the Bayview Oxbow, are limiting tidal wetland restoration opportunities and increasing flooding risks in the Alsea River estuary. These infrastructure challenges are compounded by community resistance due to costs and lack of local advocacy for upgrades. Addressing these issues requires a delicate balance of technical solutions, funding mechanisms, and community engagement to build support for necessary improvements.

Resilience Opportunities: Despite these challenges, Alsea Bay presents significant opportunities for enhancing resilience. Recent restoration efforts, such as the 2024 project at The Wetland Conservancy's Starr Creek Preserve, demonstrate the potential for improving tidal wetland habitats. Promoting beaver restoration in appropriate areas of the watershed could enhance wetland resilience and mitigate impacts of drought and wildfire. Priority sites like Barclay Meadow and Drift Bend Oxbow offer potential for collaborative restoration projects, leveraging funding from sources such as NRCS and local land trusts to improve ecosystem function and community resilience.

Key Challenges

Water Quality Impairments: High temperatures, bacteria, and nutrients impair water quality, impacting aquatic life and human health.
Invasive Species: European green crab, *Spartina*, and other invasive species threaten native ecosystems and economic activities.
Habitat Degradation: Loss of tidal wetlands, eelgrass beds, and other critical habitats reduces biodiversity and ecosystem services.

Opportunities for Resilience

Improve Wastewater Treatment: Upgrade wastewater treatment facilities and septic systems to reduce nutrient pollution and improve water quality.

Control Invasive Species: Implement targeted control measures to reduce the impacts of invasive species on native ecosystems and economic activities.

Restore Tidal Wetlands: Restore tidal wetlands to provide flood protection, improve water quality, and create habitat for fish and wildlife.

Specific Vulnerability Concerns

Bayshore Spit: The Bayshore Spit, located at the mouth of Alsea Bay, faces significant vulnerabilities to multiple natural hazards. The low-lying areas of the spit are particularly susceptible to sea level rise, earthquakes, and tsunamis, putting many residents at risk. A substantial portion of the spit is vulnerable to inundation in a medium tsunami scenario. In an XXL tsunami event, there is a high likelihood of fatalities for the majority of the area south of Marineview Drive (DOGAMI, 2021). The spit's vulnerability is exacerbated by its geological setting, as it is expected to experience the most severe shaking during a 9.0 CSZ earthquake (DOGAMI NHRR, 2020).

The Bayshore Dune Management Plan[31] highlights the area's susceptibility to erosion and sand deposition. The oceanfront residences in the southern part of Bayshore are located within a foredune on a sand spit adjacent to an uncontrolled outlet for the Alsea River. This setting elevates the risk of erosion by ocean waves during large wave events (Sonnevil & Minster, 2012).

Historical analysis reveals that much of Alsea Spit was a low-lying expanse of bare sand in 1939, with scattered vegetation. By 1952, vegetation had increased, but the area remained vulnerable. The spit's morphology and sand dynamics contribute to its instability, with strong southerly winds causing significant sand deposition during winter storms (Sonnevil & Minster, 2012).

Highways: US Highway 101 and OR 34 face significant vulnerabilities that could disrupt critical transportation links in the Alsea Bay area. The Highway 101 Alsea Bay Bridge is at risk of damage from earthquakes, which could severely impact this crucial coastal transportation route. Oregon bridges built before 1990 lack modern seismic design considerations, making them highly susceptible to damage or collapse in a major earthquake (ODOT, 2009). This

[31] https://www.srwd.org/files/4cd5dea7a/Bayshore+Dune+Management+Plan+2012.pdf

vulnerability is particularly concerning for the Alsea Bay Bridge, as it serves as a critical link along Highway 101.

Flooding is another significant concern for Highway 101 near Driftwood Village and Friday Creek. Many sections of this highway are highly susceptible to coastal hazards such as erosion, wave action, storm surge, and flooding (ODOT, 2019). Recent events have demonstrated this vulnerability, with sections of Highway 101 being shut down due to flooding as recently as December 2023.

OR 34, the primary east-west route connecting the coast to the Willamette Valley, faces its own set of challenges. The highway's low crossings, such as the bridges over Lint and McKinney Sloughs and the levee crossing at Eckman Lake, are vulnerable to inundation. These low-lying areas along the back bay are at risk from sea level rise and increased storm surge intensity, potentially compromising the highway's reliability as an evacuation route and lifeline to critical services.

East of Eckman Lake to Drift Creek, OR 34 is highly vulnerable to wildfire. The Oregon Statewide Wildfire Hazard Map[32] classifies this area as having a high wildfire risk, underscoring the need for mitigation strategies to protect this critical transportation corridor (DOGAMI NHRR, 2020).

Downtown Waldport: Downtown Waldport faces significant vulnerabilities to flooding, tsunamis, and earthquakes, particularly in its waterfront area. The Port of Alsea, nearby businesses, residences, and the Bayview Mobile Home Park are especially susceptible to flooding during high tides and storm events (DOGAMI, 2013). Erosion along the Alsea Bay shoreline in Waldport is a persistent concern, exacerbated by winter storms and changes in intertidal channels (DOGAMI, 2013). This erosion increases the flood risk in the area. All of downtown Waldport is susceptible to inundation in a medium tsunami scenario, with significant exposure in the coastal parts of town in an XXL scenario. The risk is compounded by the fact that most of Old Town Waldport was built on landfill, which can amplify seismic shaking and increase liquefaction potential during earthquakes (DOGAMI, 2021).

Lint Slough: The Lint Slough area offers notable potential for tidal wetland restoration, which could improve habitat conditions for estuarine species and enhance flood resilience by allowing for natural water storage and dissipation during storm events. Restoration efforts here could also contribute to the overall health of the Alsea River estuary, supporting fish and wildlife populations while mitigating some flood risks.

However, Lint Slough may be highly vulnerable to natural hazards. Inundation is likely in a medium tsunami scenario, with the area at risk of significant flooding during such an event (DOGAMI, 2021). Landslide susceptibility is another critical concern, with high and very high susceptibility zones identified on the west and east sides of the slough, respectively (DOGAMI

[32] https://hazardmap.forestry.oregonstate.edu/

NHRR, 2020). These risks are compounded by the steep slopes and unstable geologic conditions that characterize much of the surrounding terrain.

Bayview Road: Bayview Road faces multiple hazards that threaten its stability and the surrounding ecosystem. Several low-lying sections of the road are experiencing erosion and are prone to flooding and landslides. This vulnerability is exacerbated by the area's high susceptibility to tsunami inundation and severe shaking from a potential 9.0 CSZ earthquake (DOGAMI NHRR, 2020).

There is substantial potential for restoring former tidal wetlands in the Bayview Oxbow area. A culvert at the mouth of the oxbow currently acts as a fish passage barrier and limits tidal exchange. Upgrading this structure with a more fish-friendly culvert and possible bridge replacement would offer significant benefits for salmon and other species, improving habitat connectivity and estuarine function in this part of Alsea Bay (MCWC, 2020). The ongoing Bayview Oxbow restoration project aims to restore tidal and estuarine function, promoting wetland wildlife and generating community resilience to projected sea level rise. These restoration efforts could help mitigate some flood risks by allowing for natural water storage and dissipation during storm events.

However, the surrounding hillsides have high to very high landslide susceptibility (DOGAMI NHRR, 2020). This risk is compounded by the potential for severe shaking during a major earthquake, which could trigger numerous landslides and debris flows, potentially impacting Bayview Road and nearby infrastructure.

Eckman Lake: Eckman Lake faces multiple interconnected challenges related to flooding, water quality, and infrastructure. The OR 34 levee at Eckman Lake requires upgrading to address flooding risks, particularly in light of projected sea level rise. Central Oregon coastal areas are experiencing relative sea level rise rates of 1-3 mm/year, which could exacerbate flooding issues in low-lying areas like Eckman Lake (OCCRI, 2021).

Water quality is a major concern for Eckman Lake, with HABs being a recurring problem. In September 2024, OHA issued a recreational use advisory for Eckman Lake due to a cyanobacteria bloom and high saxitoxin concentrations of 24.0 µg/L at WB Nelson State Recreation Site (OHA, 2024). These blooms pose significant risks to human and animal health, with symptoms ranging from stomach cramping and nausea to more severe neurological effects. The HABs are likely exacerbated by nutrient pollution from leaking septic systems around the lake. Older septic systems in the area may be contributing to elevated nitrogen and phosphorus levels, which fuel cyanobacterial growth (YachatsNews, 2022).

Roads and old tide gates around Eckman Lake need improvements to protect local residential access and manage water levels. However, a better understanding of upstream inputs is required to effectively address the lake's water quality issues. The lake's stratification,

influenced by incoming saltwater from the spillway during high tides, halts lacustrine mixing and further complicates water quality management (OHA, 2024).

North Channel: A breached dike in the North Channel is acting as a hydraulic impediment, potentially affecting local water flow and ecosystem health, and presents an opportunity for ecological restoration and improved estuarine function. The current breach has altered local hydraulic conditions, potentially increasing flood risks in the surrounding area during high tides or storm events. This uncontrolled water flow may also accelerate erosion along the breach edges and in downstream areas due to increased water velocity. Controlled removal of the remaining structure could reconnect wetlands with tidal flows, improving habitat quality for fish and other aquatic species. This restoration has the potential to enhance overall estuarine health and provide natural flood mitigation benefits.

Drift Bend Oxbow: The Drift Bend Oxbow on the North Fork Alsea presents a significant opportunity for tidal restoration, with the potential to enhance local wetland habitats. This site is currently the focus of restoration efforts by the USFS and has been identified as the largest restoration opportunity in the Alsea estuary. The southern half of the peninsula has already undergone restoration, and the OCCEC is working with USFS to address the remaining area. As of early 2025, action alternatives are being assessed for restoration project design.

The need for this restoration is underscored by several concerns. Historically used for agricultural purposes, the altered state of the oxbow was largely unavailable for flood storage in the surrounding area. Restoring natural tidal flows could help mitigate flooding by allowing water to spread across the floodplain, reducing the impact on nearby infrastructure and properties. Additionally, the altered hydrology of the oxbow may accelerate erosion along the banks of the North Fork Alsea. Restoration efforts could help stabilize the shoreline and reduce erosion rates. Restoration may also improve water quality and circulation and enhance the ecosystem's natural filtering capabilities. The current condition of the oxbow also likely represents a significant loss of critical habitat for native species, including salmon, which could use this habitat for essential rearing and refuge areas. Restoration of the area may also increase the area's resilience to climate change impacts by providing natural flood storage and allowing for the landward migration of habitats.

Drift Creek Community: The Drift Creek community near Alsea Bay’s back bay area faces significant challenges tied to both natural hazards and infrastructure vulnerabilities. Leaking septic systems and saltwater intrusion into wells threaten water quality and community safety, with aging infrastructure increasingly at risk as sea levels rise. Abandoned properties in the area further contribute to concerns, as they often lack maintained wastewater systems, exacerbating contamination risks. Fish passage barriers in local waterways also limit habitat connectivity for native species like salmon.

Drift Creek is susceptible to inundation in a large tsunami scenario and will experience severe shaking during a 9.0 CSZ earthquake. Landslide susceptibility is very high in the hillsides to the

south, while wildfire susceptibility is also elevated due to dense vegetation and dry conditions (DOGAMI NHRR, 2020). Despite these risks, the area offers significant potential for tidal wetland restoration, which could help mitigate flooding and improve estuarine health. Restoration efforts could also address fish passage barriers, enhancing habitat for aquatic species while supporting ecological resilience in the face of ongoing environmental changes.

Barclay Meadows: Barclay Meadows presents a significant opportunity for tidal wetland restoration. Old tide gates in this area are obstructing tidal flow to former wetlands, limiting their ecological and estuarine function. The Oregon Estuary Plan Book[33] identifies Barclay Meadows as a potential mitigation site, recommending the removal or breaching of dikes to restore approximately 70 acres of tidal wetlands. Restoring tidal influence to Barclay Meadows could improve habitat for native species, enhance water quality, and increase the estuary's resilience to climate change impacts. However, any restoration efforts must carefully consider the needs of communities behind the tide gates, as these structures often play a crucial role in flood protection and drainage for developed areas.

Bain Slough: Located in a spruce swamp habitat, Bain Slough faces challenges with aging tide gates that are obstructing tidal flow and limiting the ecological function of former wetlands. These tide gates, which are part of a broader issue of deteriorating infrastructure along the Oregon Coast, restrict natural hydrology and create barriers for fish passage, reducing habitat quality for important species such as salmon. Restoration opportunities at Bain Slough may include upgrading or removing the tide gates to restore tidal exchange and improve estuarine function. Such efforts could enhance water quality, support fish passage, and increase habitat connectivity in this unique spruce swamp ecosystem. However, restoration must be carefully managed to balance ecological improvements with the needs of nearby communities that rely on tide gates for flood protection and drainage.

Westwood Village/Little Albany: Westwood Village and Little Albany are isolated communities located upriver beyond estuarine influence but nonetheless represent communities vulnerable to flood risks and other natural hazards. Local flood risk necessitates targeted improvements to mitigate risks and enhance community resilience. Flood modeling identifies a number of at-risk properties, highlighting the need to address community resilience (First Street Foundation, 2020). Landslide susceptibility is very high above Little Albany and compounds the flood hazard, as landslides can exacerbate flooding by altering drainage patterns and potentially damming waterways (DOGAMI, 2023).

[33] https://www.oregon.gov/lcd/Publications/TheOregonEstuaryPlanBook_1987.pdf

Yachats River

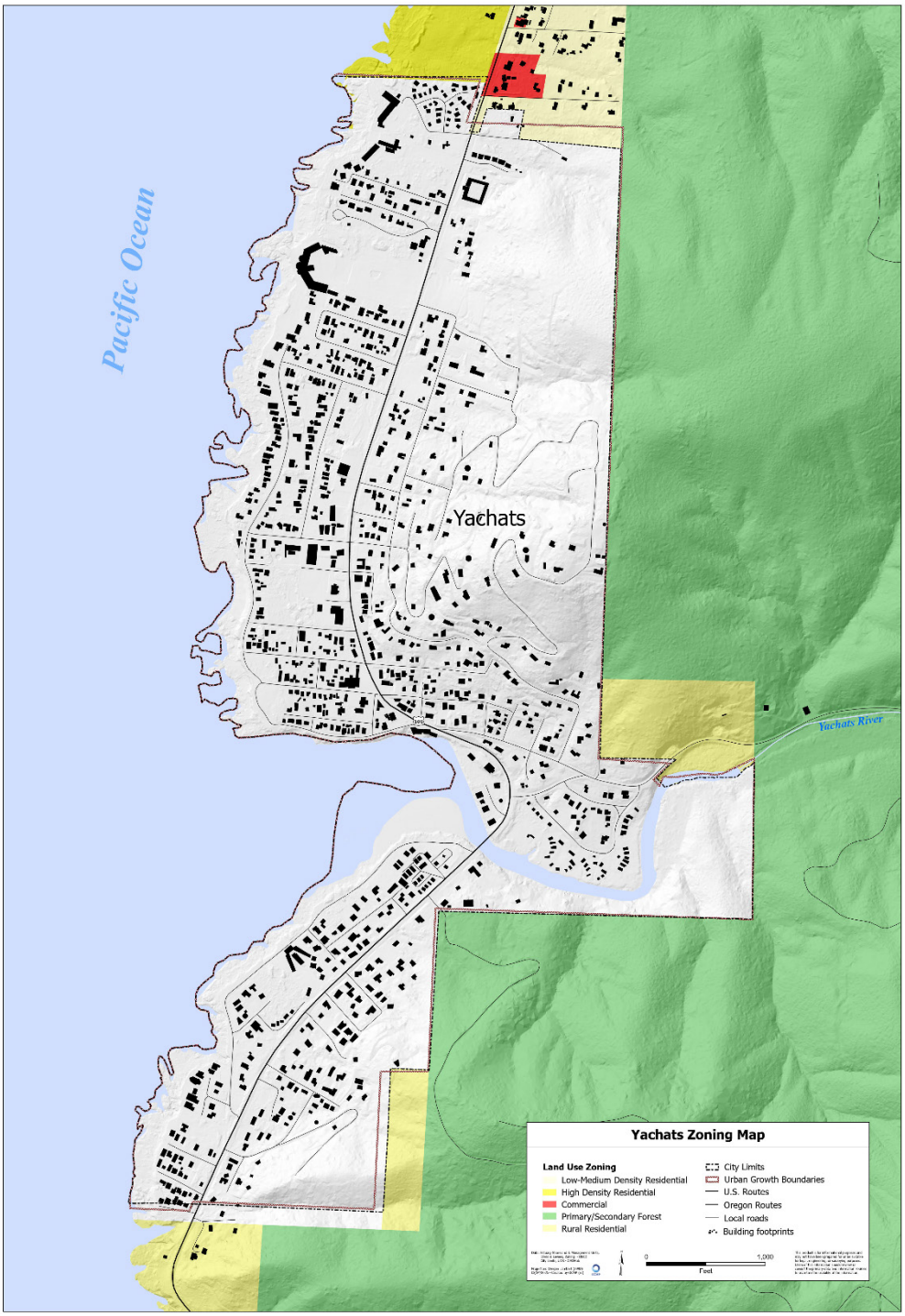


Figure 15. Yachats River estuary zoning map.

The Yachats River flows into the Pacific Ocean next to the City of Yachats. This relatively short river winds through a forested watershed, culminating in a narrow estuary with tidal flats and salt marshes. The estuary supports diverse wildlife, including salmon, cutthroat trout, and various bird species, making it an ecologically significant area despite its modest size.

The City of Yachats, situated at the river's mouth, has seen limited development, helping to preserve the natural beauty and ecological health of the Yachats River estuary. The area is valued for its scenic qualities and biodiversity, with ongoing efforts to protect its water quality and habitat. These efforts aim to maintain the estuary's role in supporting local wildlife and providing recreational opportunities for the community.

Hazard Risk

The Yachats River estuary is vulnerable to several natural hazards that can significantly impact its ecological health and surrounding communities. These risks include flooding, erosion, and tsunami threats, each with distinct implications for the area.

Flooding poses a notable risk to the Yachats River estuary, particularly impacting the community of Yachats and surrounding areas. Heavy rainfall, high tides, storm surges, and tsunami can lead to significant inundation. The low-lying areas near the estuary are particularly susceptible to these impacts. Key infrastructure and low-lying areas such as Yachats River Road and the areas near the bridge on US Highway 101 may experience occasional flooding, potentially disrupting transportation and access. These areas are also extremely vulnerable to tsunamis. Additionally, the estuarine wetlands and habitats are vulnerable to flood-related sedimentation and changes in water quality, which can affect local wildlife and plant species.

Rising sea levels also contribute to exacerbated flooding and erosion risks in the Yachats River estuary. Higher sea levels can lead to more frequent and severe inundation of the estuarine wetlands and adjacent lands. This can affect freshwater flow, increase salinity levels, and impact the ecological balance of the estuary. Critical infrastructure such as roads and bridges near the estuary may also face increased risks from rising sea levels, potentially leading to long-term damage and higher maintenance costs. Under increasing sea level rise scenarios, the Yachats River is expected to continuously gain potential tidal wetland area, especially sharply under the highest scenarios up to 11.5 ft.

Erosion along the banks of the Yachats River estuary can threaten both natural habitats and human infrastructure. The river's banks and estuarine wetlands are susceptible to erosion due to high wave action and storm surges. The erosion of the riverbanks could undermine nearby roads and properties, particularly those adjacent to the estuary, potentially leading to property damage and increased maintenance costs.

Key Themes for Vulnerability

Environmental Preservation and Land Use: The 1100-acre Yachats Ridge property, currently being pursued for conservation, contains at least eight perennial creek sources and numerous secondary streams that are critical to the health of the estuary. However, much of this land has been heavily logged for decades, leaving steep slopes prone to erosion and slides. For example, the Gender Creek slide in 1997 caused significant damage to homes and infrastructure, sending debris into the river and ocean. Concerns persist about the potential for future slides if industrial forestry practices continue unchecked. Additionally, aging tide gates and wetlands along Ocean View Drive are critical for managing water flow into the estuary but face development pressures. The Quiet Water development in the 1980s filled in wetlands with soil removed from Yachats River Road, leading to overflow issues that persist today. These examples underscore the need for updated land use regulations and proactive conservation strategies to protect both natural resources and built environments.

Cultural Resource Protection: Yachats is recognized as a leading city in Oregon for archaeological site preservation. The area contains significant cultural resources, including tribal sites under the supervision of local tribes. However, these sites face threats from development activities that can disturb or destroy them. For instance, grassroots advocacy by groups like View the Future (VtF) has successfully halted projects that would have impacted wetlands and archaeological sites that front the estuary. Continued efforts are needed to integrate cultural preservation into broader land use planning and conservation initiatives.

Community Resilience: The Yachats Ridge property holds strategic value for community resilience. It contains natural springs that could serve as emergency water sources and is home to emergency response towers maintained by the county. Preserving this property would provide critical staging areas for disaster response while also protecting its ecological functions. However, funding limitations pose a significant barrier to achieving these goals. While state agencies like OPRD have expressed interest in acquiring the property for a state park, legislative pullbacks on acquisition funds have stalled progress. Local organizations are seeking grants and partnerships with land trusts to secure ownership and management of this vital landscape.

Habitat Connectivity and Restoration: The Yachats River estuarine system relies on intact riparian zones and wetlands to maintain water quality, shade streams, and prevent erosion. However, decades of logging have fragmented habitats and reduced connectivity between upland forests and aquatic ecosystems. Restoration efforts would benefit from a focus on re-establishing these connections to support species like salmon that depend on healthy stream environments. Additionally, invasive species threaten native vegetation stability along riparian zones. Efforts to preserve wetlands along Ocean View Drive involve removing invasive plants while maintaining habitat integrity for wildlife.

Recreation and Public Access: The community values eco-friendly recreational projects that balance public access with environmental protection. Plans for an ADA-accessible boardwalk along Ocean View Drive aim to improve safety while preserving views of the estuary. However, delays in transferring ownership of key parcels from the county to the city have hindered grant applications to fund this project fully. The boardwalk would fill a critical gap in the Oregon Coast Trail while providing educational opportunities about local ecology and cultural history.

Key Challenges

Erosion and Landslides: Steep slopes on logged lands pose ongoing risks of landslides that can damage homes, roads, and waterways.

Funding Limitations: Conservation efforts are constrained by limited state acquisition funds and reliance on grants or private donations.

Development Pressures: Wetlands and riparian areas face residential development threats that can exacerbate flooding and degrade water quality.

Coordination Gaps: Delays in administrative processes (e.g., property transfers) hinder timely implementation of resilience projects.

Public Awareness: Many newer residents (50-60% have been in Yachats <5 years) lack knowledge of historical events like the Gender Creek slide or the importance of conservation efforts.

Opportunities for Resilience

Land Acquisition: Securing properties like Yachats Ridge under conservation easements or as part of a state park could protect critical watersheds while providing recreational opportunities.

Nature-Based Solutions: Restoring riparian buffers, wetlands, and forested slopes can mitigate erosion risks while enhancing habitat connectivity.

Cultural Integration: Partnering with local tribes to manage archaeological sites ensures that cultural preservation remains central to land use planning.

Community Engagement: Expanding educational initiatives about local ecology, history, and conservation efforts can build public support for resilience projects.

Strategic Partnerships: Collaborating with state agencies, land trusts, and federal programs can leverage resources for large-scale restoration efforts.

Specific Vulnerability Concerns

Downtown Yachats: The entire downtown area, including city government facilities, is located within the tsunami inundation zone and the Special Flood Hazard Area (FEMA). The area is also at risk from earthquakes, with potential for liquefaction in the event of a major seismic event like a CSZ earthquake. Limited evacuation routes compound these risks, especially for the large elderly population.

Ocean View Dr. Greenway: This area along the Yachats River estuary is slated for a boardwalk project to improve pedestrian access. The site is vulnerable to tsunami inundation, with the entire area falling within the tsunami hazard zone (DOGAMI, 2019). It is also at risk of flooding, being within the Special Flood Hazard Area (FEMA). Coastal erosion and potential landslides from nearby steep slopes pose additional threats to this low-lying area.

Landmark Property: This 1.5-acre lot between Highway 101 and the estuary faces multiple natural hazards. It's at high risk of tsunami inundation and flooding, being in both the tsunami hazard zone (DOGAMI, 2019) and the Special Flood Hazard Area (FEMA). The property is also susceptible to coastal erosion and potential liquefaction during earthquakes due to its proximity to the shoreline and underlying geology.

Quiet Water Neighborhood: Much of this residential area lies within the 1% or 2% annual chance flood zone. The neighborhood faces ongoing challenges with flood risk management, particularly areas south of Combs Circle, which are at high risk. The proximity to the river also puts this area at risk of riverbank erosion and potential landslides from adjacent slopes.

Yachats Ridge: This 1100-acre upland forest area faces significant landslide risk due to its steep slopes and history of logging. The site is crucial for watershed health in the Yachats River area but is vulnerable to wildfire hazards, especially given the increasing drought conditions in the region. Erosion and landslides from this area have historically impacted the Yachats River and downstream communities. There are also wetlands and other valuable fish and wildlife habitats present that would benefit from long-term protection and management.

Beaver Creek

Image: Beaver Creek Estuary. Courtesy of Oregon ShoreZone.

Beaver Creek, located between Newport and Waldport, flows through a predominantly forested landscape before reaching its estuary, which empties into Ona Beach. The estuary is relatively small and includes a mix of tidal wetlands and freshwater marshes, supporting a variety of bird species and providing habitat for fish such as cutthroat trout. The surrounding Beaver Creek State Natural Area offers opportunities for wildlife observation and outdoor recreation, highlighting the area's ecological significance. Tidal wetland area available for landward migration is expected to increase more sharply with increasing sea level rise scenarios in the Beaver Creek area than most other estuaries.

Key Themes for Vulnerability

Beaver Creek is a focal point for ecological restoration and flood management, situated near Ona Beach along the central Oregon Coast, where the creek meets the Pacific Ocean after a roughly 8-mile journey from its headwaters. The local community and various interested parties are actively engaged in addressing the area's interconnected challenges. These include persistent flooding, historical land use impacts, and the complexities of navigating regulatory processes to implement effective, nature-based solutions.

The central theme revolves around mitigating flood risks that frequently render sections of North and South Beaver Creek Road impassable. Historical land management practices, including the conversion of approximately five miles of wetlands into pasture through diking and channelization, have significantly altered the natural hydrology. While many of these properties are increasingly unmaintained, the community grapples with differing perspectives on how to best manage water resources, balancing a lingering desire for improved drainage with contemporary goals of ecological restoration.

The area's recognized significance as critical habitat for coho salmon underscores the need for holistic management approaches. OPRD manages 365 acres as a natural area, encompassing 119 acres of wetlands, with an additional 1200-1300 acres of upland forest. This is a critical element for OPRD, as the organization aims to restore natural processes and enhance habitat recovery. Yet, the complex regulatory landscape, involving Lincoln County, USACE, and DSL oversight, complicates restoration efforts and demands collaborative strategies, in particular to streamline permitting.

Looking ahead, the success of any Beaver Creek resilience effort will hinge on strong community engagement, data-driven decision-making, and strategic partnerships. By promoting awareness, fostering collaboration among agencies and landowners, and pursuing nature-based solutions grounded in science, Beaver Creek can navigate its complex challenges and secure a more resilient future for both its ecosystem and its community.

Key Challenges

Water Quality Impairments: High temperatures, bacteria, and nutrients impair water quality, impacting aquatic life and human health.

Invasive Species: European green crab, Spartina, nutria and other invasive species threaten native ecosystems and economic activities.

Habitat Degradation: Loss of tidal wetlands and other critical habitats reduces biodiversity and ecosystem services.

Opportunities for Resilience

Improve Wastewater Treatment: Upgrade wastewater treatment facilities to reduce nutrient pollution and improve water quality.

Control Invasive Species: Implement targeted control measures to reduce the impacts of invasive species on native ecosystems and economic activities.

Restore Tidal Wetlands: Restore tidal wetlands to provide flood protection, improve water quality, and create habitat for fish and wildlife.

Image: Salishan Spit and the entrance to Siletz Bay. Courtesy of Oregon ShoreZone.

IV. Resilience Recommendations & Actions

Image: Toledo Paddle Park, Yaquina Bay. By Gregory Hinton.

This chapter presents a set of recommendations and nature-based resilience actions identified to help strengthen the resilience of Lincoln County's estuaries and surrounding communities to natural hazards. These recommendations and actions were developed through an extensive engagement process that involved local, state, federal, and tribal partners, as well as input gathered through community outreach efforts. The ERAP Steering Committee played a central role in shaping these priorities. Their collective knowledge, experience, and understanding of local needs and opportunities have guided the development of this chapter.

The **recommendations** outline general strategies and activities that can be pursued across the county to build resilience. These include data and information needs, policy and regulatory development, habitat and land conservation initiatives, and public engagement and funding opportunities. These recommendations are intended to guide local organizations as they set priorities, seek funding, and coordinate future resilience-building efforts. They provide a shared foundation for aligning policies, programs, and partnerships in support of estuarine resilience.

The **resilience actions** describe site-specific or project-based activities identified as opportunities to advance nature-based solutions in Lincoln County estuaries. These include projects such as wetland restoration, land acquisitions, floodplain reconnection, and habitat enhancement. Many of these actions are tied to specific locations and can be pursued by local

organizations, either independently or in partnership, as they seek to implement practical, on-the-ground solutions that provide both ecological and community resilience benefits.

Both the recommendations and actions in this chapter are intended to serve as a resource for local governments, Tribes, watershed councils, non-profit organizations, and other local partners and interested parties. They can be used to inform grant applications, support local planning and decision-making, and strengthen collaborative efforts aimed at addressing natural hazard threats and sustaining the health of Lincoln County's estuaries. By identifying shared priorities and actionable opportunities, this chapter supports the continued work of local partners to reduce risks, restore natural systems, and enhance the resilience of communities and ecosystems alike.

Recommendations

The following recommendations are intended to enhance the resilience of Lincoln County's estuaries in the face of increasing environmental challenges, including climate change impacts. Developed in close collaboration with the ERAP steering committee, these recommendations reflect a comprehensive assessment of local needs, priorities, initiatives, and opportunities. They are organized into four key categories: Data & Information, Policy & Regulations, Habitat & Land Conservation, and Public Engagement & Funding, and are intended to provide a roadmap for strategic action across various sectors.

Data & Information

- **Septic System Tracking:** Implement a comprehensive inventory of septic systems within Lincoln County, in coordination with the DEQ and leveraging local government data, to address water quality concerns related to septic system failures and saltwater intrusion.
- **Beaver Populations and Habitat:** Conduct a comprehensive assessment of current beaver populations and suitable habitat within coastal watersheds, including the coast range and estuaries. Identify potential areas for habitat enhancement to support beaver populations.
- **Dredging Impacts:** Support research to evaluate the impacts of dredging activities on estuarine ecosystems, including sediment disturbance, habitat alteration, and water quality effects. Partner with USACE to gain insights from existing data and expertise. Explore beneficial use of dredge material for restoration purposes.
- **Green Stormwater Infrastructure:** Evaluate the feasibility and need for implementing green stormwater infrastructure projects throughout Lincoln County to reduce stormwater runoff and improve water quality in estuaries.
- **Sediment Budgets:** Develop comprehensive sediment budgets for all Lincoln County estuaries to understand sediment dynamics and identify areas of erosion or accretion.

Capitalize on opportunities to utilize dredge materials for habitat enhancements, recognizing that USACE is developing guidance on this practice.

- **Siletz Freshwater Dynamics:** Conduct research to improve understanding of the freshwater lens dynamics, assess the long-term stability of well fields, and address potential contamination and nutrient loading issues affecting water quality in the estuary.
- **Siletz Water Monitoring:** Implement enhanced monitoring of water volume and quality, including the installation of stream gauges along OR Highway 229, to track changes in freshwater supply and inform science-based management decisions.

Policy & Regulations

- **EMP Updates:** Regularly update EMPs, resource inventories, and management unit descriptions to incorporate the latest climate science, best management practices, and community priorities. These plans should identify existing and expected climate vulnerabilities and ensure proposed uses are viable under changing conditions. Ensure the integration of ERAPs with EMPs to streamline restoration project permitting and inform policies, zoning codes, and ordinances that increase climate resilience.
- **EMP Review Cycle:** Implement a mandatory five-year review cycle for EMPs to ensure they remain current, effective, and adaptive.
- **Climate Resilient Development Standards:** Enhance community resilience by developing clear guidance for developers and applicants that promotes climate-resilient development standards, including the use of appropriate materials, adjustments for sea level rise, and the incorporation of nature-based solutions.
- **Landward Migration Zoning:** Safeguard local resources and communities by restricting development at County level in areas within mapped LMZs according to moderate-high SLR projections for 2050 to allow for habitat migration upslope and reduce the effects of storms and floods for the community.
- **Beaver Management Regulations:** Advocate for alignment of regulations regarding beaver management, including hunting, trapping, and nuisance removal, between ODFW and federal agencies. Promote policies that recognize beavers as a valuable restoration and recovery tool, in accordance with the State Wildlife Action Plan and coho recovery documents.
- **Floodplain Development Restrictions:** Enforce strict regulations to prohibit building in floodplain and flood-prone areas, minimizing risks to life and property from flooding events. Account for water-dependent uses, such as ports and utilities, that require floodplain locations. Develop building codes and design standards that accommodate water and promote green infrastructure solutions, particularly for critical and essential facilities.
- **Riprap Restrictions:** Develop local policies to disincentivize riprap and narrow the circumstances where it is deemed acceptable. Reference existing erosion control

guidance documents and best practices to provide developers with a range of alternative options. Focus the restrictions on the estuary resilience nexus, while recognizing potential beneficial uses of riprap in specific contexts.

- **Streamlining Restoration Permitting:** Advocate for streamlined permitting processes for tidal wetland, Olympia oyster, and eelgrass restoration projects, including the establishment of sideboards and permitted uses for common restoration activities, to facilitate project implementation. Estuary management plans should include general authorizations for specified types of active restoration as outright permitted uses in specific management units to streamline permitting for such projects. Natural climate solutions should be defined and prioritized in estuary management plans as permitted uses in all management units.
- **Hazardous Materials Inventory:** Identify and catalogue hazardous materials and wastes stored along the estuary, paying specific attention to their flood threat, to help mitigate water quality threat by protecting against hazardous contaminants.
- **Yaquina Outfalls and Development Setbacks:** Evaluate issues with outfalls, establish appropriate setbacks, and prohibit development adjacent to natural management units within Urban Growth Boundaries (UGBs).

Habitat & Land Conservation

- **Off-Channel Habitat Restoration:** Promote off-channel habitat restoration projects that reconnect rivers and estuaries to their floodplains, providing a myriad of benefits for freshwater ecosystems and ecosystem services.
- **Beaver Restoration Implementation:** Support beaver restoration efforts, focusing on strategic habitat enhancements and fire mitigation strategies.
- **Eelgrass Habitat Protection:** Consider losses when updating EMPs and support eelgrass habitat protection and restoration efforts to combat habitat loss, emphasizing climate resilience benefits and carbon sequestration potential.
- **Habitat Prioritization:** Create a prioritized list of important habitats to focus on for restoration, highlighting their vulnerability, current status, and the specific benefits they provide for climate resilience, carbon sequestration, and overall ecosystem health. Include a focus on providing habitat for migratory birds, salmon, and nursery habitat for juvenile fish.
- **Urban Natural Area Preservation:** Preserve existing urban natural areas and forests through land acquisition and conservation easements, potentially funding these efforts through bond measures following the Lincoln City model. Partner with organizations such as the MCWC, TWC, and TNC, as well as the CCCOT, to leverage funding and technical assistance for land management zones. Prioritize areas that provide habitat connectivity and resilience benefits, connecting to other areas of important habitat. Overlay mapped scenarios for sea level rise and land management zones with existing

open space areas to prioritize conservation of lands that allow for habitat migration over time.

- **Managed Retreat:** Identify needs, opportunities, and incentives for managed retreat in vulnerable coastal areas, evaluating various options and strategies to minimize risks associated with sea level rise and coastal hazards.
- **Siletz Refuge Expansion and Restoration:** Encourage USFWS to maintain contacts with willing sellers within existing congressional-determined boundaries to expand the refuge boundary, focusing on habitat and sites for off-channel fish recovery. Prioritize working with counties when they own land to facilitate land transfers with the refuge. Encourage restoration on private lands within the existing working area and engage with USFWS programs like Partners, Coastal, and Ecological Services to facilitate these efforts. Develop the Siletz Keys site to include public access for activities such as kayaking, connecting open spaces to habitat conservation.

Public Engagement & Funding

- **Maintain Funding Resource:** Maintain a resource for connecting federal, state, and private funding opportunities with resilience action items.
- **Educational Program Support:** Expand support for educational programs that connect students with estuarine environments. Facilitate partnerships with organizations such as the Oregon Museum of Science and Industry (OMSI), Yakona Nature Preserve, Oregon Coast Aquarium, HMSC, and the regional STEM Hub to provide immersive learning experiences in Newport and other locations. Integrate estuary education into public school curricula, providing training for teachers and utilizing resources from Oregon Sea Grant and the South Slough National Estuarine Research Reserve (SSNERR).
- **Improve Outreach:** Improve outreach and awareness efforts through various channels, including social media campaigns, web series, practitioner involvement, and community science initiatives, to engage a broader audience in estuarine conservation. Target outreach efforts to diverse audiences, including decision-makers and local leaders, to educate them about the threats of climate change and the role of estuaries in mitigating impacts. Coordinate sessions on estuaries at conferences such as State of the Coast, as well as in tourism-related events.
- **Hazard and Climate Risk Awareness:** Raise awareness among local residents and absentee homeowners/vacationers regarding coastal hazard threats, risks, and impacts, promoting preparedness and resilience.
- **Climate Change Funding Streams:** Creatively identify and pursue diverse funding streams to address climate change impacts, potentially drawing inspiration from successful initiatives such as Measure 56 (Oregon Lottery). Explore opportunities to connect open space initiatives with habitat restoration projects, enhancing their appeal to the public.

- **Cutler City Resilience Planning:** Evaluate the need for special dispensation and funding to address the unique challenges of Cutler City. Recognize that vertical evacuation is only a partial solution and explore options for locating new land and re-zoning areas. Balance recreational benefits with conservation needs for each project. Some actions were already in development, while others represent ideas that have been deprioritized due to unmet needs, such as a lack of funding or design plans. The actions are first laid out in summary tables (see Appendix A. Acronyms for additional context) with some basic details for reference. Action descriptions follow the tables with additional context and details including icons that highlight the identified green infrastructure components and anticipated resilience benefits of each project; refer to the symbol keys below for those sections.

Resilience Actions

In the summary tables below, details are outlined for each action, including the lead organization and potential partners[34], green infrastructure components, project status and readiness, and prioritization rankings. The 'Status' and 'Project Readiness' columns provide general estimates of the project's current stage of development and initiation. Project partners and participants negotiated prioritization rankings (highlighted in green) using criteria originally developed by IPRE and adapted for ERAP. For action descriptions, high-level milestones and timelines are outlined, and expected dates are assigned to major milestones where possible. Anticipated target funding grants and programs may also be listed.

Prioritization Rankings

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

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

[34] *Note:* The 'Proposed Lead' and 'Potential Partners' columns represent recommendations from steering committees and interested parties, not formal commitments.

Salmon River Actions

Table 8. Salmon River Resilience Action Details

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
1	Salmon River	**Knight Park** - Enhance community resilience by upgrading the culvert on Crowley Creek under N 3 Rocks Rd near Knight Park, a County-owned natural estuary unit, to improve hydrologic (tidal) function, reduce flooding risks, and protect this vulnerable crossing. This action supports nature-based resilience by ensuring a fully functioning natural estuary.	Lincoln County	ODOT, MCWC, USFS	Design Phase: Engineer contracted	2027	high	low	$$$	medium
2	Salmon River	**Salmon River** - Expand the Salmon River estuary's flushing capacity and protect US Hwy 101 from future flood events by exploring options such as enhanced culverts and tide gates. This resilience project will enhance estuarine function and increase water flow to mitigate sea level rise and storm surge impacts, while leveraging existing downstream restoration efforts.		ODOT, USFS, DSL	Idea Phase: Partners open	25-30 yrs	medium	medium	$$$	medium
3	Salmon River / Otis	**Otis Bridge** - Integrate nature-based solutions with necessary upgrades (e.g., seismic retrofitting) on the N Old Scenic Hwy 101 bridge in Otis to enhance ecological function and community resilience.	Lincoln County	ODOT	Planning Phase: Partners coordinating	2025	high	low	$$$	low

Table 9. Salmon River Resilience Action Supplementary Details

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
1	Lincoln County		ODOT, FHWA, IIJA, if restoration aspects or fish passage included- OWEB, NOAA Fish Passage, CZM BIL (DLCD), NOAA Transformational Habitat Restoration funding, if public access to/within a park is a component see Coastal Access Guide funding appendices, OCVA website.	2024: funding applications 2025: FHWA evaluation of road improvements 2026: begin construction 2027: primary construction/earthwork
2	ODOT, Lincoln County		FHA/BIL, OWEB, NOAA Fish Passage, NOAA Transformational Habitat, if public access to/within a park is a component see Coastal Access Guide funding appendices, OCVA website.	- evaluate potential options incorporating NBS - develop strategy
3	Lincoln County		FHA/BIL	2024: scoping meetings, submit request 2025: begin construction, evaluate potential NBS opportunities

Siletz Bay Actions

Table 10. Siletz Bay Resilience Action Details

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
4	Devils Lake / D River	**D River Neighborhood** - Develop a multi-benefit management plan, incorporating nature-based solutions, to address seasonal flooding and drainage issues on SE 1st St and 2nd Ct in the D River neighborhood, enhancing community resilience while protecting significant natural resources.	Devils Lake WID	Lincoln City, OPRD, USACE, MCWC	Idea Phase	n/a	medium	high	$$$	high
5	Siletz Bay	**Drift Creek** - Improve community access and enhance resilience to flooding by replacing or enlarging culverts near S Drift Creek Rd/Anderson Creek Rd. This project will restore tidal flow and mitigate persistent flooding issues using a nature-based approach that considers the ecological benefits of improved hydrologic connectivity.	Lincoln County	MCWC, WSC	Design Phase: Seeking design	2026	medium	medium	$$$	medium
6	Siletz Bay	**East Siletz Bay** - Protect the low-lying section of US Hwy 101 on the east side of Siletz Bay from inundation through strategic infrastructure improvements and nature-based shoreline stabilization, enhancing community connectivity and climate resilience.		ODOT, Lincoln City, USFWS	Idea Phase	n/a	medium	medium	$$$	medium
7	Siletz Bay	**Salishan Spit** - Develop and implement nature-based solutions to address threats to vulnerable residents on Salishan Spit from high waters, storm surge, and sea level rise, including building retrofits and elevating structures to enhance community resilience.		OPRD, Lincoln City, Lincoln County, DSL	Idea Phase	n/a	low	high	$$$	high
8	Siletz Bay / Siletz Keys	**Siletz Keys** - Assess the condition of existing dikes and develop a restoration plan from the old (2015) USFWS flood modeling and project design that removes west levees, fills ditches, and restores tidal wetland function, enhancing flood protection and ecosystem health for the Siletz Keys neighborhood through nature-based solutions.	USFWS	Lincoln City, Lincoln County, DU, MCWC, CTSI	Idea Phase: Plans already exist	n/a	high	medium	$$$	high

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
9	Siletz River	**Longshore Property** - Secure community resilience and ecosystem benefits through the strategic acquisition of an 18-acre property on the Siletz River, transferring it to the Confederated Tribes of Siletz Indians for removal of a dwelling and invasive plant species, enabling long-term stewardship and restoration.	CCCOT	MRT, Lincoln County, CTSI, PLO	Planning Phase: Early stages		high	medium	$$	medium
10	Siletz Bay	**Siletz Large Wood Project** - Enhance fish habitat, restore natural processes, and support long-term estuary resilience through the phased installation of large wood structures along seven miles of the Siletz River. This project will enhance habitat complexity, slow floodwaters, and reduce erosion over time.	CTSI	all	Planning Phase: Scoping	3 yrs	medium	medium	$$$	medium

Table 11. Siletz Bay Resilience Action Supplementary Details

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
4	PLOs, OPRD, DSL			- hydrologic study to evaluate drainage issues - evaluate NBS options - develop multi-benefit management plan
5	Lincoln County	$388k for design	FHA, restoration-OWEB, NOAA Fish Passage, CZM BIL (DLCD), NOAA Transformational Habitat	2023: apply for FHA design grant 2024: issue RFP for design work 2025: design work, apply for construction funds 2026: construction
6	ODOT			- project scoping - identify NBS options - develop strategy
7	PLOs, OPRD			- public outreach/awareness of issues/threats - identify needs and opportunities
8	USFWS		USFWS likely fund updated design,	- public outreach/awareness of issues/threats - update project design - update flood modeling - bid out project (MCWC?)
9	PLO	$650k	OWEB, CZM BIL (DLCD)	- identify funding source - acquisition and restoration - transfer ownership to Tribe
10		~$1M/mile		- secure funding - complete permitting - implementation of ~ 1 mile/year

Depoe Bay Actions

Table 12. Depoe Bay Resilience Action Details

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
11	Depoe Bay	**N Depoe Bay Cr** - Enhance community water security and salmon habitat through restoration and maintenance efforts in the North Depoe Bay Creek watershed, protecting the City's primary drinking water source and fostering native species recovery.	City of Depoe Bay	DSL	Idea Phase	n/a	high	medium	$$	medium
12	Depoe Bay	**Stanley Property** - Foster community amenities and resilience by exploring nature-based solutions on a 12-acre property bordering North Depoe Bay Creek, including conservation and recreational uses that support salmon spawning habitat and provide an alternative to residential development.		City of Depoe Bay, USACE, DSL, MCWC	Idea Phase	n/a	high	medium	$$	low
13	Depoe Bay	**Depoe Bay Estuary Plan** - Update the Depoe Bay Estuary Plan to incorporate contemporary mapping, data, information, and climate change/sea level rise considerations, ensuring that future management decisions are informed by the latest data and information, and promote long-term coastal resilience.	City of Depoe Bay	DLCD	Idea Phase	n/a	high	medium	$$	high

Table 13. Depoe Bay Resilience Action Supplementary Details

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
11	PLOs			- project scoping - identify NBS options - develop strategy
12			OWEB, CZM BIL (DLCD), Oregon Conservation & Recreation Fund (ODFW) and other recreation acquisitions funds that can be found in Coastal Public Access Guide	- project scoping - identify NBS options - develop strategy
13				- identify funding source - develop timeline and assemble partners

Yaquina Bay Actions

Table 14. Yaquina Bay Resilience Action Details

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
14	Yaquina Bay / Newport	**35th St Culvert** - Restore ecological connectivity and community safety by replacing an undersized culvert on 35th St, incorporating a nature-based approach that restores flow and estuarine function, with potential for additional salt marsh restoration, while addressing neighborhood safety and flood resilience.	City of Newport	Lincoln County, MCWC, FIP, ODFW, DSL	Planning Phase: Assessing options	2026	medium	medium	$	medium
15	Yaquina Bay / Newport	**Port Docks Habitat Mitigation** - Enhance estuarine habitat and support a working waterfront by implementing mitigation measures (e.g., eelgrass restoration) associated with Port Dock 7 and Public Fishing Pier replacements, focusing on removal of creosote pilings and strategic eelgrass transplantation to promote ecosystem health.	Port of Newport	USACE, DSL	Permitting Phase: Under construction	Fall 2024	medium	high	$$$	medium
16	Yaquina Bay	**King Slough** - Protect the sole access route for Yakona Nature Preserve and enhance community resilience by addressing vulnerable crossings on SE Harborton St at the back of King Slough, working with landowners to identify nature-based alternatives and solutions.	MCWC	EENW, Yakona, Oyster Bluff, FIP	Design Phase: Seeking design	1-2 yrs	medium	medium	$$	low
17	Yaquina Bay	**Yaquina Large Wood Project** - Enhance fish habitat, restore natural processes, and support long-term estuary resilience through the phased installation of large wood structures along five miles of the Yaquina River. This project will enhance habitat complexity, slow floodwaters, and reduce erosion over time.	CTSI	all	Planning Phase: Scoping	3 yrs	medium	medium	$$$	medium
18	Yaquina Bay	**Yaquina Bay Crossings** - Enhance community resilience and restore vital wetland habitats by addressing vulnerable crossings on Yaquina Bay Rd and S Bay Rd, upgrading culverts, and reconnecting critical upstream tidal spruce swamp and scrub/shrub wetland habitats, promoting improved tidal exchange and ecosystem function.	MCWC	Lincoln County, TWC, FIP, ODOT	Planning & Permitting Phases: Seeking designs and permits	2026	medium	high	$$$	medium

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
19	Yaquina Bay / Toledo	**Steenkolk Property** - Conserve 8 acres of tidal wetland through strategic acquisition of the Steenkolk Property, enhancing ecological function and providing opportunities for storytelling and engagement with other landowners facing similar sea level rise challenges.	CCCOT	FIP, PLO, CCCOT, Lincoln County	Idea Phase: In discussion	n/a	high	medium	$$	high

Table 15. Yaquina Bay Resilience Action Supplementary Details

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
14	City of Newport & Lincoln County	$40k (2020 est.)	FIP for design, implementation of upstream work	2024: County pavement overlay 2025: Assess options, particularly after Dec 1st FEMA deadline
15	Port of Newport, DSL	>$2m for recreational structure, consulting; estimated $34.5m total	Connect Oregon grant for $9.5m; plan to leverage for $25m federal match. Need to identify/secure funding source for eelgrass mitigation component. NOAA Transformational Habitat Restoration, CZM BIL (DLCD), ODFW's Oregon's Conservation and Recreation Fund, other access funding listed in Coastal public access guide and on OCVA's website	Nov 2024: begin construction
16	EENW		FIP for TA design funding, NOAA fish passage, NOAA Transformational Habitat Restoration, CZM BIL (DLCD), ODFW's Oregon's Conservation and Recreation Fund, other access funding listed in Coastal public access guide and on OCVA's website	2024: evaluate design alternatives
17		~$1M/mile		- secure funding - complete permitting - implementation of ~ 1 mile/year

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
18			FIP for TA design funding, NOAA fish passage, NOAA Transformational Habitat Restoration, CZM BIL (DLCD), ODFW's Oregon's Conservation and Recreation Fund, other access funding listed in Coastal public access guide and on OCVA's website	2024: FIP prioritization 2025: FIP TA design funding (spring) 2026+: implementation
19	PLO		FIP, LMZ, ODFW Oregon Conservation and Recreation Fund, OWEB, CZM BIL (DLCD)-depends on who is final owner (needs to be a non-federal public entity)	- secure acquisition funds - purchase property - develop outreach and restoration strategies
14	City of Newport & Lincoln County	$40k (2020 est.)	FIP for design, implementation of upstream work	2024: County pavement overlay 2025: Assess options, particularly after Dec 1st FEMA deadline

Beaver Creek Actions

Table 16. Beaver Creek Resilience Action Details

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
20	Beaver Creek	**Beaver Creek** - Enhance community safety and improve ecological function by addressing persistent flooding along Beaver Creek, combining culvert upgrades with nature-based restoration efforts that address differential landowner needs to ensure long-term resilience.	Lincoln County	ODOT, OPRD, PLOs, TWC, MCWC	Planning Phase: Scoping and outreach	2-3 yrs	low	high	$$$	medium
21	Seal Rock	**Fox Creek Wetlands** - Restore drainage function and address beaver-related flooding on the highway and for local residents at Fox Creek Wetlands, employing nature-based solutions and collaborating with the Confederated Tribes of Siletz Indians to enhance community and ecosystem resilience.	ODOT	CTSI, Hampton Timber, PLOs, Lincoln County	Planning Phase: Scoping	1-2 yrs	high	medium	$$	low

Table 17. Beaver Creek Resilience Action Supplementary Details

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
20	PLOs, Lincoln County, OPRD, TWC (80 ac)		FWA-culvert removal funding, OPRD access funding-see Coastal public access guide, NOAA fish passage?	2025: PLO outreach, begin bridge replacement on N Beaver Cr Rd 2026: continue PLO outreach, bridge construction, identify partners/funds
21	ODOT, PLOs, CTSI		ODFW Oregon Conservation and Recreation Fund, OWEB, CZM BIL (DLCD)-depends on who is final owner (needs to be a non-federal public entity)	2024: acquisition of Collins Cr property 2025: assess options and begin planning

Alsea Bay Actions

Table 18. Alsea Bay Resilience Action Details

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
22	Alsea Bay / Waldport	**Friday Creek** - Enhance community resilience and safeguard critical habitat by pursuing the potential acquisition of a high-conservation-value wetland connecting Friday, Buckley, and Twombly Creeks, which can address flooding on Hwy 101, in the Driftwood Village Mobile Home Park, and in adjacent Driftwood State Park, protecting vulnerable populations and ecosystems.		ODOT, OPRD?, PLOs, land trusts?	Idea Phase: In discussion	n/a	high	high	$$	high
23	Alsea Bay / Waldport	**Lint Slough** - Restore degraded habitat and promote ecosystem health by acquiring parcels in the upper Lint Slough and conducting strategic restoration efforts, including the removal of fill, utilizing nature-based approaches to enhance community resilience.	CCCOT	FIP, CCCOT, MCWC, MRT, TWC, TNC, LLL, USFWS, DU	Planning Phase: Prioritization underway	2-3 yrs	medium	high	$$	high
24	Alsea Bay / Waldport	**Eckman Lake** - Restore water quality and improve the lake's hydrologic function while addressing local concerns about use. First steps are understanding local needs and concerns, water quality, HABs, and upstream inputs. This will improve resilience of the lake, as well as the Alsea estuary.	City of Waldport	MCWC, Port of Alsea, PLOs, FIP, State Parks	Planning Phase: Scoping	3-4 yrs	low	high	$$	high
25	Alsea Bay / Waldport	**Hwy 34** - Enhance estuarine connectivity and restore tidal flow by upgrading undersized culverts along Hwy 34, reconnecting sloughs, bays, and wetlands on the south side of the highway. This is a nature-based solution which will enhance ecosystem resilience by flushing out areas and improving habitat, as well as benefiting human community members.	MCWC	City of Waldport, ODOT, PLOs, FIP	Planning Phase: Prioritization underway	3-5 yrs	medium	medium	$$$	medium
26	Alsea Bay / Waldport	**Bayview Oxbow** - Restore natural tidal wetland processes on approximately half of a 75-acre oxbow, restoring ~34% of lost tidal wetlands. Limited tidal exchange in culvert acting as fish passage barrier. This project will enhance fish passage and increase resilience to storm surges, while also restoring important ecological structure and function.	MCWC	TWC, PLOs, FIP, Lincoln County, FIP	Design Phase: 60% completed	2027	medium	high	$$	high

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
27	Alsea Bay	**North Channel** - Improve hydrologic function to add to the resiliency of the Alsea system by addressing a breached dike acting as a hydraulic impediment.	USFS	FIP, MCWC	Permitting Phase	2026	medium	low	$$	low
28	Alsea Bay	**Alsea Large Wood Project** - Enhance fish habitat, restore natural processes, and support long-term estuary resilience through the phased installation of large wood structures along eight miles of the Alsea River. This project will enhance habitat complexity, slow floodwaters, and reduce erosion over time.	CTSI	all	Planning Phase: Scoping	3 yrs	medium	medium	$$$	medium
29	Alsea Bay	**Drift Bend Oxbow** - Restore natural ecosystem function in this 60-acre oxbow, enhancing resilience by restoring a high level of topographic diversity through the creation of tidal channels and breaches, as well as removal of invasive species.	USFS	FIP, MCWC, Env Sci Assoc.	Design Phase: Assessing alternatives	2028	high	high	$$	high
30	Alsea Bay	**Barclay Meadows** - Restore high functioning coastal wetlands, enhancing resilience, by addressing old tide gates blocking former tidal wetlands. First steps are understanding local needs and concerns, better understanding of flood risk, SLR impacts.	MCWC	DU, ODFW	Planning Phase: Scoping	2-3 yrs	medium	medium	$$	medium

Table 19. Alsea Bay Resilience Action Supplementary Details

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
22			ODFW Oregon Conservation and Recreation Fund, OWEB, CZM BIL (DLCD)-depends on who is final owner (needs to be a non-federal public entity), USFWS Section 6 funding if listed species benefit.	- identify funding and conservation land holder - acquire property - develop strategy
23			FIP USFWS Coastal Program for TA funding, appraisals MRT, TNC Conservation Fund for bridge funding	2024: prioritizations - acquisitions and transfer to land trust - restoration
24	Port of Alsea		OWEB-engagement grants for outreach to landowners?, water quality funding may depend on source of issue (ODA, SWCD, DEQ, BOR all have various funding sources for WQ),	2025: data collection
25	PLOs, ODOT		FHWA AOP	2024: FIP prioritization 2025: con't for fish passage, SLR, etc.
26	TWC, PLOs		FIP Stakeholder Outreach grant application Fall 2024 MCWC has some funding to complete design, culvert/bridge replacement FIP for permitting, will need to augment	2024: community engagement 2025: designs, TA design grant 2027: habitat restoration
27			FIP for most, but will need to augment	2024: evaluate design alternatives, collect baseline data for modeling 2025: permitting 2026: implementation
28		~$1M/mile		- secure funding - complete permitting - implementation of ~ 1 mile/year
29	USFS		FIP for most, but will need to augment	2025: evaluate design alternatives 2026: permitting 2027: implementation
30	PLOs		DU working on NOAA grant proposal	2024: apply for NOAA grant - assess flood risk, SLR - outreach and engagement

Yachats River Actions

Table 20. Yachats River Resilience Action Details

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
31	Vingie Creek	**Vingie Creek** - Reduce the frequency and intensity of flood events occurring on Hwy 101 in and around Vingie Creek by assessing this area and developing nature-based solutions to address flood risk.	ODOT		Idea Phase: In discussion	n/a	medium	medium	$$	low
32	Yachats River	**Cape Ranch Rd** - Acquire this 40-acre parcel and create a conservation easement for the property that protects the community against erosion and provides habitat as a nature-based community amenity.	View the Future	PLO	Ongoing	Ongoing	low	medium	$$$	medium
33	Yachats River	**Ocean View Dr. Greenway** - Enhance pedestrian connections within this community while enhancing water quality through nature-based stormwater and flood control processes.	View the Future	Trails Cmte, PW, CTSI, City of Yachats	Planning Phase: Seeking funds	Stalled	high	low	$$$	low
34	Yachats River	**Landmark Property** - Create a new nature-based community green space on the bayfront that enhances habitat by acquiring and restoring the vacant 1.5-acre lot on Hwy 101.	View the Future	City of Yachats, MRT, OR Shores, ODOT	Planning Phase: Acquisition	1-3 yrs	high	low	$$	low
35	Yachats River	**Quiet Water Neighborhood** - Engage the community and investigate nature-based solutions for mitigating frequent flooding within the Quiet Water Neighborhood to reduce flood risks and restore the riparian buffer along the adjacent river to protect this vulnerable community.	City of Yachats	HOA, SWCD, MCWC	Idea Phase	n/a	high	medium	$$	low
36	Yachats River	**Yachats Ridge** - Conserve 1,100 acres of contiguous forest viewshed through a strategic land acquisition to reduce community risk from landslides and preserve multiple benefits through the protection of a variety of valuable habitats.	View the Future	ODF, USFS, Manulife, possibly OPRD	Planning Phase: Seeking buyer	1-3 yrs	low	medium	$$$	medium

Table 21. Yachats River Resilience Action Supplementary Details

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
31	ODOT			- evaluate flood threat - assess NBS options - develop strategy
32	Rocha		OWEB, Forest Legacy (depending on holder of CE), CZM BIL (DLCD)-(depending on holder of CE), Community Forest	Summer 2024: clearcutting - identify funding sources, land holder - property acquisition
33	County, but trying to transfer to City	$1.3m (3/4ths) $60k private donation for boardwalk	OPRD for $1.3m (3/4) City of Yachats match w/visitor amenity funds (1/4) Private donation funds	2023/4: planning 2025: January - apply for OPRD grant
34	TBD	$327k for property purchase	City of Yachats visitor amenity funds Private donation	- assess NBS options - complete boardwalk at Ocean View Dr greenway - ODOT complete sidewalk - geotechnical study - archeological site evaluations, soil testing - design work
35	PLOs, HOA		OWEB, CZM BIL (DLCD)-(depending on holder of CE)	- identify funding sources - native plantings
36	Manulife, Weyerhaeuser	$5-7m	CZM BIL(DLCD)-depending on final ownership by a non-federal public entity, OWEB	- identify buyer - conduct OPRD appraisals - property acquisition
31	ODOT			- evaluate flood threat - assess NBS options - develop strategy

Non-Structural Actions

Table 22. Non-Structural Resilience Action Details

Action #	Estuary / Location	Action Description	Proposed Lead	Potential Partners	Status	Project Readiness	Ease (L, M, H)	Impact (L, M, H)	Cost ($, $$, $$$)	Priority (L, M, H)
37	Lincoln County	**Olympia Oyster Enhancement** - Improve water quality, enhance community fishing capacity, and enhance resilience of the local ecosystem by supporting efforts to identify potential Olympia Oyster restoration sites and conduct longer-term restoration.		MCWC, Agencies Tribes, TWC, TNC, OR Shores, OR Oyster Farms, Wakanda Reserve	Idea Phase	n/a	high	high	$$	high
38	Lincoln County	**Estuary Management Planning** - Update and adopt the Lincoln County Estuary Management Plan, and associated comprehensive plan chapters, implementing ordinances, and maps for each jurisdiction with estuaries within their boundaries.	Lincoln County, DLCD	Lincoln City, Newport, Toledo, Waldport, Yachats	Planning Phase	1-3 yrs	high	high	$	high

Table 23. Non-Structural Resilience Action Supplementary Details

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
37		3 yrs to support FTE ~$375k Possibly one 0.5 FTE staff $15k per batch of oysters	USDA NRCS	18 mos: planning and permitting 3 yrs: implementation including: - assess habitat suitability - evaluate enhancement locations - collect oysters from bays - screen for pathogens, parasites - grow and settle in tanks at hatchery - place oyster bags in water - cut bags open after 1 yr and spread out - repeat at regular intervals at 4-5 locations upriver Long-term: identify 3-4 index sites for annual monitoring
38	n/a	In kind resources of staff at cities, county, and DLCD	OCMP-DLCD, NOAA	- update remainder of EMPs for county - adoption of plans

Resilience Action Components and Benefits

The following graphics highlight key components and anticipated benefits associated with the resilience actions identified in this plan. The icons represent nature-based or green infrastructure strategies and the resilience outcomes they are designed to support. Together, these visual keys and the accompanying table[35] illustrate how each project contributes to both ecological function and community resilience.

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/conservation easement

 = multi-use green space

 = myriad nature-based solution options

Anticipated Resilience Benefits Key

 = improved waterway connectivity and hydrologic function

 = flooding/storm surge reduction

 = improved fish passage

 = habitat protection or enhancements

 = improved community resilience

 = erosion control or mitigation

 = improved safety and access

[35] See Appendix B. for a textual version of Table 24

Table 24. Resilience Action Components and Benefits

Action #	Estuary / Location	Action	Green Infrastructure Component(s)	Anticipated Resilience Benefits
1	Salmon River	**Knight Park**		
2	Salmon River	**Salmon River**		
3	Salmon River / Otis	**Otis Bridge**		
4	Devils Lake / D River	**D River Neighborhood**		
5	Siletz Bay	**Drift Creek**		
6	Siletz Bay	**East Siletz Bay**		
7	Siletz Bay	**Salishan Spit**		
8	Siletz Bay / Siletz Keys	**Siletz Keys**		
9	Siletz River	**Longshore Property**		
10	Siletz Bay	**Siletz Large Wood Project**		
11	Depoe Bay	**N Depoe Bay Cr**		
12	Depoe Bay	**Stanley Property**		
13	Depoe Bay	**Depoe Bay Estuary Plan**		
14	Yaquina Bay / Newport	**35th St Culvert**		
15	Yaquina Bay / Newport	**Port Docks Habitat Mitigation**		
16	Yaquina Bay	**King Slough**		
17	Yaquina Bay	**Yaquina Large Wood Project**		
18	Yaquina Bay	**Yaquina Bay Crossings**		

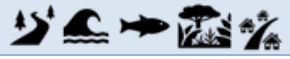
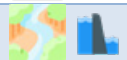
19	Yaquina Bay / Toledo	**Steenkolk Property**		
20	Beaver Creek	**Beaver Creek**		
21	Seal Rock	**Fox Creek Wetlands**		
22	Alsea Bay / Waldport	**Friday Creek**		
23	Alsea Bay / Waldport	**Lint Slough**		
24	Alsea Bay / Waldport	**Eckman Lake**		
25	Alsea Bay / Waldport	**Hwy 34**		
26	Alsea Bay / Waldport	**Bayview Oxbow**		
27	Alsea Bay	**North Channel**		
28	Alsea Bay	**Alsea Large Wood Project**		
29	Alsea Bay	**Drift Bend Oxbow**		
30	Alsea Bay	**Barclay Meadows**		
31	Vingie Creek	**Vingie Creek**		
32	Yachats River	**Cape Ranch Rd**		
33	Yachats River	**Ocean View Dr. Greenway**		
34	Yachats River	**Landmark Property**		
35	Yachats River	**Quiet Water Neighborhood**		
36	Yachats River	**Yachats Ridge**		
37	Lincoln County	**Olympia Oyster Enhancement**		
38	Lincoln County	**Estuary Management Planning**		

Image: Depoe Bay. Courtesy of Oregon ShoreZone.

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Image: Waldport. By MReeves.

Appendix A. Acronyms

Acronym	Definition	Acronym	Definition
ADA	Americans with Disabilities Act	**NPS**	(United States) National Park Service
AOP	Aquatic Organism Passage	**NRCS**	(USDA) Natural Resources Conservation Service
BIL	Bipartisan Infrastructure Law	**NWF**	National Wildlife Federation
BLM	(United States) Bureau of Land Management	**NWRF**	Northwest Regional Framework
BOR	Bureau of Reclamation	**NWS**	National Weather Service
BRAT	Beaver Restoration Assessment Tool	**OA**	Ocean Acidification
CCCOT	Central Coast Conservation Opportunity Team	**OAR**	Oregon Administrative Rule
CCNR	Covenants, Conditions and Restrictions	**OCAP**	Oregon Coast Adaptation Partnership
CE	Conservation Easement	**OCCBP**	Oregon Central Coast Beaver Partnership
CMECS	Coastal and Marine Ecological Classification Standard	**OCCEC**	Oregon Central Coast Estuary Collaborative
CO2	Carbon Dioxide	**OCCRI**	Oregon Climate Change Research Institute
CPRG	Climate Pollution Reduction Grants	**OCMP**	Oregon Coastal Management Program
CSP	Conservation Stewardship Program	**OCRF**	Oregon Conservation and Recreation Fund
CSZ	Cascadia Subduction Zone	**OCVA**	Oregon Coast Visitors Association
CTSI	Confederated Tribes of Siletz Indians	**OCWCOG**	Oregon Cascades West Council of Governments
CZMA	Coastal Zone Management Act	**ODA**	Oregon Department of Agriculture
DEQ	(Oregon) Department of Environmental Quality	**ODF**	Oregon Department of Forestry
DLCD	(Oregon) Department of Land Conservation and Development	**ODFW**	Oregon Department of Fish and Wildlife
DO	Dissolved Oxygen	**ODHS**	Oregon Department of Human Services
DOE	(United States) Department of Energy	**ODOT**	Oregon Department of Transportation
DOGAMI	(Oregon) Department of Geological and Mineral Industries	**OEC**	Oregon Environmental Council
DOI	(United States) Department of Interior	**OEM**	(Oregon) Office of Emergency Management
DSIRE	Database of State Incentives for Renewable Energy	**OHA**	Oregon Health Authority
DSL	(Oregon) Department of State Lands	**OMSI**	Oregon Museum of Science and Industry
DU	Ducks Unlimited	**OPB**	Oregon Public Broadcasting
EDRR	Early Detection and Rapid Response	**OPRD**	Oregon Department of Parks and Recreation
EENW	Environmental Engineering Northwest	**OSG**	Oregon Sea Grant
EMP	Estuary Management Plan (DLCD)	**OSMB**	Oregon State Marine Board
EPA	(United States) Environmental Protection Agency	**OSU**	Oregon State University
EQIP	Environmental Quality Incentives Program	**OWEB**	Oregon Watershed Enhancement Board

ERAP	Estuarine Resilience Action Plan (this document)	**OWRD**	Oregon Water Resources Department
ESA	Endangered Species Act	**PCSRF**	Pacific Coast Salmon Recovery Fund
EWG	Environmental Working Group	**PFAS**	Polyfluoroalkyl Substances
FEMA	Federal Emergency Management Agency	**PLO**	Private Landowner(s)
FHWA	Federal Highway Administration	**PMEP**	Pacific Marine and Estuaries Fish Habitat Partnership
FIP	Focused Investment Partnership	**PROTECT**	Promoting Resilience Operations for Transformative Efficient and Cost-Saving Transportation
FWA	Family Water Alliance	**PW**	Public Works
GHG	Greenhouse Gas	**RCPP**	Regional Conservation Partnership Program
HAB	Harmful Algal Bloom	**RFP**	Request For Proposals
HMSC	Hatfield Marine Science Center	**RM**	River Mile
HOA	Homeowners Association	**SFINCS**	Super Fast Inundation of Coasts
IIJA	Infrastructure Investment and Jobs Act	**SLR**	Sea Level Rise
IPCC	Intergovernmental Panel on Climate Change	**SSNERR**	South Slough National Estuarine Research Reserve
IPRE	(University of Oregon) Institute for Policy Research and Engagement	**STEM**	Science, Technology, Engineering, and Math
IRA	Inflation Reduction Act	**SWCD**	Soil and Water Conservation District
LMZ	Landward Migration Zone	**TA**	Technical Assistance
LNG	Liquified Natural Gas	**TESLA**	Time-Varying Emulator for Short and Long-term Analysis
LUCS	Land Use Compatibility Statements	**TMDL**	Total Maximum Daily Load
LWD	Large Woody Debris	**TNC**	The Nature Conservancy
MCWC	MidCoast Watersheds Council	**TWC**	The Wetlands Conservancy
MCWP	Mid-Coast Water Partners	**TWL**	Total Water Level
MCWPP	Mid-Coast Water Planning Partnership	**UGB**	Urban Growth Boundary
MOC-P	(NOAA) Marine Operations Center - Pacific	**UO**	University of Oregon
MRT	Mckenzie River Trust	**USACE**	United States Army Corps of Engineers
NBS	Nature-Based Solutions	**USDA**	United States Department of Agriculture
NCRF	(NFWF) National Coastal Resilience Fund	**USDOT**	United States Department of Transportation
NEPA	National Environmental Policy Act	**USFS**	United States Forest Service
NERRS	National Estuarine Research Reserve System	**USFWS**	United States Fish and Wildlife Service
NF	National Forest	**USGS**	United States Geological Survey
NFWF	National Fish and Wildlife Foundation	**VA**	Vulnerability Assessment
NGO	Non-Governmental Organization	**VtF**	View the Future
NHMP	Natural Hazard Mitigation Plan	**WFPO**	Watershed and Flood Prevention Operations
NHRR	(DOGAMI) Natural Hazard Risk Report	**WID**	Water Improvement District
NMFS	(NOAA) National Marine Fisheries Service	**WQ**	Water Quality
NOAA	National Ocean and Atmospheric Administration	**WSC**	Wild Salmon Center
NOFO	Notice of Funding Opportunity	**WWTP**	Wastewater Treatment Plant

Appendix B. Resilience Action Components and Benefits Table

For ease of use, Table 24 is duplicated here with text entries in place of icons.

Table 25. Resilience Action Components and Benefits (text version)

Action #	Estuary / Location	Action	Green Infrastructure Component(s)	Anticipated Resilience Benefits
1	Salmon River	**Knight Park**	- water drainage/retention features - multi-use green space - myriad nature-based solution options	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - improved safety and access
2	Salmon River	**Salmon River**	- restoration - riparian/stream channel enhancements - wetlands/marsh - water drainage/retention features	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - improved fish passage - habitat protection or enhancements - improved community resilience - improved safety and access
3	Salmon River / Otis	**Otis Bridge**	- myriad nature-based solution options	- flooding/storm surge reduction - improved community resilience - improved safety and access
4	Devils Lake / D River	**D River Neighborhood**	- riparian/stream channel enhancements - water drainage/retention features - myriad nature-based solution options	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - improved community resilience - improved safety and access
5	Siletz Bay	**Drift Creek**	- restoration - wetlands/marsh - water drainage/retention features	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - improved fish passage - habitat protection or enhancements - improved community resilience - improved safety and access
6	Siletz Bay	**East Siletz Bay**	- myriad nature-based solution options	- flooding/storm surge reduction - improved community resilience - improved safety and access
7	Siletz Bay	**Salishan Spit**	- myriad nature-based solution options	- flooding/storm surge reduction - habitat protection or enhancements - improved community resilience - erosion control or mitigation - improved safety and access
8	Siletz Bay / Siletz Keys	**Siletz Keys**	- restoration - wetlands/marsh - levee/dike	- flooding/storm surge reduction - habitat protection or enhancements - improved community resilience

Action #	Estuary / Location	Action	Green Infrastructure Component(s)	Anticipated Resilience Benefits
			- multi-use green space - myriad nature-based solution options	
9	Siletz River	**Longshore Property**	- restoration - invasive species control - wetlands/marsh - natural area/conservation easement - myriad nature-based solution options	- flooding/storm surge reduction - habitat protection or enhancements
10	Siletz Bay	**Siletz Large Wood Project**	- restoration - riparian/stream channel enhancements - large wood debris/log cribs	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - habitat protection or enhancements
11	Depoe Bay	**N Depoe Bay Creek**	- restoration - riparian/stream channel enhancements - water drainage/retention features - myriad nature-based solution options	- improved waterway connectivity and hydrologic function - habitat protection or enhancements - improved community resilience
12	Depoe Bay	**Stanley Property**	- multi-use green space - myriad nature-based solution options	- habitat protection or enhancements - improved community resilience
13	Depoe Bay	**Depoe Bay Estuary Plan**	- myriad nature-based solution options	- improved community resilience
14	Yaquina Bay / Newport	**35th St Culvert**	- restoration - wetlands/marsh - water drainage/retention features	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - improved fish passage - habitat protection or enhancements
15	Yaquina Bay / Newport	**Port Docks Habitat Mitigation**	- restoration - native plants - myriad nature-based solution options	- habitat protection or enhancements - improved safety and access
16	Yaquina Bay	**King Slough**	- restoration - wetlands/marsh - levee/dike - water drainage/retention features	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - improved fish passage - habitat protection or enhancements - improved community resilience - improved safety and access
17	Yaquina Bay	**Yaquina Large Wood Project**	- restoration - riparian/stream channel enhancements - large wood debris/log cribs	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - habitat protection or enhancements
18	Yaquina Bay	**Yaquina Bay Crossings**	- restoration - wetlands/marsh - water drainage/retention features	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - improved fish passage - habitat protection or enhancements - improved community resilience - improved safety and access
19	Yaquina Bay / Toledo	**Steenkolk Property**	- restoration - wetlands/marsh	- habitat protection or enhancements

Action #	Estuary / Location	Action	Green Infrastructure Component(s)	Anticipated Resilience Benefits
			- natural area/conservation easement - myriad nature-based solution options	
20	Beaver Creek	**Beaver Creek**	- restoration - riparian/stream channel enhancements	- flooding/storm surge reduction - habitat protection or enhancements - improved community resilience - improved safety and access
21	Seal Rock	**Fox Creek Wetlands**	- wetlands/marsh - water drainage/retention features - natural area/conservation easement - myriad nature-based solution options	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - habitat protection or enhancements - improved community resilience
22	Alsea Bay / Waldport	**Friday Creek**	- wetlands/marsh - natural area/conservation easement - myriad nature-based solution options	- habitat protection or enhancements
23	Alsea Bay / Waldport	**Lint Slough**	- restoration - wetlands/marsh - water drainage/retention features - natural area/conservation easement	- habitat protection or enhancements
24	Alsea Bay / Waldport	**Eckman Lake**	- restoration - wetlands/marsh - levee/dike - water drainage/retention features	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - habitat protection or enhancements - improved community resilience - erosion control or mitigation
25	Alsea Bay / Waldport	**Hwy 34**	- restoration - wetlands/marsh - water drainage/retention features	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - improved fish passage - habitat protection or enhancements - improved community resilience
26	Alsea Bay / Waldport	**Bayview Oxbow**	- restoration - wetlands/marsh - water drainage/retention features	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - improved fish passage - habitat protection or enhancements - improved community resilience
27	Alsea Bay	**North Channel**	- riparian/stream channel enhancements - levee/dike	- improved waterway connectivity and hydrologic function
28	Alsea Bay	**Alsea Large Wood Project**	- restoration - riparian/stream channel enhancements - large wood debris/log cribs	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - habitat protection or enhancements
29	Alsea Bay	**Drift Bend Oxbow**	- restoration - invasive species control - riparian/stream channel enhancements - native plants - wetlands/marsh	- improved waterway connectivity and hydrologic function - habitat protection or enhancements
30	Alsea Bay	**Barclay Meadows**	- restoration - riparian/stream channel enhancements	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction

Action #	Estuary / Location	Action	Green Infrastructure Component(s)	Anticipated Resilience Benefits
			- wetlands/marsh - water drainage/retention features	- habitat protection or enhancements - improved community resilience
31	Vingie Creek	**Vingie Creek**	- myriad nature-based solution options	- flooding/storm surge reduction - improved safety and access
32	Yachats River	**Cape Ranch Road**	- natural area/conservation easement - myriad nature-based solution options	- habitat protection or enhancements - erosion control or mitigation
33	Yachats River	**Ocean View Dr. Greenway**	- multi-use green space - natural area/conservation easement - myriad nature-based solution options	- habitat protection or enhancements - improved community resilience - improved safety and access
34	Yachats River	**Landmark Property**	- multi-use green space - myriad nature-based solution options	- flooding/storm surge reduction - habitat protection or enhancements - improved community resilience
35	Yachats River	**Quiet Water Neighborhood**	- natural area/conservation easement	- flooding/storm surge reduction - habitat protection or enhancements - improved community resilience
36	Yachats River	**Yachats Ridge**	- natural area/conservation easement - multi-use green space	- habitat protection or enhancements - improved community resilience - erosion control or mitigation
37	Lincoln County	**Olympia Oyster Enhancement**	- restoration	- habitat protection or enhancements
38	Lincoln County	**Estuary Management Planning**	- myriad nature-based solution options	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - habitat protection or enhancements - improved community resilience - erosion control or mitigation - improved safety and access

Appendix C. Vulnerability Assessment Feedback Summary

Survey Summary

Natural Hazard Threats and Concerns

Question: Natural hazards can threaten communities and the landscape in a variety of ways. What is the highest level of risk that you perceive (current or projected) for each of the following categories of natural hazard threats?

Table 26. Percent risk ranking selections associated with natural hazard threat categories.*

Natural Hazard Threat Category	Do Not Know / N/A	No Risk	Very Low	Low	Med.	High	Very High
Air (decreased air quality, increased pollutants, ozone, smoke, pollen, etc.)	4%	3%	10%	23%	37%	9%	9%
Climate (changes in precipitation, drought, or other weather patterns)	4%	0%	3%	5%	20%	32%	32%
Earthquake and/or Tsunami	4%	0%	3%	8%	15%	29%	41%
Flooding (storm surge, heavy rains, king tides, river flooding, etc.)	1%	0%	4%	5%	16%	38%	35%
Land (landslides, erosion, accretion, sedimentation, subsidence, or deposition of soils, sediments, beaches, or dunes)	1%	0%	4%	9%	19%	35%	32%
Ocean (changes to ocean cycles e.g., Pacific Decadal Oscillation, El Niño/La Niña, spring transition timing)	1%	4%	1%	11%	16%	41%	25%
Sea Level (sea level rise, saltwater intrusion, landward migration)	1%	3%	0%	13%	18%	29%	38%
Species and/or Habitats (population changes, invasive species, pests, loss of habitat or biodiversity, etc.)	4%	1%	1%	10%	20%	30%	32%
Temperature (changes to temperature averages in air or water, heat waves, cold snaps, etc.)	1%	3%	3%	14%	25%	38%	16%
Water (changes in quality or availability, runoff, ocean acidification, turbidity, water table issues)	1%	3%	1%	8%	13%	41%	33%
Wildfire	3%	1%	3%	4%	29%	29%	32%

* Colored shading indicates highest percent ranking for each hazard category. *n*=79

Table 27. Average risk rating (0-5) for natural hazard threat categories.

Natural Hazard Threat Category	Average Rating /5 (*n=79*)
Earthquake and/or Tsunami	4.03
Flooding (storm surge, heavy rains, king tides, river flooding, etc.)	3.97
Water (changes in quality or availability, runoff, ocean acidification, turbidity, water table issues)	3.91
Climate (changes in precipitation, drought, or other weather patterns)	3.87
Sea Level (sea level rise, saltwater intrusion, landward migration)	3.85
Land (landslides, erosion, accretion, sedimentation, subsidence, or deposition of soils, sediments, beaches, or dunes)	3.83
Wildfire	3.82
Species and/or Habitats (population changes, invasive species, pests, loss of habitat or biodiversity, etc.)	3.81
Ocean (changes to ocean cycles e.g., Pacific Decadal Oscillation, El Niño/La Niña, spring transition timing)	3.67
Temperature (changes to temperature averages in air or water, heat waves, cold snaps, etc.)	3.45
Air (decreased air quality, increased pollutants, ozone, smoke, pollen, etc.)	2.68

Survey respondents were asked to select their top, second, and third hazards of concern. The count of each hazard selected and composite percent of total selections can be found in the table below.

Table 28. Count and percent of natural hazard priority selections.

Natural Hazard of Concern	Count of Priority Selections (*n*=79)	Percent (composite)
Climate change	34	15.0%
Wildfire	27	11.9%
Earthquakes	22	9.7%
Severe weather (strong winds, storm surge)	21	9.3%
Tsunami	18	7.9%
Sea level rise, saltwater intrusion	17	7.5%
Ocean cycles changing	11	4.8%
Water quality hazards (chemistry, temperature, ocean acidification)	11	4.8%
Drought	10	4.4%
King tides, tidal flooding	10	4.4%
Other (enter below)	10	4.4%
Erosion, subsidence, accretion, or deposition of beaches, dunes, or soils	8	3.5%
River flooding, heavy rains	8	3.5%

Heat waves	7	3.1%
Landslides	7	3.1%
Water table issues	5	2.2%
Air quality hazards (pollutants, pollen, etc.)	1	0.4%
Cold snaps	0	0.0%

What built, natural, or social assets, resources, or populations do you see as most vulnerable to the above hazard?

- **Built Infrastructure:** US Hwy 101, E-W highways, buildings, bridges, roadways, culverts, tide gates, communications, all within low-lying/flood zones, failing septics, vulnerable residential areas, docks, agricultural buildings/facilities, HMSC
- **Critical/Environmental Infrastructure:** estuary/intertidal habitat, tidal and freshwater wetlands, forests, fish and wildlife, eelgrass, drinking water, noxious weeds, shellfish (esp. oysters), salmonids (esp. juv.), potable water, electrical/power lines, sewer, wells, Big Creek reservoir, birds, crabs (esp. Dungeness), access/egress points, dams, Devils Lake
- **Social Factors:** response organizations, sociocultural aspects of natural resources, fishing/seafood industry
- **Vulnerable Populations:** underserved, low-income, traditionally marginalized, ESL, low-lying communities (Nye Beach, South Beach, Cutler City), elderly/non-ambulatory, tourists, rural residents experiencing water scarcity, isolated communities/residents

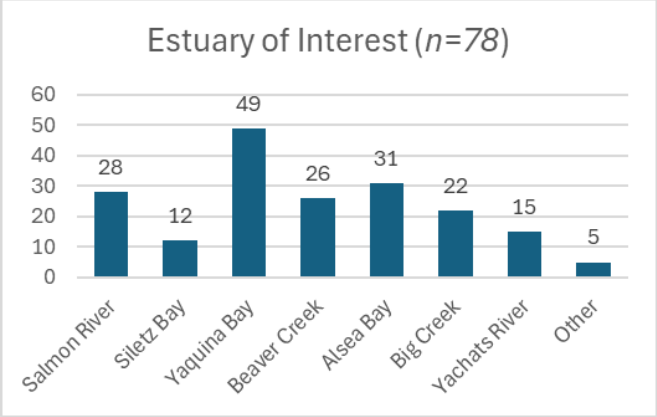
What are the potential impacts that most concern you?

- **Built Infrastructure:** destruction, food/resources availability, loss of connectivity/access, damage from crumbling infrastructure (e.g., dock pilings)
- **Critical/Environmental Infrastructure:** water scarcity, habitat diversity/loss/productivity/ degradation, WQ impacts (saltwater intrusion, pollution, temperature rise, HABs), erosion, changing conditions, species loss, pollution, inundation, hydrologic impacts, impacts to shellfish, species invasions, ecosystem collapse
- **Social Factors:** loss of life, loss of cultural resources, reduction in emergency response capacity/coordination, job losses, loss of habitability, food availability, human health, impacts to commercial fish species/aquaculture, fuel availability, inappropriate responses/solutions, civil unrest, increased costs, economic/tourism impacts
- **Vulnerable Populations:** isolation, forced migration, limited medical response capacity

Demographics

There were a total of 79 respondents to the survey. A plurality of respondents were from Newport and Lincoln City, with others spread throughout Lincoln County and beyond. The average respondent had lived in their community 19.1 years, with an average of 21.1 years in any Oregon coastal community. The average age of respondents was 60, which aligns with the age of the average coastal resident (61).

Question: Please select the Lincoln County estuary(ies) that may be of interest or relevance to you/your organization:



Other areas mentioned include other small ocean tributaries, Drift Creek, and Devils Lake.

Please select the sector(s) that most closely relates to your job duties or organization, or use the space below under 'other' to enter a different sector.

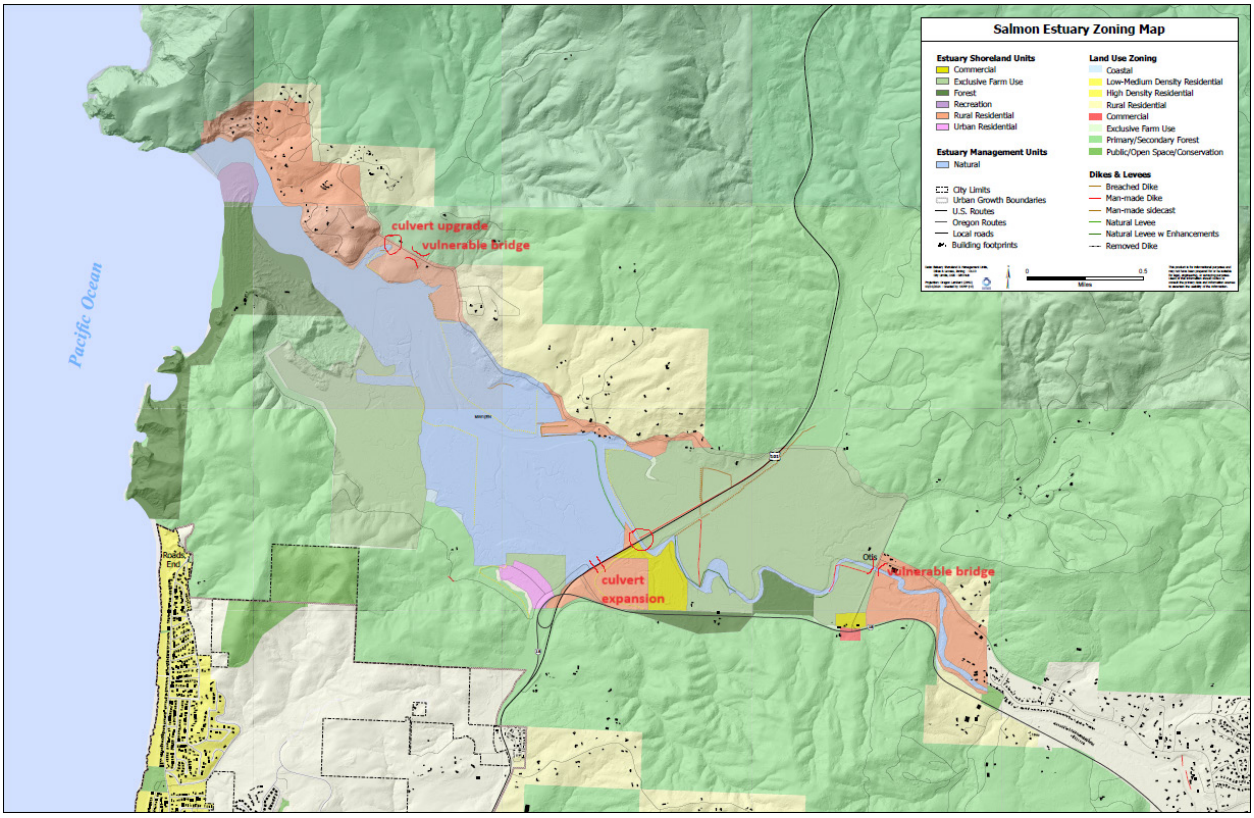
Table 29. Count of self-identified participant sector selections.

Sector	Number of Responses
Agriculture	4
Forestry and Wood Products	4
Fishing and Aquaculture	9
Natural Resources	23
Transportation (e.g., roads, ports, shipping, etc.)	2
Emergency Services	5
Health Services	5
Social Services (e.g., low-income, housing, job placement, childcare, etc.)	2
Utilities	2
Parks/Open Space	7
Education	8
Community Organizations and Cultural Centers	10
Business (e.g., retail, tourism, hospitality, services, finance, etc.)	6
Industry (e.g., trades, manufacturing, materials, construction, maintenance, etc.)	0
Local Government and Land Use Planning	12
Other	22

Listening Session Summary

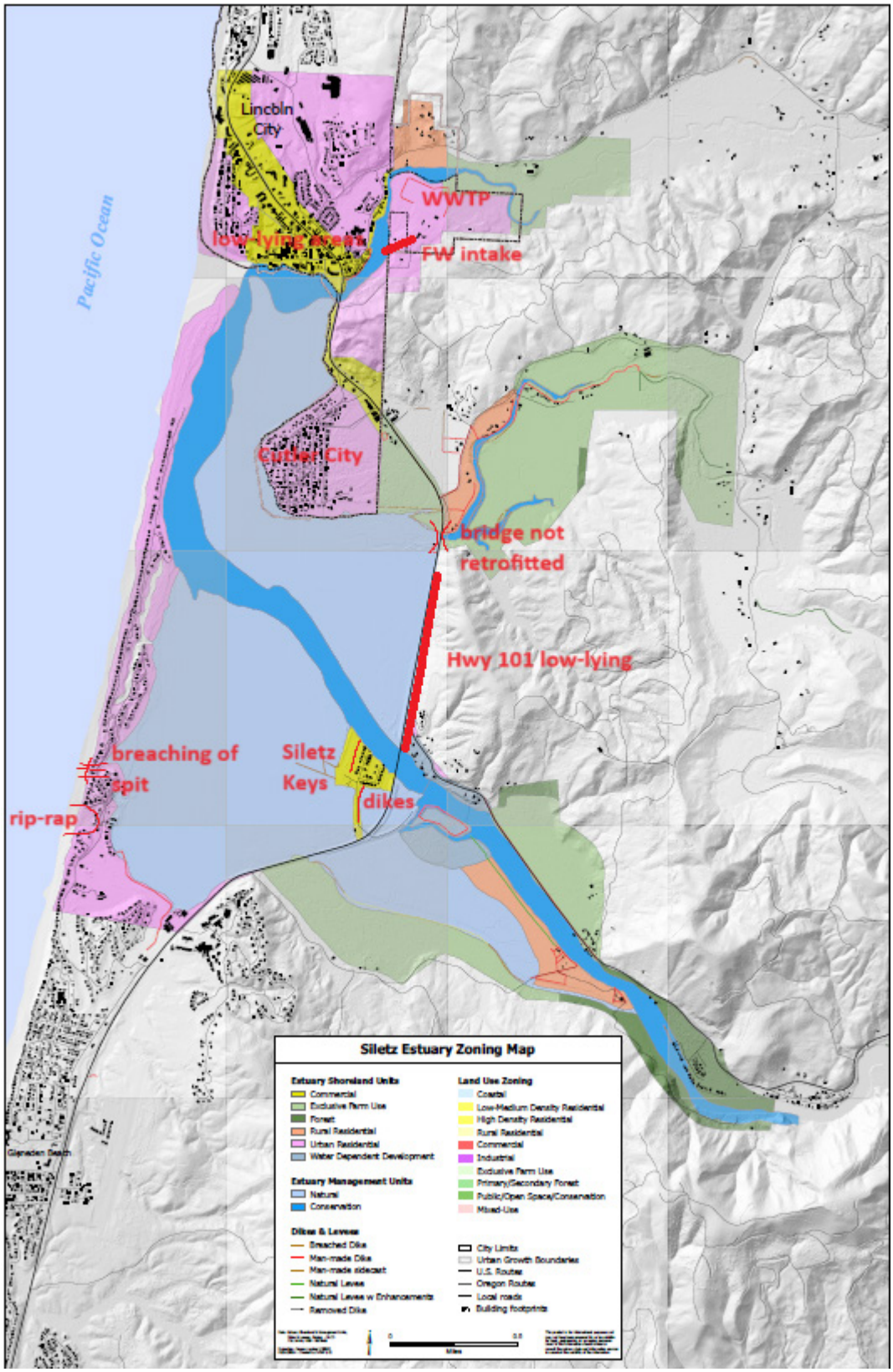
Vulnerabilities

Salmon River



- **US Hwy 101:** Water levels in the culverts under the US Hwy 101 crossing over the Salmon River will frequently reach the top of the culverts during high water events (e.g., king tides). Installation of additional or larger culverts to expand flushing capacity of the bay would restore and enhance estuarine function in a significantly sized area east of 101.
- **N 3 Rocks Rd:** A larger, more functional culvert upgrade is needed on Crowley Creek near Knight Park on N 3 Rocks Rd to protect a vulnerable bridge.
- **Otis:** the bridge on N Old Scenic Hwy 101 in Otis is in need of upgrades.

Siletz Bay

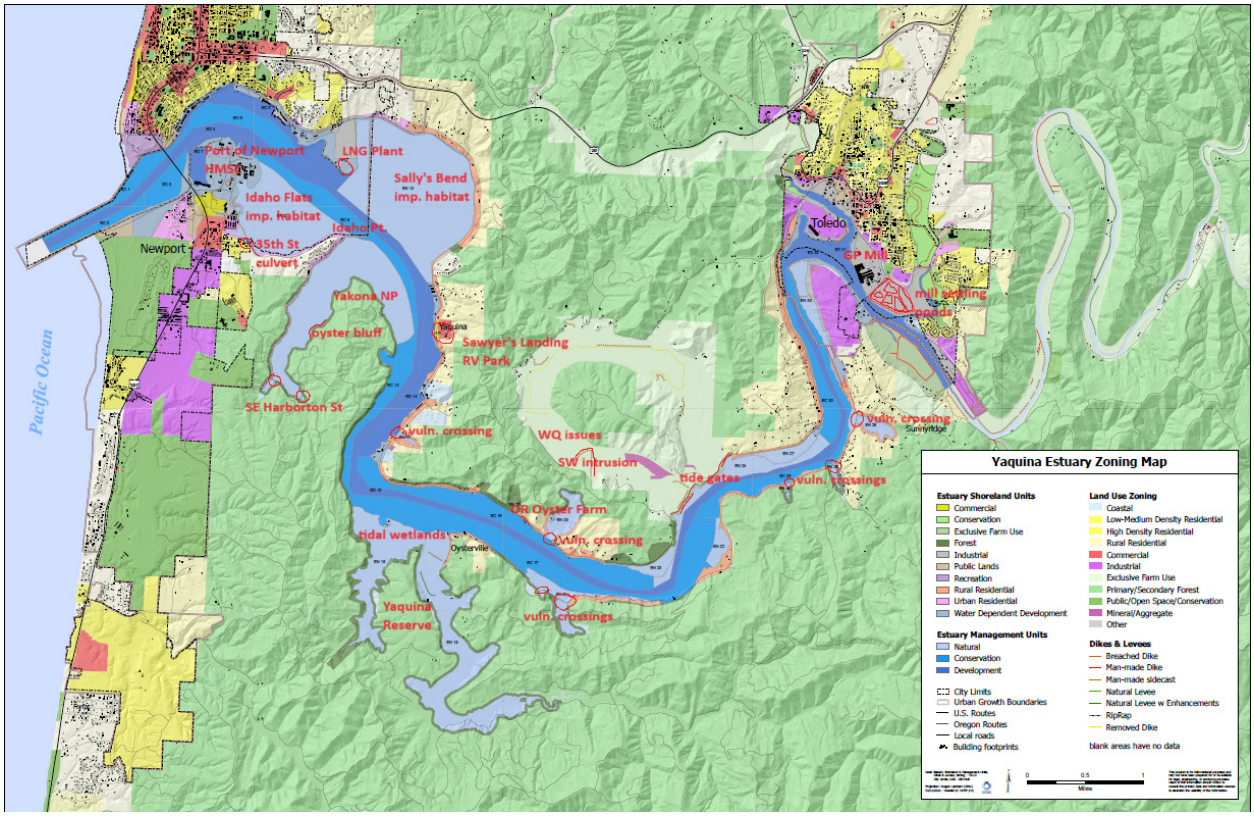

Lincoln City
Pacific Ocean
WWTP
low-lying areas
FW intake
Cutler City
bridge not retrofitted
Hwy 101 low-lying
breaching of spit
rip-rap
Siletz Keys
dikes
Siletz Estuary Zoning Map
Estuary Shoreland Units
Commercial
Exclusive Farm Use
Forest
Rural Residential
Urban Residential
Water Dependent Development
Estuary Management Units
Natural
Conservation
Dikes & Levees
Breached Dike
Man-made Dike
Man-made sidecast
Natural Levee
Natural Levee w Enhancements
Removed Dike
Land Use Zoning
Coastal
Low-Medium Density Residential
High Density Residential
Rural Residential
Commercial
Industrial
Exclusive Farm Use
Primary/Secondary Forest
Public/Open Space/Conservation
Mixed-Use
City Limits
Urban Growth Boundaries
U.S. Routes
Oregon Routes
Local roads
Building footprints

- **Hwy 101 bridge:** US Hwy 101 bridge over Drift Cr is not retrofitted and needs upgrades.
- **Hwy 101/Siletz:** US Hwy 101 along the east side of Siletz Bay is low-lying and vulnerable to inundation
- **Salishan Spit:** The Salishan Spit has occasionally been breached by high waters, threatening local residents. Older rip-rap nearby may be exacerbating the issue.
- **Lincoln WWTP:** The freshwater intake in Siletz Bay is experiencing saltwater intrusion, as well as in Beaver Cr. and Depoe Bay. The dikes around the wastewater treatment plant treatment ponds are also an asset of concern. Currently, Gleneden Beach is pumping their wastewater to Depoe Bay, but capacity is already strained. Upgrades are in the works.
- **Low-lying areas** such as Taft and Cutler City are vulnerable to flooding, and new construction is being built in these areas.
- **Siletz Keys:** The dikes around Siletz Keys are another asset of concern.

Depoe Bay

- **Boating:** Older docks being replaced now. Waterfront/moorage facilities vulnerable to impacts. High water (king tides, sea level rise) can make it difficult to cross the bar. There is a fleet of charter fishing boats in the harbor and many recreational fishermen that are sensitive to impacts in the harbor.
- **Salmon:** The City has a standing advisory commission for salmon enhancement. Focused on restoration and maintenance of N Depoe Bay Cr, which has spawning salmon that migrate to and from the reservoir. This is the primary local drinking water source as well.
- **Harbor:** The harbor has not been dredged in several years, and is not currently on USACE's calendar but needs to be done in the near future. USACE possibly interested in removal of dam on S Depoe Bay Cr to increase tidal flow.
- **Wastewater:** The City currently takes in wastewater from Gleneden district, and is now in the process of separating, but will take 5+ more years. The treatment plant has been updated several times but still needs more. Sewer infrastructure is aging and needs upgrades.
- **Stanley property:** There is a 12 acre parcel off of NE Stanley St that is steep, with poor access, zoned R5, and is an opportunity for residential development as well as nature-based solutions.
- **Estuary plan:** The City has an Estuary Management Plan from 1991 that is in need of updating.

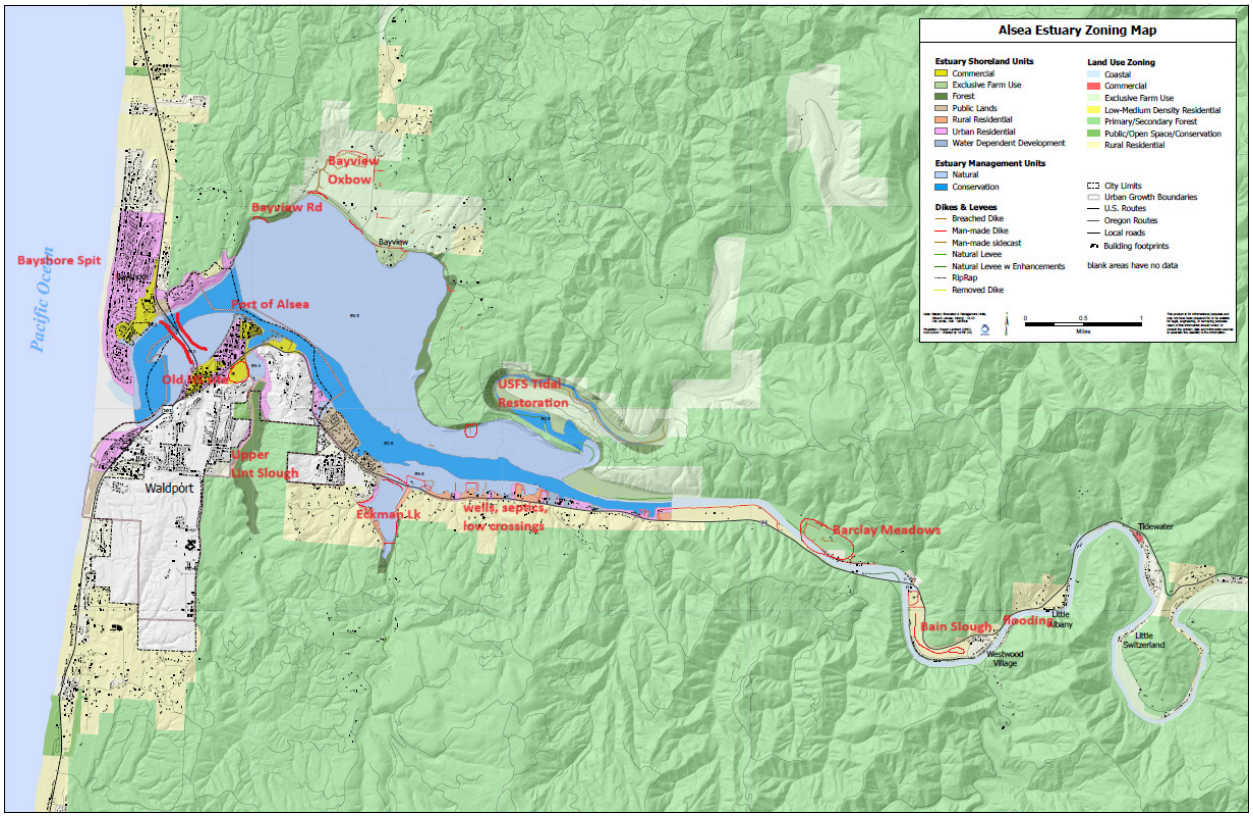
Yaquina Bay



- **HSMC:** HMSC, Port of Newport, NOAA facilities in low-lying area vulnerable to tsunami/sea level rise/storm surge. Seawater intake and sewer systems of particular concern at HSMC.
- **35th St:** 35th culvert needs upgrade with restoration of salt marsh
- **Idaho Point:** Idaho Flats identified as important habitat for many species. Idaho Point has some vulnerable (low-lying) residents, reliant on vulnerable road (35th St).
- **King Slough:** important habitat for many species with very good water quality amenable to aquaculture development. There is an oyster bluff on the east shore. SE Harborton St crosses the back end of the slough with two vulnerable dikes. Yakona Nature Preserve and Learning Center is on the eastern peninsula and relies on these crossings.
- **Sally's Bend:** tidal flats identified as important habitat for many species. LNG plant located in vulnerable (low-lying) spot.
- **Yaquina Bay Rd:** Sawyer's Landing RV Park in Yaquina is low-lying and vulnerable. Several low-lying crossings also vulnerable to sea level rise. Several tide gates at entrance to Boone-Nute Slough and may need upgrading. Some saltwater intrusion and water quality issues further up the slough, with local impacts to farming. Many restoration, mitigation, and carbon sequestration possibilities there.
- **S Bay Rd:** several vulnerable crossings over tidal wetlands between Oysterville and Sunnyridge, some with pipes.

- **Toledo:** Georgia-Pacific Mill site on waterfront and may be vulnerable. Mill settling ponds are extremely vulnerable to sea level rise, earthquake, and tsunami, and would have catastrophic impacts downstream if breached.

Alsea Bay



- **Bayshore Spit:** extremely vulnerable to sea level rise, earthquake, and tsunami. Many residents here in low-lying areas.
- **Highways:** US Hwy 101 Alsea Bay Bridge is vulnerable to earthquake. OR Hwy 34 only local E-W route connecting to valley and beyond.
- **Downtown Waldport:** Port of Alsea facilities, businesses, and residents in low-lying area on waterfront vulnerable to flooding.
- **Old HS site:** the site of the old high school is vacant and is being converted to a city park
- **Lint Slough:** tidal wetland restoration opportunities
- **Bayview Rd:** several low-lying spots that are actively crumbling and vulnerable to flooding and landslides. Some tide gates that may need upgrades. Bayview Oxbow is a former tidal wetland and there are possibilities for restoration.
- **Eckman Lake:** dike needs to be upgraded. Lake has water quality, HABs issues, with leaking septics contributing to issue. Roads around the lake and old tide gates at back end all need to be improved. Upstream inputs into lake need to be better understood.

- **North Channel:** there is a breached dike that is acting as a hydraulic impediment.
- **USFS:** there is a USFS site on the N. Fork Alsea with tidal restoration opportunities.
- **Drift Cr community:** leaking septics, saltwater intrusion into wells, abandoned properties, waste, low-lying residents, and some fish barriers all need to be addressed. Lots of tidal wetland restoration and conservation opportunities here.
- **Barclay Meadows:** old tide gates here blocking formal tidal wetlands that could be restored.
- **Bain Slough:** tide gate issues and a spruce swamp habitat here.
- **Westwood Village/Little Albany:** flooding issues in these isolated communities.

Other Areas

- The entire downtown area of Yachats and city government facilities are located in the tsunami zone. With one highway in and out of town, the town would be split into north and south as well as being unable to exit in either direction from the disaster. There is a large population of elderly with health issues, and water, food, and shelter will be stretched to the limits.
- US Hwy 101 is crumbling near Beverley Beach and could isolate residents if it fails. There are currently 27 active slides between Depoe Bay and Newport.

Listening Session Themes

More than 30 people participated in four listening sessions (one virtual, and one each in Newport, Waldport, and Lincoln City).

Sensitivity & Impacts

Critical Hazards

Table 30. Top natural hazard concerns for each listening session.

Listening Session	Critical Hazards Focus
Virtual	Tsunami, Sea Level Rise, Water Quality
Newport	Sea Level Rise, Water Quality
Waldport	Water Quality, Sea Level Rise
Lincoln City	Sea Level Rise, Erosion, Tsunami

The major hazard concerns expressed for Lincoln County estuaries focused on tsunami, sea level rise, and impacts related to water quality and erosion. Tsunami concerns focused on the immediate potential for damage to infrastructure, loss of life, disruption to transportation and services, and isolation of residents and communities. For longer-term, more chronic impacts, flooding associated with sea level rise was expressed most frequently. This threat is compounded by other flood-related hazards such as storm surge and king tides, and will also accelerate erosion processes. Not only will this impact roadways and infrastructure, but also a great deal of concern was expressed for impacts to habitats, fish, and wildlife, particularly with inundation of tidal wetlands. Water quality issues derive from several sources, including non-point source pollution such as herbicides/pesticides and failing septics. Erosion threats from inundation, storm events, and wildfire are a particular threat to transportation connectivity and function. Wildfire was also occasionally mentioned, with the recent fires in 2020 as a clear reminder of the need for communities to prepare.

Participants on average ranked sensitivity of assets, resources, and populations to their most concerning hazards as **VERY HIGH** (a large hazard event will have moderate to devastating effects on the resource, or chronic events will have moderate to devastating effects in the short-term). With respect to time to return to normal levels, participants on average ranked recovery time as **VERY HIGH**, taking one or more decades to achieve recovery, with some assets, resources, and populations viewed as unable to return to normal. The impact of external stressors on vulnerable assets, resources, and populations was seen as **HIGH**. The degree to which these assets, resources, and populations are expected to be impacted by the hazards of concern is seen as **HIGH** (major damage/impact is substantial or irreversible). Most of the local

population was seen to have **VERY HIGH** risk to adverse hazard impacts. Overall, the anticipated impact of the most concerning hazards was viewed as **VERY HIGH**.

Stressors

Climate change was the most frequently expressed chronic stressors on local resources and populations, with concerns that increased intensity and frequency of storms, drought, winds, or other weather extremes will create challenges for natural habitats and human infrastructure. Participants felt that lack of adaptability of government planning and policy and community assets in general (e.g. inability to move out of low-lying areas) will exacerbate the impacts of natural hazards. This was often attributed to lack of resources, funding, and/or staff for planning, and there is concern it will disproportionately impact underserved communities (e.g. retired, disabled, low SES).

Catastrophic Impacts

The primary catastrophic impacts expected from the major hazards of concern focus on social factors including transportation safety and connectivity for safe egress and access to resources such as food, water, and medical services. Impacts to local economies are also concerning, particularly for affected businesses and workers in waterfront areas, and for low-income and underserved communities. Concerning environmental impacts include reductions in water quality and availability, impacts to habitat diversity, soil degradation and erosion.

Long-term/Indirect impacts

Second-order hazard impacts that play out over time will also be costly and should be considered. These include long-term alterations to natural resources such as reductions in rearing habitat or tidal wetlands for key species, including those that are commercially important such as salmon and crab. Impacts to low-lying areas with infrastructure, residents, and businesses that may become isolated or eliminated are also of primary concern. Loss of life, jobs, homes, and employment could have major downstream negative effects on communities. There is fear that irreplaceable socially and culturally important assets could also be destroyed, or that rebuilding could take decades.

Adaptive Capacity

Current and Future Needs

In order to determine how adaptive a sector will be to future scenarios, an understanding of a community's current needs is necessary. For the mid-term and long-term, two themes emerged: 1) the need for increased education and awareness of hazard threats and potential impacts for local residents, businesses, and tourists, and 2) preparation, build-up, and maintenance of existing resources to increasing communities' ability to buffer hazard impacts. Because many significant impacts may not be felt for decades, efforts to increase awareness

should start now to help prepare communities for chronic issues (e.g., sea level rise) and vulnerabilities, and understand the array of potential solutions including nature-based solutions. Implementing solutions will require funding, staffing, and planning to maintain and upgrade existing resources, and build up supplies and redundancies. Key infrastructure such as water treatment plants and sewage are strained to capacity and it will take time to upgrade and expand operations. Adaptive and up-to-date municipal planning and zoning can help prepare vulnerable areas, populations, and resources through efforts such as managed retreat. Funding and support for multi-organizational partnerships can help protect ecosystem services, drinking water, and infrastructure.

Current and future needs were ranked on average as **HIGH**.

Planning and Upgrades

Upgrading and retrofitting infrastructure is a costly endeavor and many communities do not have the tax base to generate the necessary revenue, relying instead on federal funds. Planning will require public willingness and involvement, requiring staff time and funding. These efforts should focus on identifying tidal wetland restoration projects, removing old dikes and non-functional tide gates, restoring unproductive farm lands, etc. to help mitigate flooding and improve sediment deposition. Several vulnerable areas on US Hwy 101 are in vulnerable and in need of costly upgrades (e.g., Beverley Beach, Siletz Bay). Older infrastructure such as roads, bridges, pilings, and shoreline protections will also need to be removed or replaced, and need to be facilitated by low-barrier planning, zoning, and permitting.

Given catastrophic failures of the major vulnerable systems, costs to recover were seen as **HIGH**, likely costing between $10 million - $1 billion. The difficulty to achieve this recovery was ranked generally as **HARD** to **VERY HARD**, and preparedness for planning and upgrades was generally seen as **MEDIUM**.

Limiting Factors

Many external factors affect the function and operation of major systems. Funding is seen as the major key limiting factor for an array of issues, and is ancillary to staff capacity and politics. Bureaucratic hurdles are perceived as challenging to progress, including zoning, permitting, conflicting property rights, and other regulatory barriers. Public understanding and awareness and its effects on politics and decision-making were also frequent concerns. Other factors including an aging population, landowner buy-in and willingness to participate, outdated planning (e.g., Estuary Management Plans), lack of data and information for planning, and other competing interests. Partnerships were seen as critical to addressing current needs, but many organizations are viewed as unable to keep up with local needs.

The impact of limiting factors was ranked generally as **HIGH**.

Sector Interdependencies

It is important to understand which systems in a community or organization are fundamentally reliant upon another. The systems identified as most relied upon were natural systems (e.g., watersheds, forests, wetlands, parks/open spaces), drinking water, and communications (e.g., internet ,telephone, television, radio). Key system interdependencies identified include drinking water, natural systems, and culture/community (e.g., non-profits, churches, tribes). Other interdependent systems frequently mentioned include business/industry, food (e.g., agriculture, processing, distribution/storage, wholesale/retail), and governance. Concerns for these interdependencies focused on redundancies, supply stockpiles/caches, and sensitivities of ecosystem services.

Interdependency of major systems were generally ranked as **HIGH**.

Adaptation and Mitigation

Most participants reported awareness of organizational emergency plans within their own organizations or local government. There was broad awareness of Lincoln County Emergency Management and North Lincoln CERT plans in particular. Emergency preparedness (e.g., tsunami and fire evacuation) was the top concern, with other efforts reported for long-term planning focused on sea level rise, renewable energy alternatives, and water conservation and access. Some of these plans and efforts incorporate nature-based solutions, particularly those in natural resource fields.

Adaptability and mitigation with respect to planning was generally ranked as **MEDIUM**.

Additional Information

Overall, based on the discussion and assessment, participants generally ranked Adaptive Capacity as **MEDIUM**. The greatest concerns focus on earthquake/tsunami impacts and sea level rise, with expressed need for continued planning and engagement with organizations and communities to prepare for the worst impacts of major hazards.