Lane County

Estuarine Resilience Action Plan

2025

Prepared for the communities and residents of Lane County
with support from the Siuslaw Watershed Council,
Oregon State University Extension Service, and Oregon Sea Grant.

OREGON
Coastal Management Program
DEPARTMENT OF LAND CONSERVATION & DEVELOPMENT

Lane County

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Cover photo: Aerial view of Duncan Inlet. 2014.
Courtesy of LightHawk.

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Executive Summary

The Lane 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 Lane 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.

Lane County's estuaries, the Siuslaw River, Siltcoos River, Sutton Creek, and several smaller coastal creeks 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 Lane 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 Lane County ERAP identifies a range of vulnerabilities across the county's estuarine systems, with site-specific issues concentrated in and around the Siuslaw River estuary and adjacent floodplain. While some challenges are unique to particular areas, several recurring themes emerged across the estuaries.

Flooding and Infrastructure Exposure: Regular flooding along low-lying roads remains a persistent issue, particularly between Florence and Mapleton where portions of OR Highway 126 and local access routes flood during high river flows. These disruptions affect emergency response and can isolate rural residents. In Florence, key facilities and community assets are located in flood-prone areas near the Siuslaw River. Inundation risks to these systems are expected to increase with rising groundwater levels and more intense storm events.

Water Quality Impairments: The Siuslaw River estuary remains impaired for multiple beneficial uses due to elevated bacteria levels, low dissolved oxygen, and elevated temperatures. High nutrient concentrations in the North Fork watershed may contribute to these impairments. Florence's aging stormwater and wastewater infrastructure has been identified as a contributing factor, particularly in older neighborhoods without modern stormwater controls. Failing septic systems in unincorporated areas, including around North Fork and Sutton Lake, may also pose a risk to downstream water quality.

Estuarine Habitat Loss and Degradation: The Siuslaw River estuary has experienced extensive historic habitat loss, with over 65% of tidal wetlands diked or filled. Remaining habitats are fragmented by road and dike infrastructure, limiting fish passage and floodplain connectivity. Ongoing restoration efforts such as those led by the Siuslaw Watershed Council and Mckenzie River Trust have made progress in reestablishing tidal flow and habitat function. Significant restoration potential remains however, particularly around haich ikt'at'uu (formerly Waite Ranch), North Fork Marsh, and the lower river floodplain.

Invasive Species Pressures: Invasive plants such as reed canarygrass, purple loosestrife, and Himalayan blackberry are widespread in the Siuslaw River estuary and adjacent wetlands, suppressing native plant communities and complicating restoration efforts. Gorse, a fire-prone invasive shrub that has caused serious problems on the South Coast, has not yet established in the Siuslaw River basin, but poses a growing threat. Early detection and rapid response will be critical to prevent further spread.

Earthquake and Tsunami Hazards: Much of the estuary-adjacent land in Florence lies within the tsunami inundation zone, including major roadways, the wastewater treatment plant, and residential areas. While vertical evacuation options exist in parts of the city, several low-lying neighborhoods and rural areas lack accessible evacuation routes or designated high-ground refuges. Mapleton, though located upstream where tsunami threat is reduced, is highly vulnerable to strong ground shaking and associated landslides along steep slopes.

Land Use and Regulatory Constraints: Restoration and adaptation efforts face challenges from existing land uses, including residential development and active agricultural operations in floodplains. Diked lands upstream of Florence provide restoration opportunities but may also require significant coordination with landowners and changes to existing land management practices. In unincorporated areas, inconsistent enforcement of septic system standards and limited local planning capacity can constrain resilience investments.

Community Capacity and Coordination Needs: Numerous partners are actively engaged in habitat restoration, water quality improvements, and hazard planning, but coordination across jurisdictions and sectors remains a challenge. Florence and Lane County each manage aspects of land use and infrastructure, while restoration initiatives rely on outside funding and nonprofit leadership. Stronger collaboration and shared implementation pathways will be necessary to align long-term estuary resilience actions with existing local priorities and resource constraints.

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 Lane 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. It provides tools and information to help partners advance estuary resilience efforts over time. The plan 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 Lane 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 Lane 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: Waite Island, 2014. By LightHawk.

I. Introduction

Image: Siuslaw Marina, 2020. By John Bragg.

Coastal Lane County, Oregon, with its rich estuarine systems and dynamic coastal geography, faces a complex array of challenges as natural hazards and environmental pressures continue to intensify. Communities throughout the county are closely tied to key estuarine areas like the Siuslaw River estuary, the Siltcoos River, and several smaller coastal creeks. These estuaries provide essential habitats for fish, wildlife, and aquatic vegetation while supporting tourism, fishing, and recreation — making them vital to the local economy, cultural identity, and ecological health.

However, persistent threats such as climate change, sea level rise, increased storm intensity, coastal erosion, and tsunami pose growing risks to these ecosystems and the communities that depend on them. These vulnerabilities are further compounded by pressures from land development, water quality concerns, and habitat loss, underscoring the need for a robust and forward-thinking approach to resilience planning.

Lane County has laid important groundwork through past efforts in conservation, restoration, and hazard mitigation, but there remains 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, science-based actions to protect and restore estuarine ecosystems while safeguarding community interests.** By focusing on

both immediate vulnerabilities and long-term sustainability, Lane 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 received funding from the National Fish and Wildlife Foundation's (NFWF) National Coastal Resilience Fund (NCRF) to develop an Estuarine Resilience Action Plan (ERAP) for Lane 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 is designed through a collaborative, community-driven approach, involving stakeholders 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 that 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 Lane 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. 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 relied 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 Florence developing infrastructure and industry around their rich natural resources. 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. 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 industry 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 13.9% of Lane 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 about flood risks can present accessibility challenges. Furthermore, rural coastal

areas of Lane County, including communities such as Mapleton and Florence, face unique challenges such as higher poverty rates, limited access to healthcare, and reduced availability of 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 11.7% of Lane County's population in 2023 (US Census Bureau, 2023), underscores 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 Lane 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

Lane 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 Lane County

Lane County, located on the central coast of Oregon, is defined by its diverse natural landscapes, including rugged shorelines, extensive sand dunes, lush forests, and dynamic estuarine systems. The county's coastal geography features dramatic scenery where rivers meet the Pacific Ocean, creating rich estuarine environments that serve as ecological and economic anchors for local communities. The Siuslaw River, the largest in coastal Lane County,

stretches approximately 110 miles from the Coast Range to its mouth at Florence and is influenced by tides up to 26 miles inland, forming a dynamic estuarine zone where freshwater and saltwater mix. Other notable waterways, such as the Siltcoos River, Sutton Creek, and smaller coastal creeks like Tenmile, Rock, Big, China, Cape, and Berry Creeks, further contribute to the region's ecological diversity.

These estuarine areas are vital ecological zones that support a variety of habitats, including tidal marshes, mudflats, and freshwater wetlands. They provide crucial breeding and feeding grounds for numerous species of fish (Figure 1), birds, and other wildlife. Anadromous fish such as coho and Chinook salmon and steelhead trout rely on these estuaries during critical life stages, underscoring their ecological importance to both freshwater and marine systems.

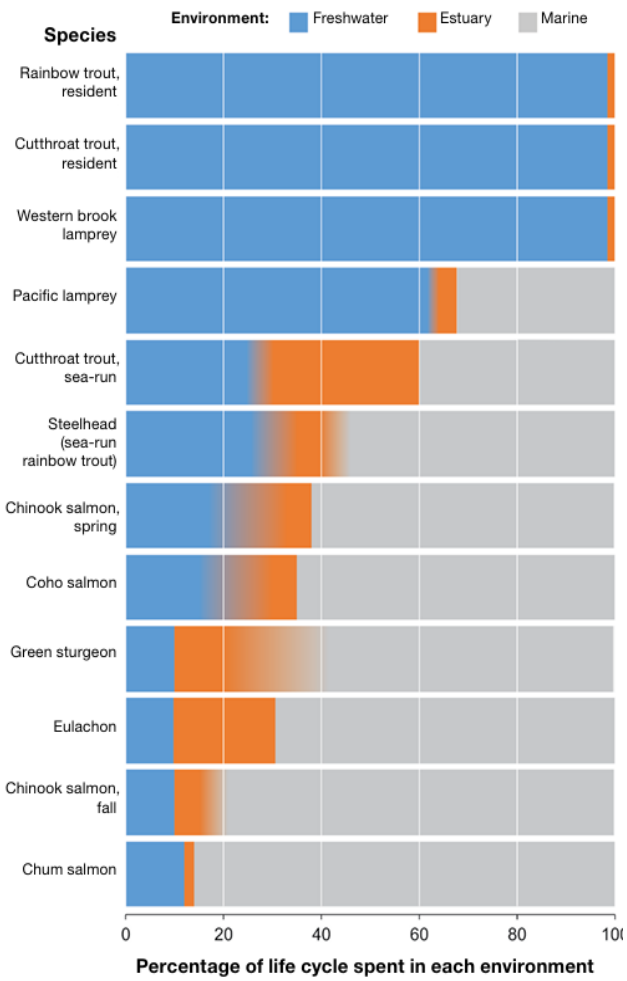


Figure 1. Generalized proportion of the life cycle of focal fishes in freshwater, estuary, and marine environments of coastal Oregon. Source: USFS Climate Change Vulnerability and Adaptation in Coastal Oregon (2024). Note: there are presently no resident rainbow trout in the focal streams and tributaries for this plan. White sturgeon are present with similar life cycles to Green sturgeon.

Historically, Lane County's coastal communities, including Florence and Mapleton, have been shaped by industries tied to these estuaries, such as fishing, farming, and forestry. Today, while these traditional sectors remain important, the region has increasingly turned to tourism, outdoor recreation, and retirement living, drawn by its natural beauty and proximity to dunes, rivers, and oceanfront. These estuarine environments continue to play a vital role in supporting both the local economy and the area's environmental health, making their conservation and management an ongoing priority.

The health of fish and wildlife in Lane County's estuaries is closely tied to the structure and function of the broader landscape. Tidal wetlands, river 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 and streamflow alteration to invasive species, 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 natural dynamics and human activities are constantly shaping ecological conditions.

At the same time, Lane County's coastal areas face persistent natural hazards, including flooding from the Siuslaw and other rivers, erosion of beaches and dunes during El Niño events, tsunami risk, severe winter storms, and landslides, all of which are compounded by the long-term impacts of climate change. Balancing the preservation of these unique estuarine ecosystems with the safety and prosperity of coastal communities remains a central challenge and priority for the county's resilience and conservation efforts.

Siuslaw Estuary: A Complex and Dynamic System

The Siuslaw River estuary is the largest and most ecologically diverse estuary in Lane County, spanning from the river mouth at Florence to the upper tidal reaches near Mapleton. This estuarine system encompasses a mosaic of tidal wetlands, forested sloughs, and intertidal mudflats, each playing a critical role in supporting fish, wildlife, and water quality. The estuary provides essential habitat for Chinook and coho salmon, as well as Pacific lamprey, steelhead, and cutthroat trout. Extensive eelgrass beds near the river mouth contribute to estuarine productivity, stabilizing sediments and providing shelter for Dungeness crab, juvenile fish, and other marine organisms. Farther upstream, near Mapleton, tidal influence gradually diminishes, transitioning into a freshwater-dominated system. However, this upper estuary remains a critical transition zone for anadromous fish, as well as an area where sediment transport and water quality dynamics shape the overall health of the system.

The North Fork Siuslaw River is a particularly important tributary within the estuary, containing a network of tidal channels and expansive wetlands that support salmonid rearing and migration. Significant restoration efforts have focused on this area, aiming to reconnect historic floodplains, enhance fish passage, and restore degraded wetlands. These projects have helped improve habitat complexity, benefiting juvenile salmon that rely on off-channel areas for refuge and feeding.

Several islands, backwater sloughs, and marsh complexes throughout the Siuslaw River estuary provide key foraging and nesting areas for waterfowl, shorebirds, and raptors. The presence of these diverse habitats underscores the Siuslaw's ecological significance, but ongoing challenges such as sedimentation, sea level rise, and habitat fragmentation necessitate continued conservation and adaptive management.

Smaller Estuaries: Siltcoos, Sutton, and Other Coastal Creeks

While the Siuslaw dominates Lane County's estuarine landscape, several smaller estuaries also contribute to the region's ecological richness.

Siltcoos Lake and its Outflow

Siltcoos Lake, located south of Florence, is the largest coastal lake in Oregon and serves as the headwaters for the Siltcoos River, which forms a small but ecologically valuable estuary at its confluence with the Pacific Ocean. The lake and its associated wetlands provide important habitat for coho salmon, cutthroat trout, and a variety of bird species. Water level management and past modifications, including the construction of a dam near the lake's outlet, have altered hydrological conditions, affecting fish passage and wetland and estuarine dynamics. Restoration efforts have focused on improving connectivity between the lake, estuary, and ocean to enhance habitat for salmonids and other aquatic species.

Sutton Creek Estuary

Sutton Creek, north of Florence, has undergone significant modification over time, with diking and past development altering tidal exchange and wetland structure. While less-studied than larger estuarine systems, Sutton Creek and its wetlands provide critical habitat for estuarine-dependent fish and invertebrates. The surrounding dunes and forested wetlands also contribute to the hydrology of the system, influencing seasonal freshwater inputs and sediment deposition. Efforts to restore natural hydrology and tidal connectivity could enhance the resilience of this small but ecologically valuable estuary.

Other Coastal Creeks

Several other small creeks along the Lane County coastline form seasonal or intermittently open estuaries that provide important habitat for native fish and wildlife. Many of these systems have been affected by past land use changes, including road construction, culvert installations, and alterations to natural drainage patterns. While these estuaries may be small in size, their role in supporting migratory fish and maintaining coastal ecosystem connectivity is significant. Identifying opportunities to restore tidal exchange and improve fish passage in these smaller systems remains an important component of broader estuarine resilience efforts in Lane County.

Coastal Lane County's small estuarine creeks, Tenmile Creek, Rock Creek, Big Creek, China Creek, Cape Creek, and Berry Creek, provide critical ecological functions despite limited systematic studies. Each creek supports diverse riparian and estuarine habitats that are vital for both wildlife and local ecological diversity. These systems face interconnected challenges from habitat constraints and climate-linked hazards.

Tenmile Creek enters the ocean at Stonefield Beach State Recreation Site and supports federally threatened fish species, including coho and Chinook salmon, steelhead trout, and historically, the eulachon smelt, an important forage fish once abundant along the Oregon Coast. Its watershed is home to Roosevelt elk, black-tailed deer, cougar, black bear, Bald Eagles, and potentially Marbled Murrelets and Northern Spotted Owls.

Rock Creek flows through the 7,486-acre Rock Creek Wilderness, entering the ocean near Rock Creek Campground about 10 miles south of Yachats. This creek winds through dense coniferous rainforest dominated by old-growth Douglas fir and Sitka spruce, with bigleaf maple and red alder lining its banks. It provides habitat for coastal cutthroat trout and intermittently for runs of coho salmon and steelhead trout.

Big Creek, which empties into the ocean north of Heceta Head, forms a valuable freshwater wetland near its mouth. This wetland offers critical rearing habitat for young salmonids, including coho, Chinook, steelhead, and coastal cutthroat trout, as they transition to ocean-going adulthood. The surrounding forested watershed also contributes to the area's rich biodiversity and offers opportunities for outdoor recreation, particularly in the lower sections which are owned by the Oregon Parks and Recreation Department.

Together, these smaller creek systems illustrate the ecological richness of Lane County's coastal streams, supporting both threatened fish species and diverse terrestrial wildlife within their forested watersheds. The Rock Creek Wilderness, along with the nearby Cummins Creek and Drift Creek Wilderness areas, forms part of a network of protected lands in the central Oregon Coast Range. This cluster of wilderness areas, established in 1984 within the Siuslaw National Forest, represents some of the most intact and remote coastal rainforest ecosystems in the region. Characterized by steep, forested slopes and pristine streams, these wilderness areas offer a glimpse into the primeval landscape of the Oregon Coast, with old-growth Sitka spruce, western hemlock, and Douglas fir forests that have remained largely unchanged by human activity. The proximity of these wilderness areas to each other enhances their ecological value, providing contiguous habitat for wildlife and preserving the natural processes of these coastal watersheds.

All these systems likely serve as important stopovers for migratory birds and support local wildlife populations. However, critical data gaps regarding ecological conditions, species populations, estuarine functions, and natural hazard risk exist for these systems, particularly for China, Cape, and Berry Creeks.

While specific flood histories for these creeks are poorly documented, regional patterns indicate vulnerability to December-January flooding from rain-on-snow events, as evidenced by Lane County's 1964 and 1996 disasters (DLCD, 2015). Coastal Lane County's small estuarine creeks likely experience amplified flood risks due to limited floodplain connectivity from historical wetland loss, increased sedimentation from erosion-prone geological formations (e.g., Flournoy Formation siltstones), and climate-driven precipitation intensification (Mote et al., 2019).

Future Considerations

The future of Lane 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 Lane County's estuaries remain ecologically functional in the face of a changing climate (OCCEC, 2021).

Planning Context for Estuary Resilience

The estuaries in Lane County, particularly the Siuslaw River, have been significantly altered by development, affecting floodplains, hydrology, habitats, species, and infrastructure. For example, the construction of dikes and levees in the Siuslaw estuary during the early 20th century aimed to reclaim land for agriculture but significantly disrupted natural estuarine processes, including tidal exchange and nutrient cycling (Lane County, 1984). 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. Restoration projects such as those facilitated by the **Mckenzie River Trust**[1] and **Siuslaw Watershed Council**[2], have focused on re-establishing tidal wetlands, restoring riparian vegetation, and improving fish passage. These efforts aim to address habitat fragmentation and declining water quality, which are critical for the recovery of native fish and other aquatic species (Siuslaw Watershed Council, 2019).

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

[1] https://mckenzieriver.org/
[2] https://www.siuslaw.org/
[3] https://www.oregon.gov/lcd/op/pages/goals.aspx

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 guidance for managing estuaries, shorelands, and ocean resources while balancing the needs of natural systems with human activities. 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 the Siuslaw River are given an overall management designation (as described above) and then are further divided into one of three estuary management units based on ecological characteristics and past and potential future uses. These units are Natural, Conservation, and Development, each with specific allowable activities and protections outlined by Goal 16. For example, Natural management units prioritize habitat preservation and prohibit intensive development, while Development management units accommodate water-dependent uses like marinas or ports, provided they align with environmental safeguards. This aquatic 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. The Siuslaw River estuary is the only major estuary in Lane County. There are also five minor estuaries in the county, in addition to many coastal lakes. 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, Lane County's coastal resource management and planning strives for balancing ecological integrity and economic development. Lane County implements all of the coastal land use goals through the **Lane County Coastal Resource Management Plan**[4]. Updating and improving this coastal resource management plan can also offer 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.

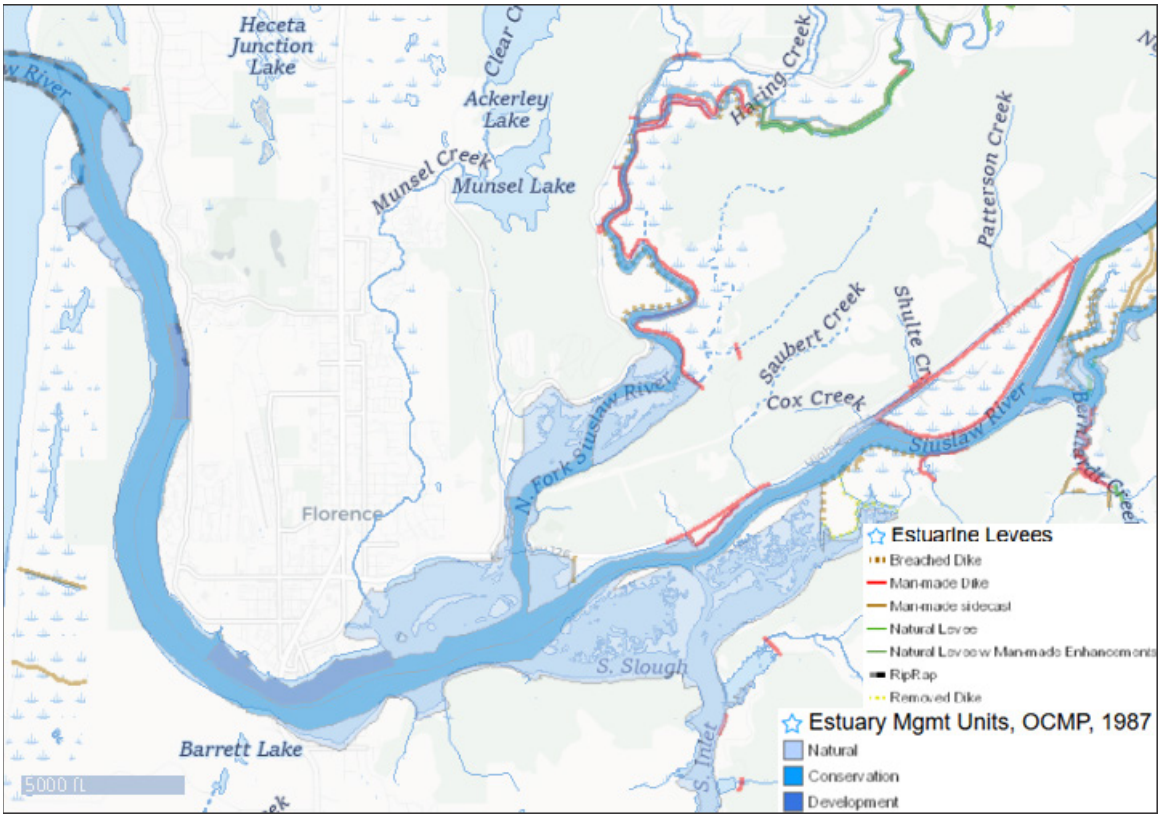


Figure 2. Siuslaw River Estuary Zoning. Source: Oregon Estuary Planning Tool[5].

Lane County and the coastal cities within the county implement the requirements of the Statewide Land Use Planning Goals through their comprehensive plans and development ordinances, which regulate a range of uses and activities from housing to transportation to natural resource protections. These efforts include enhancing water quality, mitigating flood risks, and promoting resilience to climate change impacts, such as sea level rise and storm surge (City of Florence, 2021). Such policies ensure that estuaries and the communities surrounding

[4] https://cdnsm5-hosted.civiclive.com/UserFiles/Servers/Server_3585797/File/Government/County%20Departments/Public%20Works/Land%20Management%20Division/Land%20Use%20Planning%20Zoning/Coastal%20Resources%20Management%20Plan_2006.pdf

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

them can sustain critical habitats for salmon, migratory birds, and shellfish while supporting recreational, cultural, and economic activities.

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 Lane County's estuaries and coastal creeks 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, Big, Cape, Sutton, Sweet, and Knowles Creeks are all impaired for temperature, as well as all estuarine reaches of the Siuslaw River. Additionally, several estuarine areas may face impairments from bacteria (*E. coli*), dissolved oxygen, nutrients, and sedimentation, particularly the Siuslaw River, but most have yet to be assessed or lack sufficient data to make a determination. 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 Lane County Estuarine Areas

Estuary	Temperature	Bacteria (*E. coli*)	Dissolved Oxygen	Nutrients (N, P)	Sediment/ Turbidity
Tenmile Creek N.	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Rock Creek	Not listed	Not listed	Insufficient	Not listed	Not listed
Big Creek	Impaired	Not listed	Not listed	Not listed	Not listed
China Creek	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Cape Creek	Impaired	Not listed	Insufficient	Not listed	Not listed
Berry Creek	Not assessed	Not assessed	Not assessed	Not assessed	Not assessed
Sutton Creek	Impaired	Not listed	Not listed	Not listed	Not listed
Siuslaw River Mainstem Lower	Impaired	Impaired	Not listed	Not listed	Impaired
Siuslaw River Mainstem Upper	Impaired	Impaired	Not listed	Not listed	Not listed
North Fork Siuslaw River	Impaired	Not listed	Not listed	Not listed	Impaired
Sweet Creek	Impaired	Not listed	Not listed	Not listed	Not listed
Knowles Creek	Impaired	Not listed	Not listed	Not listed	Not listed
Siuslaw River Lake Creek to Berkshire Creek	Impaired	Impaired	Not listed	Not listed	Impaired
Siltcoos River	Not listed	Insufficient	Not listed	Not listed	Not listed

Source: Oregon DEQ 2022 Integrated Report[6]

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

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

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 Siuslaw. 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 Lane 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. State agencies are likely to participate in updates to local comprehensive plans for coastal resources, 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 and coastal shoreland matters during individual permit reviews. There are many benefits in taking the time to modernize and update comprehensive plans for coastal resources. Policy adoption and implementation (usually through permitting) shapes over time how the land and water are developed, how resources are protected or restored, and how impacts from activities are avoided or minimized. The possibility of new development or changes to existing development means new challenges and implications for Oregon's estuaries, such as navigation channel expansions, new construction for infrastructure, and additional vessel traffic and mooring. Additionally, increasing protections through policy for coastal habitats can lead to community co-benefits such as flood reduction, improved water quality, increased recreation opportunities, and storm buffering. There is a critical need for dedicated investments to update comprehensive plans for coastal resources, understand new information, coordinate among jurisdictions and tribes, and develop and implement new or updates policies.

Regional and Nonprofit Collaborations

Organizations such as the Siuslaw Watershed Council (SWC), Mckenzie River Trust (MRT), 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 on the Siuslaw River has reconnected tidal flows and improved wetland habitats by removing old levees and excavating tidal channels, benefiting juvenile salmon rearing habitat and estuarine wetlands. Led by CTCLUSI, MRT, SWC, and numerous other partners, this work supports broader efforts to restore natural estuarine processes and enhance resilience in the Siuslaw River estuary, benefiting from partnerships that leverage both state and federal resources.

Study Area

The focal area encompasses coastal Lane County's estuarine systems, including the Siuslaw River estuary, the North Fork Siuslaw River, and smaller tidal systems such as Siltcoos River, Tenmile Creek, Big Creek, Berry Creek, and Sutton Creek, along with their adjacent historic tidal floodplains and surrounding communities (see Table 2 for additional details). These estuarine environments support diverse habitats, species, and economic activities, forming critical connections between natural ecosystems and human communities. Each estuary's management designation under Oregon's Goal 16 reflects its ecological and economic roles, guiding conservation priorities and permissible uses.

The Siuslaw River estuary is designated as a "**Shallow-draft Development**" estuary, balancing navigation, economic activities, and ecological functions. This designation allows for dredging to maintain navigation channels, waterfront commercial activities, and water-dependent development while requiring careful management of ecological resources.

Table 2. Characteristics of Lane 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***
Tenmile Creek North	Riverine	Tidally restricted coastal creek	Natural	4	N/A	0.24
Rock Creek	Riverine	N/A	N/A	1.68*	N/A	N/A
Big Creek	Riverine	N/A	Natural	4	N/A	1.7
China Creek	Riverine	N/A	N/A	0.52*	N/A	N/A
Cape Creek	Riverine	N/A	N/A	1	N/A	0.07
Berry Creek	Riverine	Tidally restricted coastal creek	Natural	1	N/A	N/A
Sutton Creek	Riverine	Tidally restricted coastal creek	Natural	30	N/A	13
Siuslaw River	Riverine	Moderately river-dominated drowned river mouth	Shallow-draft development	6,320	50%	3,324
Siltcoos River	Riverine	Tidally restricted coastal creek	Natural	79	N/A	21

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

Siltcoos River, Tenmile Creek, Big Creek, Berry Creek, and Sutton Creek are designated as "**Natural**" estuaries, emphasizing the preservation of significant fish and wildlife habitats. These areas have stringent restrictions on major alterations and development to protect their

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

ecological functions. Siltcoos River, the largest of these systems, supports a dynamic coastal lagoon, wetlands, and critical habitat for salmonids, migratory birds, and other estuarine-dependent species. Tenmile Creek serves as an important corridor for fish migration and supports riparian and estuarine wetlands. Big Creek and Berry Creek, located north of Florence, flow through forested uplands and wetlands, providing key habitat for native fish and wildlife. Sutton Creek, which meanders through dune wetlands near Sutton Lake, supports a mosaic of freshwater and tidal habitats that contribute to the broader resilience of Lane County's coastal environment.

These estuary management designations[8], shaped by Oregon's land-use planning framework, help coastal Lane 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

Work to develop this ERAP in Lane County was guided by a steering committee composed of local land use, natural resource management, 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. SWC served as the lead local partners, helping to guide ERAP development. Other participating organizations include:

- City of Florence
- Confederated Tribes of Coos, Lower Umpqua and Siuslaw Indians
- Confederated Tribes of Siletz Indians
- Lane County
- Mckenzie River Trust
- OR Shores Conservation Coalition
- Oregon Department of Fish and Wildlife
- Oregon Department of Geology and Mineral Industries
- Oregon Department of State Lands
- Oregon Parks and Recreation Department
- Oregon State University
- Oregon State University Extension Service
- Port of Siuslaw
- Siuslaw Soil and Water Conservation District
- The Nature Conservancy
- The Wetlands Conservancy
- US Fish and Wildlife Service
- US Forest Service

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

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:

Siuslaw Watershed Council[9]

The SWC is dedicated to protecting and restoring the ecological health of the Siuslaw River watershed and surrounding coastal ecosystems. Their work emphasizes habitat restoration, water quality improvement, and community engagement to support fish and wildlife populations, particularly salmon.

Key Restoration Efforts

- **Siuslaw Estuary Habitat Restoration:** SWC has been involved in efforts to restore tidal wetlands and improve fish passage in the Siuslaw River estuary. This includes breaching dikes, removing or replacing undersized culverts, and restoring tidal channels to enhance habitat for coho salmon, Chinook salmon, and other estuarine-dependent species.
- **Indian Creek and North Fork Siuslaw Restoration:** These projects focus on restoring floodplain connectivity and enhancing in-stream habitat complexity through large wood placement, side-channel reconnection, and riparian plantings. These efforts improve habitat conditions for salmon and other aquatic species while increasing the watershed's resilience to climate change.
- **Riparian and Upland Restoration Projects:** SWC works with landowners to restore riparian buffers, control invasive species, and replant native vegetation along tributaries of the Siuslaw River. These projects improve water quality, decrease stream temperature, stabilize streambanks, increase groundwater storage, and provide critical habitat for fish and wildlife.

Key Reports and Products

SWC produces a variety of reports that inform restoration planning and assess watershed conditions:

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

- **Annual Reports** document ongoing restoration projects, monitoring efforts, community engagement initiatives, and local economic contributions, providing a comprehensive overview of SWC's impact.
- **Watershed Assessments**, such as the Siuslaw Watershed Assessment, offer data-driven analyses to identify restoration priorities and strategies.
- **Habitat Restoration Plans** outline specific actions to improve estuarine and freshwater habitats within the watershed, guiding future conservation efforts.

Through these initiatives, SWC plays a vital role in restoring and protecting the Siuslaw River watershed, ensuring long-term ecological resilience and benefits for fish, wildlife, and local communities.

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 Lane County that informed this effort.

Lane County Climate Action Plan (2022)[10]

The Lane County Climate Action Plan serves as a comprehensive framework to address climate change within the county. Structured in three phases: Internal Operations Climate Action Plan, Greenhouse Gas Reduction Plan, and Climate Adaptation and Resilience Plan, the plan outlines strategic actions to mitigate greenhouse gas emissions and enhance community resilience against climate-induced hazards. By focusing on both mitigation and adaptation strategies, the plan is instrumental in identifying vulnerabilities, particularly in estuarine areas, habitats, and communities susceptible to natural hazards such as sea level rise, increased storm intensity, and coastal erosion. Its implementation is crucial for safeguarding Lane County's environmental assets and ensuring the well-being of its residents in the face of a changing climate.

Lane County Multi-Jurisdictional Natural Hazards Mitigation Plan (2023)[11]

The Lane County Multi-Jurisdictional Natural Hazards Mitigation Plan (NHMP) is a collaborative framework designed to minimize the long-term effects of natural disasters across the county. The plan identifies 10 natural hazards impacting the county, and while the provided text does not specify the priority hazards outlined in the plan, it is a plan with a focus on water resource management. Relevant strategies include septic system management, promoting beaver populations for ecosystem benefits, dredging impact research, green infrastructure implementation, sediment budget development, and addressing water quality issues in specific areas like the Siletz Estuary. The NHMP's commitment to interagency collaboration, community

[10] https://www.lanecounty.org/government/county_departments/county_administration/climate_action
[11] https://www.lanecounty.org/cms/one.aspx

involvement, and the integration of mitigation strategies with existing planning documents underscores its role in building a safer, more sustainable Lane County.

Oregon Climate Change Research Institute

Sixth Oregon Climate Assessment (2023)[12]

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, Lane County (2022)[13]

This report focuses on downscaled climate projections for Lane 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.

Oregon Central Coast Estuary Collaborative Strategic Action Plan (2021)[14]

The OCCEC Strategic Action Plan outlines a framework for restoring and protecting estuarine ecosystems across several major estuaries on the central coast, including the 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.

[12] https://blogs.oregonstate.edu/occri/oregon-climate-assessments/
[13] https://blogs.oregonstate.edu/occri/projects/dlcd/
[14] https://www.orcentralcoastestuaries.com/restoration-links

Other Helpful Resources

USFS Climate Change Vulnerability and Adaptation in Coastal Oregon (2024)[15] 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)[16] 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. Hazard maps and other materials have been developed for tsunami and landslide risks in coastal Lane County, but a more comprehensive natural hazard risk report to evaluate vulnerability mapping for estuarine areas has yet to be developed. These resources provide data-driven insights to identify at-risk areas, inform adaptive management strategies, and support mitigation efforts tailored to local conditions.

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 coastal Lane 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 same methods the University of Oregon's Institute for Policy Research and Engagement (IPRE) utilized for the **Coos Bay Estuary Climate Hazard Adaptation Plan**[17], and developed by IPRE from the EPA's **Being Prepared for Climate Change**[18] guidebook.

The Lane County steering committee reached out to over 125 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

[15] https://research.fs.usda.gov/treesearch/68797
[16] https://www.oregon.gov/dogami/pubs/pages/ofr/p-ofr.aspx
[17] https://partnershipforcoastalwatersheds.org/
[18] https://www.epa.gov/cre/being-prepared-climate-change-workbook-developing-risk-based-adaptation-plans

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 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 Lane County.

Image: Lane County Adaptation Action Workshop, November 2024. By 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 Lane County was approached through the framework

identified by the National Research Council report **Disaster Resilience: A National Imperative**[19], 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.

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

Adaptation Strategy

Nature-Based Solutions

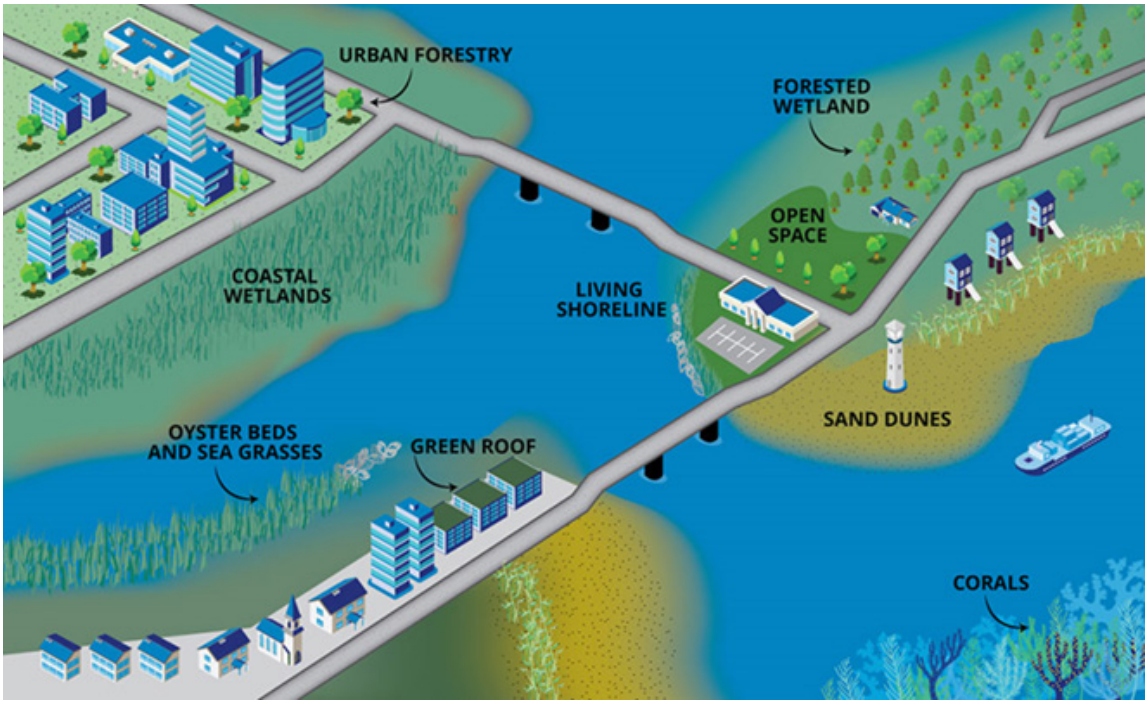


Figure 3. Example nature-based solutions for coastal areas. Image source: NOAA

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.

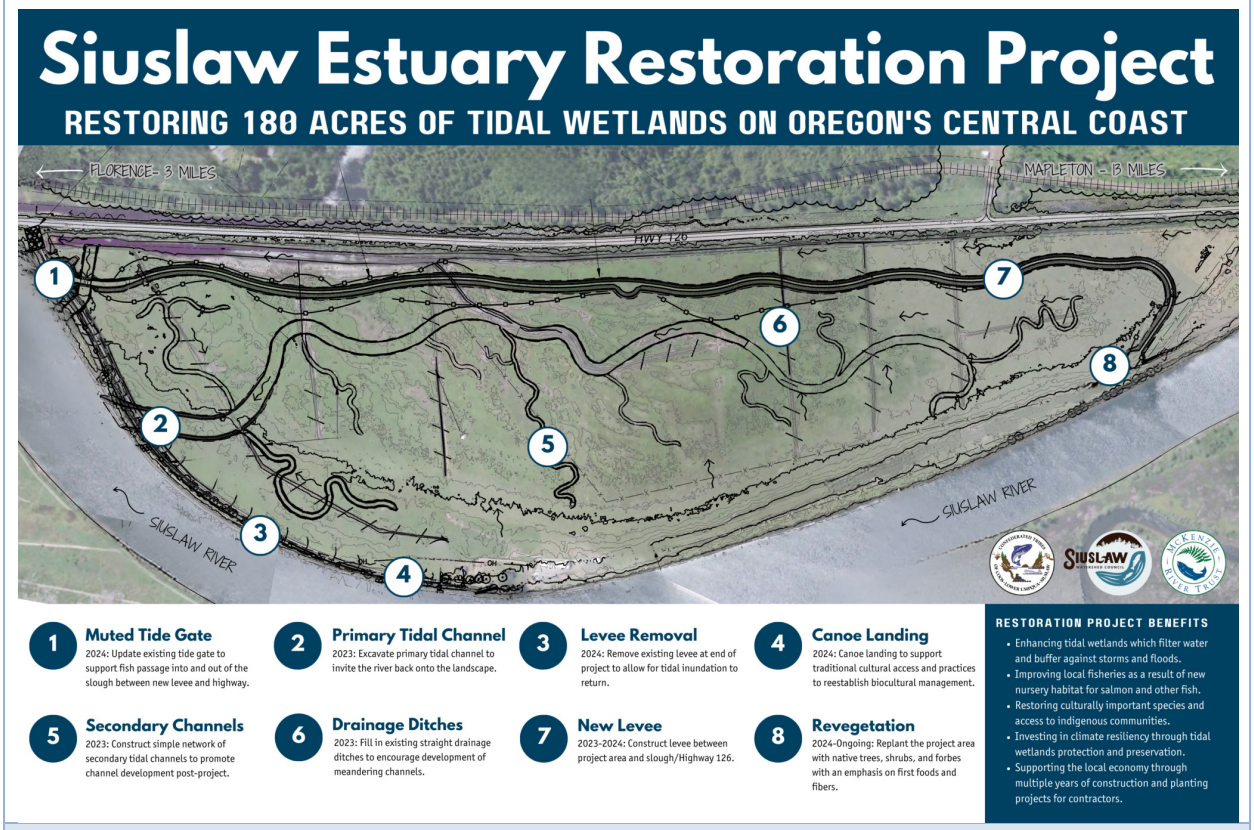
In coastal contexts, nature-based solutions include a range of practices such as wetland restoration, dune rebuilding, and riparian buffer restoration. For example, restoring tidal wetlands in the Siuslaw River Estuary can help absorb storm surges, reduce coastal flooding, and improve water quality by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

Figure 4. Highlighting Nature-Based Solutions: haich ikt'at'uu Restoration (Waite Ranch)

The haich ikt'at'uu (Waite Island Ranch) Tidal Wetlands Restoration Project exemplifies collaborative efforts to restore estuarine habitat and enhance resilience in the Siuslaw River estuary near Florence, Oregon. This ambitious project aims to revitalize over 200 acres of former tidal wetlands previously used as a dairy farm, improving habitat for various fish and wildlife species. Through strategic partnerships and innovative restoration techniques, the project seeks to balance ecological recovery with community needs and climate change resilience benefiting estuarine species, habitats, and ecological function.

Restoration Features

Wetland Enhancement: Restoring tidal wetlands to improve water quality and provide essential habitat for estuarine species like salmon.	**Riparian Planting:** Planting native trees and shrubs along stream banks to stabilize soils, provide shade, and enhance complexity.	**Invasives Control:** Removing invasive plants to promote growth of native vegetation, improve habitat quality.	**Removing Barriers:** Breaching existing dikes to restore tidal processes and historical floodplain marsh conditions.	**Recontouring the Landscape:** Restoring an estimated six miles of tidal channels to create diverse wetland habitats.	**Protecting Infrastructure:** Constructing a setback dike and implementing erosion protection measures to safeguard OR 126.



A Collaborative Approach The haich ikt'at'uu Tidal Wetlands Restoration Project is a collaborative effort with multiple organizations, including the McKenzie River Trust, Siuslaw Watershed Council, Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians (CTCLUSI), and numerous other local, state, and federal partners. This partnership brings together diverse expertise and resources to address the complex challenges of estuarine restoration.

The project not only revitalizes critical habitat for salmon, shorebirds, and other wildlife but also holds profound cultural significance for CTCLUSI. By restoring the landscape to its historical tidal wetland state, the project reconnects Tribal citizens to their ancestral lands, supports traditional practices such as subsistence fishing, and incorporates Siuslaw language place names, ensuring the cultural heritage and stewardship of the Tribe are interwoven with ecological recovery.

By leveraging nature-based solutions for restoring tidal processes and degraded wetland habitats, this project will enhance habitat for fish and wildlife, help restore ecological integrity of the Siuslaw River estuary, and increase the resilience of the surrounding community to climate change and other environmental challenges. The project is recognized for its ecological significance in restoring critical fish rearing habitat and returning the landscape to its pre-development state under Tribal stewardship.

along creeks such as Sutton and Tahkenitch 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 estuarine wetlands along the Siuslaw River, led by efforts such as the Siuslaw Estuary Partnership, has demonstrated significant benefits in improving habitat for fish and bird species while reducing flood risks (Siuslaw Watershed Council, 2019). Additionally, the removal of outdated dikes and the restoration of natural tidal channels in the Coos Bay estuary have contributed to increased fish populations and more resilient estuarine ecosystems by reestablishing natural hydrology. The Southern Flow Corridor[20] 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).

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 Action for Resilience

Natural hazards present significant challenges for the estuarine ecosystems and human communities in coastal Lane 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 Lane County's estuarine habitats have increasingly focused on collaborative, science-based strategies that rely on the following kinds of actions:

- **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 other species such as eelgrass (Brophy, 2023). Given that Lane County's estuaries have experienced significant historic wetland loss, these

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

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. Two notable examples of these actions are in development concurrent with the Lane 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 Midcoast Watersheds Council, 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)[21] 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.

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 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.

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

Image: Duncan Inlet and Island, Siuslaw River. Courtesy of Oregon ShoreZone.

II. Natural Hazards in the Estuaries

Image: North Fork Siuslaw River, 2014. By LightHawk.

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 Lane County's estuaries and the people who depend on them (DLCD, 2024).

Climate Change

The Oregon Coast, including Lane 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 poses 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).

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 Lane County.

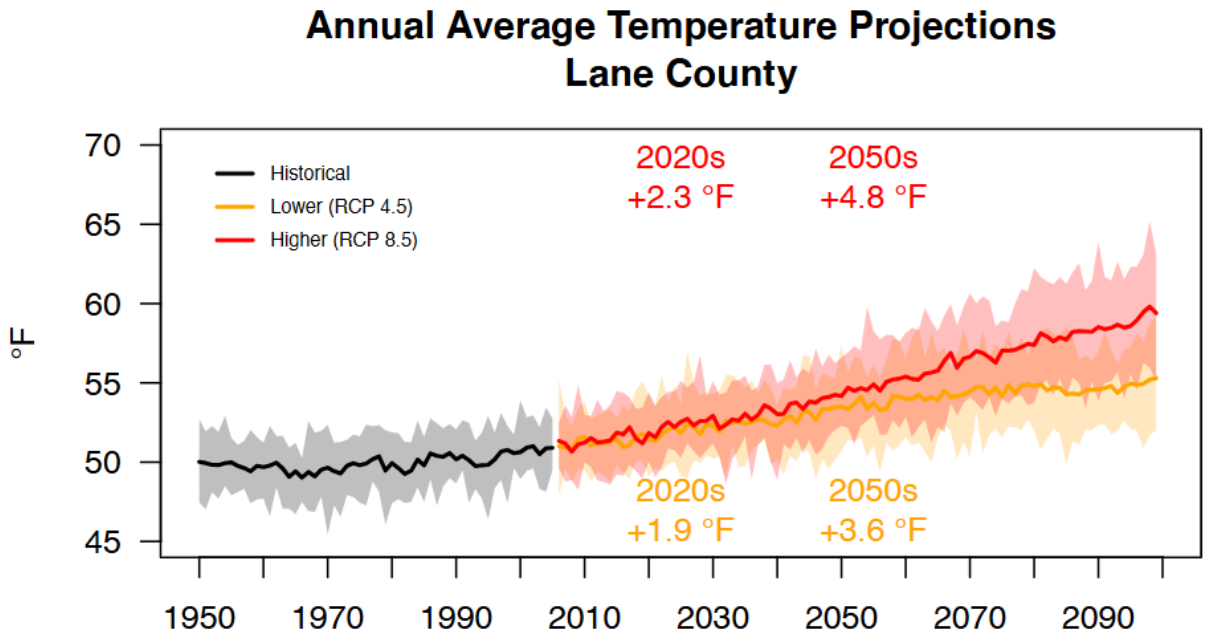


Figure 5. Projected annual average temperatures for Lane County based on climate models under two emission scenarios. The graph shows the multi-model mean and range, with comparisons to historical baseline for future periods. Source: Dalton (2020).

Sea Level Rise

Sea level rise is one of the most immediate and consequential threats to Lane 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 the Siuslaw River, signaling the kinds of chronic impacts expected in the future (OCMP, 2022). 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).

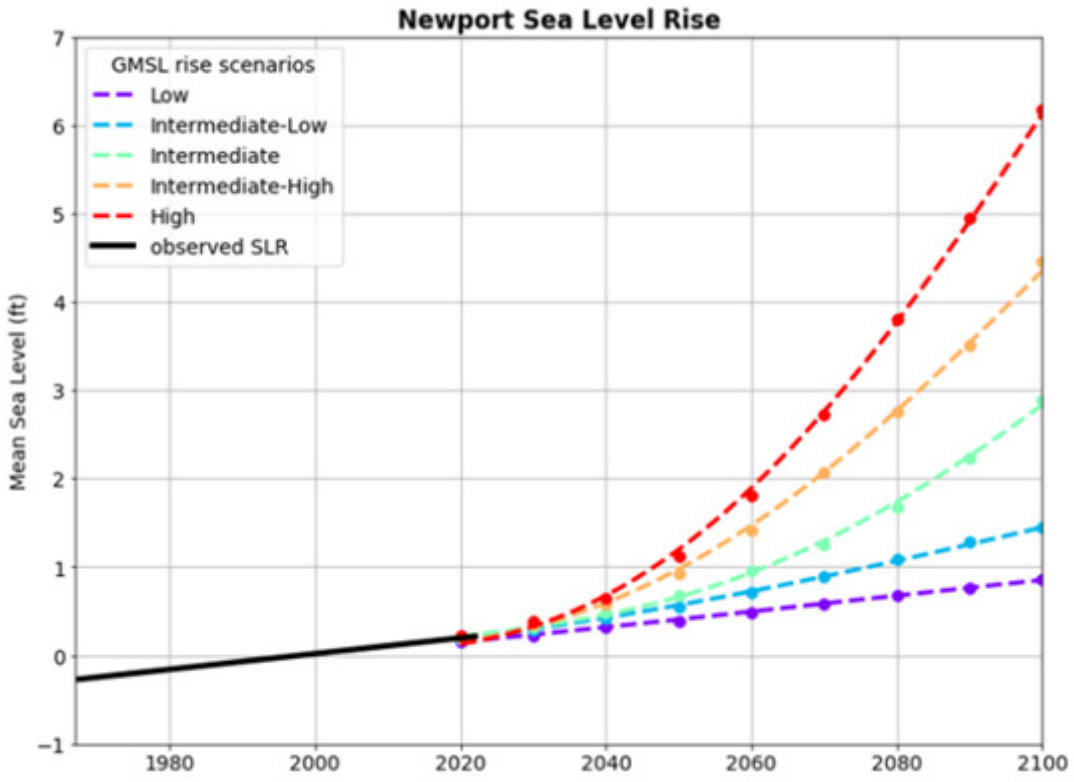


Figure 6. Observed and projected sea level rise for Newport, Oregon, illustrating local variability due to tectonic and hydrodynamic factors. Source: OCMP, 2022.

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 Lane County's coastline and estuaries, where communities like Florence and Mapleton face increased vulnerability due to low-lying geography and exposure to tidal flooding (Siuslaw Estuary Partnership, 2014; Brophy et al., 2019). Critical infrastructure such as the Siuslaw River Bridge and US Highway 101 is at growing risk of damage or disruption, while the loss of natural barriers further exposes inland areas to hazards, compounding the risks from other climate-driven changes (DOGAMI, 2020; 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 Florence (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 Oregon's coastal 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).

Precipitation and Drought

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

The Oregon Coast, including Lane County, experiences a maritime climate with wet winters and drier summers. Winter storms often bring heavy rainfall, increasing the risk of flooding in estuaries and low-lying communities such as Florence and Mapleton, as well as causing erosion that impacts water quality and habitat stability (NWS, 2023; Siuslaw Estuary Partnership, 2014). However, recent trends show increasing variability in precipitation patterns, including periods of unusual dryness and more intense winter storms (OCCRI, 2019). Lane County has experienced multiple drought declarations in recent years, including severe droughts in 2021 and 2023, marking a sharp change from previous decades (OPB, 2023). Droughts, such as the 2023 summer event, strained water supplies across the region, with record-low rainfall recorded during critical summer months. Statewide, 18 of the last 24 years have experienced below-average precipitation, a trend expected to continue (OCCRI, 2019; OCAP, 2020). These changes challenge both municipal water systems, such as those serving Florence and Mapleton, and the stability of estuarine habitats that rely on predictable river flows.

Climate models predict increased precipitation during winter, especially in the form of rain rather than snow, raising wintertime streamflows and potentially increasing flood risks. By mid-century, Lane County could experience more frequent and intense winter storms, exacerbating flood hazards, particularly in the lower Siuslaw River, which has a history of 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 expected to strain municipal and rural water supplies, particularly in communities dependent on shallow wells or self-supplied surface water sources (Lane County Drought Declaration, 2023). Communities such as Mapleton and Florence have already faced summer water use restrictions and supply challenges, underscoring the urgency of adaptive water management strategies (USDA NRCS, 2023).

Reduced summer flows, coupled with 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 coho salmon in the Siuslaw Basin, which depend on stable water temperatures and streamflows for spawning (OWEB, 2020; Brophy et al., 2019). 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.

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 (OCMP, 2024; DLCD, 2020, NOAA 2022). These efforts are vital for sustaining the ecological and economic vitality of coastal Lane County and the broader Oregon Coast in the face of ongoing climate change.

Flooding

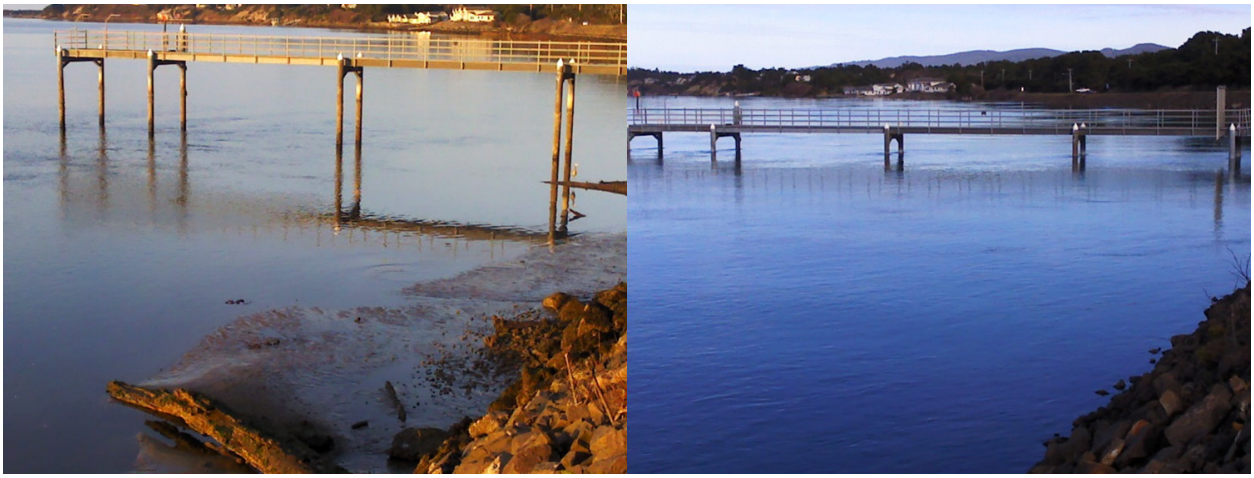


Image: Siuslaw River dock, 2013-14. By DeEtte Miller.

Flooding is a persistent hazard for coastal regions, and Lane County's estuaries and surrounding communities are especially vulnerable. The Siuslaw River estuary in particular contains 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 (Lane County, 2024).

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. Lane 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, and storm surge, driven by coastal storms and low atmospheric pressure, are both major threats to Lane County estuaries. These forces often converge in the Siuslaw River estuary, where upstream flows and coastal ocean processes interact in complex ways (OCCRI, 2021).

Historical flooding events in Lane County demonstrate the region's vulnerability. The December 1964 flood brought record-breaking rainfall, inundating estuarine areas near Mapleton and washing out sections of OR Highway 36 and OR Highway 126 (DOGAMI, 2000). In February

1996, the Siuslaw River reached flood stage, damaging rural properties and infrastructure along the lower river corridor (Lane County, 2022). During the winter storm season of 2015-2016, multiple high-tide events combined with storm surges, flooding low-lying areas in Florence and damaging docks, marinas, and transportation routes (Lane County, 2022). More recently, the 2021 atmospheric river event caused extensive flooding upstream near Mapleton and contributed to prolonged high-water levels in the estuary, disrupting access and affecting local businesses (OWRD, 2022).

Future projections indicate increased frequency and intensity of flooding due to stronger storms and higher precipitation extremes. In the Siuslaw River estuary, extreme events that were once considered 100-year floods may become more frequent. For example, modeled projections suggest that river flows exceeding 50,000 cfs near Mapleton, previously considered rare, will have a greater likelihood under future climate conditions (OCCRI, 2021). These shifts will strain infrastructure such as US Highway 101, bridges, and wastewater systems, and may displace residents in low-lying neighborhoods like those near Munsel Lake Road and the North Fork floodplain. As floodplain regulations evolve, including new Federal Emergency Management Administration (FEMA) guidelines, Lane County and the City of Florence will need to adapt planning approaches to safeguard both natural systems and community assets (Lane County, 2022; 2020).

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 the Siuslaw River estuary, gradual salinity shifts are already affecting estuarine ecosystems. These changes threaten freshwater-dependent vegetation and wildlife and may impair drinking water resources drawn from coastal aquifers (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 (Lane County, 2022).

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 (OCMP, 2022). However, the ability of habitats to migrate naturally is increasingly constrained by roads, dikes, and development along the Siuslaw River estuary. In Lane County, estuarine edges that historically supported natural habitat transitions are now fragmented by infrastructure like Highway 126 and residential neighborhoods in Florence (Lane County, 2020).

Preserving LMZs through conservation, restoration, and land use planning is a priority for sustaining 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 (OCMP, 2022). 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 the Siuslaw River estuary, where wetland migration is constrained by developed areas, making effective land-use policies and conservation efforts 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 the Siuslaw River estuary.

LMZ Area	Sea Level Rise Scenario (ft)						
	0.0	0.8	1.6	2.5	4.7	8.2	11.5
Acres	2996	2899	2685	2435	1365	557	356
% loss/gain (-/+)*	0%	-3%	-10%	-19%	-54%	-81%	-88%

**compared to baseline; Data: Brophy & Ewald (2017)*

Erosion

Erosion risks along the Oregon Coast, particularly in Lane County and its estuaries, are a growing concern due to both natural processes and human activities. The dynamic coastal environment, characterized by powerful wave action, storm surges, and tidal forces, predisposes the region to ongoing erosion. Areas with sandy beaches and bluffs, such as those found in the Siuslaw River basin and around the Florence area, face challenges from wave action and shoreline retreat. Estuarine areas, including the Siuslaw River and the lower reaches of the Coastal Range rivers, also experience sediment loss and shoreline erosion, exacerbated by human activities like dredging, construction, and the installation of protective structures (OCMP, 2022).

In Lane County, ongoing erosion is especially concerning along the Siuslaw River, which provides vital habitats and supports local infrastructure. The erosion of tidal wetlands and shoreline retreat has affected both habitat quality for species like salmon and the integrity of infrastructure along the waterfront (City of Florence, 2005). Dredging activities, which are necessary to maintain navigability in the estuary, have further altered sediment dynamics, contributing to shoreline erosion and loss of critical habitats (DOGAMI, 2021).

Similarly, in the Siltcoos Lake estuary, erosion along the northern shore has led to the retreat of marshland, negatively impacting wetlands. These areas are also vulnerable to property loss, particularly along the fringe of the lake 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 flow, ultimately reducing the resilience of the shoreline over time.

Recent erosion events have highlighted the ongoing vulnerability of coastal communities and estuaries in Lane County. For instance, severe erosion in 2016 along the Siuslaw River and in the Florence area 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 coastline has contributed to increased erosion and property loss, while also limiting 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 beaches (City of Florence, 2005).

Efforts to address erosion in Lane 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 (OCMP, 2022; DOGAMI, 2021).

Earthquake and Tsunami

The Oregon Coast, particularly Lane 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, including estuarine systems like the Siuslaw River (Atwater et al., 2005). 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).

In Lane County, the potential for a major earthquake poses severe risks to infrastructure and public safety. Communities such as Florence and Mapleton are particularly vulnerable due to their proximity to the coastline and the presence of older structures built before modern seismic standards. Key facilities, including bridges, water treatment plants, and emergency services, face elevated risk from ground shaking and liquefaction. Liquefaction is a hazard of particular concern in estuarine areas, where infrastructure has been built on loose or saturated soils. This process can cause buildings and roads to collapse or sink during intense shaking, posing serious threats in areas like Florence's waterfront and the low-lying sections of the Siuslaw River estuary (Lane County, 2023). The region's limited evacuation routes and natural barriers, such as rivers and hills, may further hinder 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 and cause land subsidence, exacerbating long-term flooding risks.

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 estuaries like the Siuslaw (Atwater et al., 2005). Modern tsunami modeling and historical records suggest that the next major subduction zone earthquake could produce a similarly devastating tsunami.

For Lane County, the threat of tsunami inundation is pronounced. Coastal communities such as Florence and nearby areas along the lower Siuslaw River are at high risk due to their low-lying locations. DOGAMI has identified these areas as particularly vulnerable to tsunami impacts, including potential inundation zones that could extend far inland along the estuary (DOGAMI, 2020). The risk of a tsunami from a local earthquake produced by the CSZ could 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 Lane County communities. 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 distant seismic events (NWS, 2021).

Florence, with its critical infrastructure and dense residential areas, could experience extensive damage and loss of life in the event of a tsunami. The city's water and sewage treatment facilities, located near the estuary, are highly susceptible to tsunami waves, which could disrupt essential services and lead to long-term contamination concerns (Lane County, 2023). Mapleton and other low-lying communities along the Siuslaw River also face significant risks. The

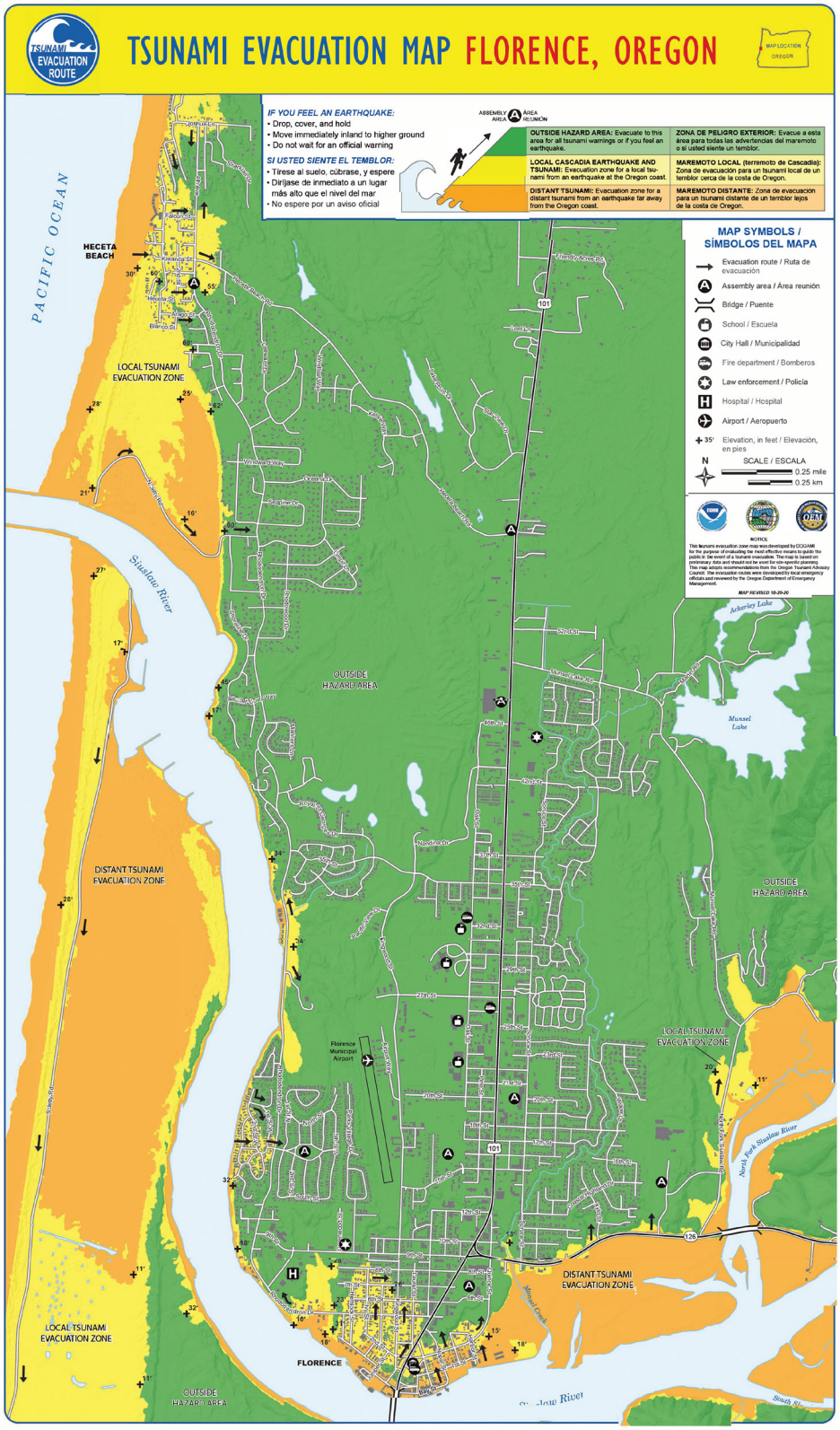


Figure 7. User-generated tsunami evacuation brochure for the Florence area. Visit OregonTsunami.org to view and generate similar maps for other areas of the Oregon Coast.

potential for widespread flooding, property damage, and loss of life underscores the urgent need for comprehensive preparedness and mitigation strategies.

Current preparedness efforts in Lane County include updating tsunami evacuation plans, improving early warning systems, and conducting public education and preparedness campaigns. For example, tsunami evacuation drills have been held in Florence and surrounding communities to ensure residents are aware of evacuation routes and procedures in the event of a tsunami warning. Additionally, community planning initiatives, such as those supported by the OCMP, aim to enhance resilience by incorporating risk assessments and emergency response strategies into local land-use and development plans (OCMP, 2023). 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 coastal Lane 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 Lane County. In the Siuslaw River estuary, water temperature increases of 0.7-1.6°C are projected with a 3°C rise in air temperature, with the upper estuary and freshwater tributaries being most vulnerable to warming. These higher temperatures can stress aquatic species, particularly cold-water fish like salmon, and disrupt ecological balances.

The impacts are not limited to fish; increasing temperatures also affect vegetation patterns and habitat availability. For instance, in the Siuslaw River estuary, warmer waters may contribute to shifts in aquatic vegetation and reduce suitable conditions for species such as eelgrass, which provide essential nursery habitats. 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 upstream portions of the estuary (DEQ, 2022). These changes highlight the urgent need for adaptive management strategies, as reflected in the Siuslaw Estuary Partnership's emphasis on addressing climate-related vulnerabilities in future restoration and protection projects (OCMP, 2022).

Turbidity

Turbidity, or the cloudiness of water caused by suspended sediments, remains a significant concern in Lane County's waterways. Activities such as logging, construction, and poorly managed forest roads contribute to sediment runoff, which can degrade water quality by reducing light penetration and harming aquatic plants and animals. In the Siuslaw 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 Siuslaw Soil and Water Conservation District is actively working to address these issues through riparian restoration and road improvement projects, 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 on the Oregon Coast 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. The Siuslaw River estuary 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 Lane 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). The Siuslaw River estuary has seen occurrences of HABs that affect water quality and ecosystem health (DEQ, 2023), as well as in upstream areas affecting drinking water supplies, including the community of Mapleton.

Table 5. Oregon Health Authority recreational-use health advisories related to cyanobacteria outbreaks in coastal Lane County water bodies.*

Water Body	Year	Duration (days)	Season
Siltcoos Lake	2007	52	Summer/fall
Siltcoos Lake	2008	93	Fall/winter

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

Nutrient Pollution

Excessive nutrients from agricultural runoff, wastewater discharges, and septic systems contribute to eutrophication in Lane County estuaries, leading to algal blooms, oxygen

depletion, and degraded water quality. In the Siuslaw River, elevated nitrate levels during heavy precipitation events increase biochemical oxygen demand, stressing aquatic life (EPA, 2019). Seasonal hypoxia, particularly in summer months, is linked to nutrient-driven algal growth and decomposition (NOAA, 2023). In Mapleton, chronic boil-water notices have been linked to increased turbidity and algal-related taste and odor issues following heavy rains. 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). In broader Lane County, a 2015 statewide assessment found concerning levels of legacy pesticides like DDT, aldrin, and chlordane in several water bodies, 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 combustion and 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 Mapleton Water District, disinfection byproducts such as haloacetic acids have been detected at elevated levels, highlighting the complexity of maintaining safe drinking water while managing other pollutants (OHA, 2023).

Wildfire and Air Quality

Wildfire Risks on the Oregon Coast, particularly in Lane County, are an emerging concern driven by climate change, evolving land use, and shifting fire patterns.

Current Wildfire Risks

Vegetation and Terrain

Western Lane County’s landscape, dominated by dense coastal forests, riparian zones, and upland shrublands, is increasingly vulnerable to wildfire. Climate change is intensifying these risks by producing hotter summers, altered rainfall patterns, and longer periods of dry vegetation. Although the coastal fog zone has historically moderated wildfire risk, extreme conditions, such as prolonged drought and east wind events, can rapidly elevate fire hazards, as seen during the 2020 Labor Day fires. Shifts in vegetation driven by climate stress, including the

spread of invasive, fire-prone species, are compounding these risks and altering forest fuel loads (ODF, 2022).

Human Activities

The expanding urban-wildland interface in communities like Florence and Mapleton creates heightened vulnerability, where residential development meets fire-prone landscapes. Human activities such as outdoor burning, recreational fires, and equipment use remain significant ignition sources. Population growth and tourism have increased activity in these areas, amplifying potential risks. Climate change is expected to exacerbate wildfire frequency, size, and severity in western Lane County, with longer fire seasons posing new challenges. The Lane County Community Wildfire Protection Plan[22] addresses these threats by outlining prevention, response, and adaptation strategies in light of changing fire dynamics (OEM, 2023).

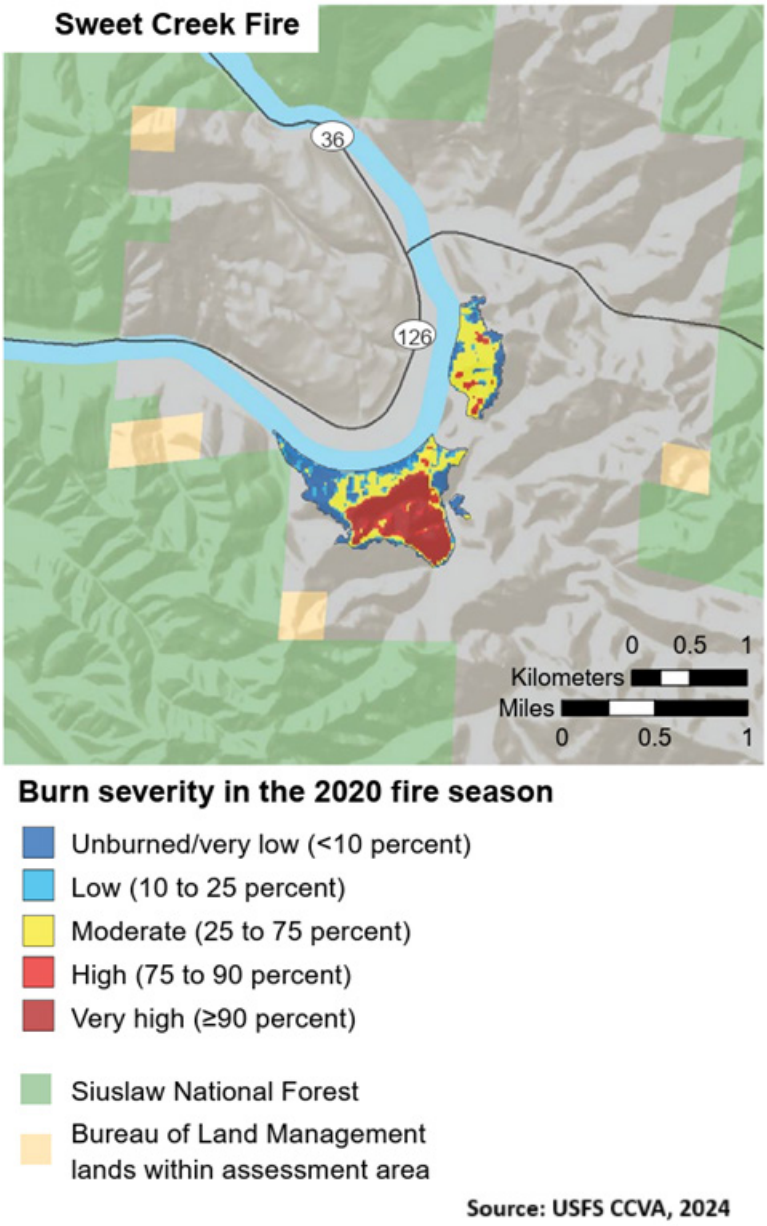


Figure 8. Locations and burn severity of the 2020 Sweet Creek Fire.

2020 Wildfire Season

The 2020 wildfire season marked a turning point for wildfire awareness on the Oregon Coast. In Lane County, the Sweet Creek Fire (Figure 8) near Mapleton burned significant tracts of forest in August, impacting nearby communities and testing local emergency response systems. A few weeks later, the massive Labor Day fires erupted across western Oregon, causing widespread destruction inland but also sending thick smoke westward to the coast. While the fires near Sweet Creek were less destructive than the Labor Day fires, both events forced evacuations and resulted in hazardous air quality across the Siuslaw River basin. Smoke from these fires blanketed coastal

[22] https://www.lanecounty.org/cms/one.aspx?pageId=4278759

communities, including Florence, driving air quality index levels into the "unhealthy" and "very unhealthy" categories. Together, these events underscored the vulnerability of coastal Lane County to wildfire and smoke impacts, even in areas traditionally perceived as low risk. The 2020 fires provided critical lessons in preparedness, evacuation coordination, and smoke response for communities along the Siuslaw (OHA, 2022).

Increased Fire Risk Due to Climate Change

Climate projections indicate that wildfire risks in coastal Lane County will escalate as summers become hotter and drier. Rising temperatures, reduced summer precipitation, and longer drought periods are expected to create conditions increasingly favorable for wildfire ignition and spread, particularly in the wildland-urban interface where human development meets natural vegetation. By mid-century, models suggest more frequent and severe fires in coastal forests, especially during late summer and early fall when east wind events can intensify fire behavior (USDA Climate Hubs, 2020). Large wildfires, once rare in the damp coastal zone, may become more common, posing new threats to ecosystems, communities, and infrastructure (OSU, 2024).

Vegetation Changes

Ongoing climate shifts are expected to alter forest composition in western Lane County, with potential transitions from conifer-dominated forests to mixed hardwood and shrubland ecosystems (OSU, 2024). These changes could increase fire fuel loads and flammability, while invasive species adapted to warmer, drier conditions, such as gorse and Scotch broom, may further elevate fire risk. Post-fire regeneration patterns are also likely to favor these invasives, complicating recovery efforts and reshaping long-term ecosystem dynamics (ODF, 2022).

Impacts to Local Air Quality

Wildfire smoke has emerged as a significant air quality threat to Lane County's coastal communities. Historically buffered by marine air, places like Florence and Mapleton now experience frequent smoke intrusions from inland and local fires. DEQ has documented an uptick in days with air quality index levels classified as unhealthy for sensitive groups or worse along the central coast (DEQ, 2023). This trend is projected to intensify as wildfire seasons grow longer and more severe.

Smoke impacts extend beyond public health, with potential effects on estuarine ecosystems such as the Siuslaw River estuary. Wildfire smoke and post-fire runoff can degrade water quality, alter nutrient cycles, and disrupt habitat for fish and wildlife. Emerging research suggests that stressors like wildfire smoke could impair estuarine carbon storage, potentially releasing greenhouse gases and diminishing the ecosystem's resilience to climate change (Pew Charitable Trusts, 2022). As coastal Lane County faces more frequent smoke events, these combined human and ecological risks will require expanded monitoring and mitigation strategies.

To evaluate locally-specific wildfire risks further and access other wildfire hazard resources, visit the Oregon Wildfire Risk Explorer[23].

Invasive Species

Invasive species pose a significant threat to the estuaries and waterways of the Oregon Coast, including Lane 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 the Siuslaw River 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 Lane County's estuaries and waterways, including early detection and rapid response programs to control the spread of invasive species and preserve the ecological integrity of these vital coastal ecosystems.

Invasive Plant Species Risks

Invasive plant species pose significant risks to the health of estuarine ecosystems in Lane County. These species can outcompete native vegetation, alter habitat conditions, and disrupt ecosystem processes, leading to long-term ecological and economic consequences. Table 6 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 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.

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

Table 6. 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

Invasive Wildlife Species Risks

Invasive wildlife species can pose significant threats to the ecological balance of estuarine and coastal habitats in Lane County. 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 invasive species has established populations in Oregon's estuaries, including those in Lane 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 Yaquina and Alsea Bays and all major estuaries along the Oregon Coast (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 Lane 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. While they can potentially affect habitat structure, their specific impacts in Lane County estuaries are not yet fully understood.

Image: Veteran's Memorial Park, Florence. By Brian Parmelee.

III. Vulnerability Summary

Image: Cushman Railroad Bridge, Hwy 126, Florence. By Brian Parmelee.

Coastal Lane County

This chapter introduces broad themes of vulnerability that affect Lane 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

Environmental Conservation and Habitat Protection: The community places high value on preserving air quality, water resources, and natural habitats. Efforts to establish broader buffer zones along estuarine areas are met with mixed reactions, particularly from industries such as timber. Balancing economic interests with environmental conservation remains a complex issue requiring collaborative solutions.

Infrastructure Deterioration and Contamination Risks: Neglected maintenance of critical infrastructure, such as the six railroad bridges over the Siuslaw River, increases the risk of issues such as lead contamination and structural failures. Regular painting and other maintenance are essential to prevent corrosion and protect both the environment and communities relying on these structures.

Sea Level Rise and Saltwater Intrusion: Rising sea levels threaten to exacerbate saltwater intrusion into freshwater aquifers, particularly in areas like the South Lakes region, where dune movements have historically altered estuarine boundaries. Reports of new wells yielding saline water highlight the vulnerability of unincorporated communities lacking resources to secure alternative water supplies.

Septic System Failures Due to Rising Water Tables: Many residences situated just above aquifers face increased risks of septic system failures as estuarine water levels rise. Even minor increases can lead to saturated soils, compromising septic functionality and posing public health risks.

Tsunami Preparedness and Evacuation Challenges: The coastal topography of Lane County, characterized by limited east-west access routes and expansive dune systems, complicates tsunami evacuation efforts. Enhancing community education, developing clear evacuation corridors, and maintaining accessible paths to higher ground are critical for resident safety.

Landslide Susceptibility in Coastal Ranges: The unstable soils of the Coast Range are prone to landslides, particularly during seismic events. Earthquakes can trigger debris flows that block streams, increase sedimentation, and inundate evacuation routes, emphasizing the need for public education on safe evacuation procedures and addressing impacts to the watershed.

Water Quality and pH Fluctuations: The central coast's low alkalinity buffering capacity leads to significant pH fluctuations in estuarine waters, adversely affecting water quality. This variability complicates the 303(d) listing process, which identifies impaired water bodies, and poses challenges for aquatic species sensitive to pH changes.

Community Engagement and Resource Limitations: A significant portion of the coastal population comprises retirees and individuals on fixed incomes, presenting challenges in

funding infrastructure improvements and hazard mitigation initiatives. Engaging these community members through volunteerism, citizen science programs, and partnerships with local organizations can harness valuable skills and foster broader support for resilience efforts.

Educational Initiatives and Organizational Collaboration: Addressing natural hazard vulnerabilities necessitates improved communication and collaboration among various specialties and organizations. Initiatives like the Oregon King Tides Project[24] offer opportunities for local governments and citizens to visualize and understand gradual environmental changes, promoting proactive adaptation strategies.

Data Acquisition and Research Partnerships: Limited access to comprehensive environmental data hinders effective planning and response. Establishing partnerships with universities and research institutions can facilitate the acquisition of low-cost monitoring solutions and enhance the community's capacity to address natural hazards through informed decision-making.

These themes underscore the multifaceted challenges faced by coastal Lane County in mitigating natural hazards. Addressing these issues requires a holistic approach that integrates environmental monitoring, infrastructure maintenance, community engagement, and collaborative planning to enhance resilience and protect vulnerable estuarine ecosystems and communities.

Overview of Community Concerns

This section summarizes key concerns surfaced through Lane 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 the Siuslaw River Basin identified significant vulnerabilities in their built infrastructure, particularly in and around Florence and Mapleton. Key transportation routes such as US Highway 101 and the bridge over the Siuslaw River are critical lifelines but face mounting risks from flooding, sea level rise, coastal erosion, and extreme storms. Mapleton's infrastructure, including roads, utilities, and water systems, is especially vulnerable due to its location in low-lying floodplain areas along the river. Concerns also extend to aging wastewater treatment plants and associated pipelines, which are susceptible to erosion, flooding, and saltwater intrusion during severe weather events. The failure of these systems could disrupt

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

daily life, endanger public health, and strain emergency response capacity in both urban and rural communities.

Anticipated impacts include damaged roadways and bridges that could sever regional connectivity, isolating communities like Mapleton and cutting off access to essential services. Flooded or contaminated wastewater and drinking water infrastructure would further escalate health risks and complicate disaster recovery. These disruptions threaten to overwhelm already limited resources for emergency management and infrastructure repair, deepening vulnerabilities among residents during and after hazard events.

Critical/Environmental Infrastructure

Environmental infrastructure in the Siuslaw River Basin is closely linked to the health, safety, and cultural identity of local communities. Surface water sources such as the Siuslaw River and Berkshire Creek are vital for drinking water, irrigation, and ecological function but are increasingly threatened by flooding, agricultural runoff, and saltwater intrusion. Mapleton's heavy reliance on Berkshire Creek creates acute risks, as any disruption could leave the community without safe drinking water. The Siuslaw River estuary and its floodplain habitats, essential for migratory fish like Chinook and coho salmon, are under pressure from sedimentation, altered flow regimes, and erosion. Ongoing habitat restoration efforts intersect with these challenges, as climate-driven changes jeopardize more recent ecological gains.

Expected impacts include degraded water quality, increased drinking water scarcity, and the loss of habitat critical to sustaining fish populations and local biodiversity. Environmental disruptions could undermine restoration projects and destabilize ecosystems that support fisheries, recreation, and tourism in the region. Such ecological shifts would have cascading effects on the social and economic wellbeing of communities that depend on healthy river and estuarine systems.

Social Factors

Communities in Florence, Mapleton, and along the Siuslaw River face complex social vulnerabilities linked to flooding, sea level rise, and intensified storms. Mapleton's floodplain location makes it especially susceptible to displacement and service disruptions during flood events, particularly given its proximity to fragile infrastructure and emergency services. Florence, with low-lying areas along both the river and Pacific Ocean coastline, also faces growing risks from erosion and inundation. Both communities are challenged by limited resources and dependence on a mix of local, state, and federal assistance to implement resilience strategies. Compounding these issues are concerns about saltwater intrusion threatening water supplies and the capacity of emergency response systems to cope with escalating disasters.

Potential consequences include job losses in sectors such as fishing and tourism, reduced access to safe drinking water, and heightened risks to public health. Residents worry about

displacement, rising costs of living, and the erosion of social ties that sustain community resilience. Without adequate investment and coordination, the impacts of climate change could further strain emergency services and deepen existing inequities across the region.

Vulnerable Populations

Certain populations in the Siuslaw River basin are especially at risk from natural hazards and climate change. Elderly residents, low-income households, and people living in flood-prone areas face heightened dangers during floods and storm events, including displacement and health crises. Communities dependent on surface water for drinking and irrigation, particularly those in Mapleton, are vulnerable to contamination and shortages as flooding and saltwater intrusion increase. Indigenous populations in the region, whose cultural practices and livelihoods are intimately tied to the health of the river and estuary, face compounding threats from ecosystem degradation and resource loss.

These vulnerabilities raise serious concerns about forced migration, cultural disruption, and deepening economic hardship. Displacement would not only threaten homes and livelihoods but also break apart social networks vital to community cohesion. The potential loss of culturally significant species and habitats, such as salmon fisheries, endangers both the economic and cultural resilience of Indigenous and traditional communities. Persistent barriers such as limited transportation, financial constraints, and inadequate emergency preparedness further expose vulnerable residents to disproportionate risks during disasters, underscoring the need for inclusive and equitable resilience strategies.

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Community feedback highlights widespread vulnerabilities across built, environmental, and social systems in the Siuslaw River basin. These concerns emphasize the interconnectedness of infrastructure, ecosystems, and community wellbeing, and the need for comprehensive, community-led planning to address the multiple risks posed by climate change and natural hazards. Strengthening infrastructure resilience, safeguarding water supplies, protecting vulnerable populations, and enhancing emergency response capacity will be critical steps in building a more resilient future for Lane County’s coastal communities.

Siuslaw River

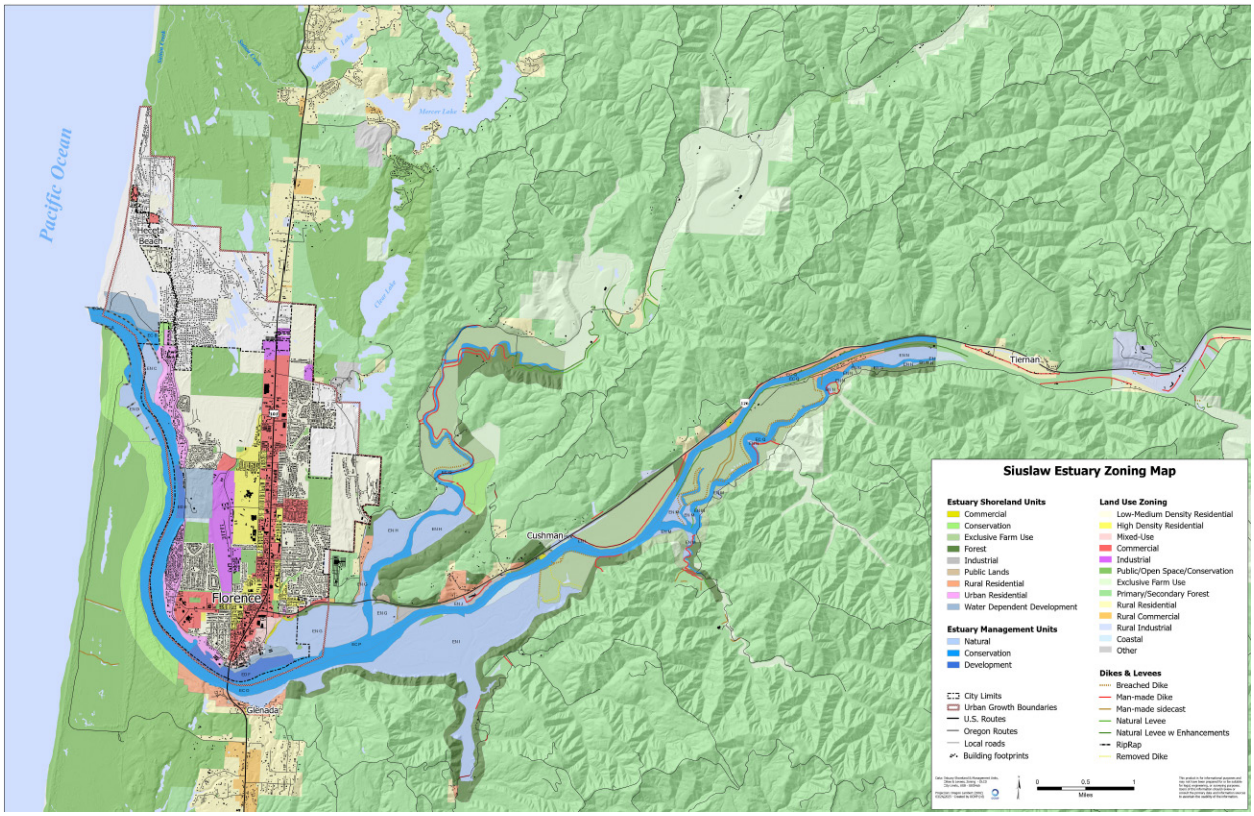


Figure 9. Siuslaw River estuary zoning map.

The Siuslaw River estuary, located on the central Oregon Coast, is a smaller yet ecologically significant coastal system. The estuary is formed where the Siuslaw River, which flows approximately 110 miles from its source in the central Oregon Coast Range, meets the Pacific Ocean near the city of Florence. Draining an area of about 773 square miles, the Siuslaw River estuary covers approximately 3,067 acres and is characterized by its sand-dominated subtidal zone and extensive tidal marshes (Oregon Conservation Strategy, 2023).

The estuary's unique features include forested tidal swamps dominated by Sitka spruce, a habitat type that has seen significant loss over the past century (Brophy, 2009). These swamps, along with the estuary's channels and wetlands, provide crucial habitats for a variety of fish species, including coho and Chinook salmon, steelhead trout, and coastal cutthroat trout. The Siuslaw was once considered the second richest salmon fishery in Oregon after the Columbia River, with historical runs estimated at 260,000 coho salmon per year. However, fish populations have declined significantly due to historical land use practices, with coho numbers dropping to a low of 500 in 1997 (ODFW, 2022; NMFS, 2016).

The estuarine environment supports a diverse array of wildlife. Migratory birds utilize the wetlands and tidal flats as important stopover points along the Pacific Flyway. The estuary's

varied habitats, from freshwater wetlands to saltwater marshes, create a productive ecosystem that serves as a nursery for juvenile fish and supports numerous invertebrate species crucial to the food web. The estuary also provides habitat for various species of flounder, sole, perch, crab, shrimp, and clams. Rocky areas near jetties and rock groins in the lower bay are preferred feeding and rearing areas for perch, greenling, and cabezon (Brophy, 2005; Oregon Conservation Strategy, 2023).

Historically, the Siuslaw River estuary was home to the Siuslaw people, who were forcibly removed from the area in 1860. Since then, the watershed has undergone significant changes, particularly due to intensive logging practices that have altered the river's hydrology and sediment transport. Notably, the destructive practice of "splash-dam" logging in the past century severely impacted salmon populations and river morphology (DEQ, 2022). Other impacts include unsustainable timber harvesting, overharvesting of fisheries, road building, and agricultural and residential development in floodplains.

Today, the City of Florence, with a population of about 9,000, serves as the primary urban center near the estuary's mouth. The area has transitioned from a primarily resource-extraction economy to one that increasingly relies on tourism and recreation. The estuary and surrounding areas offer opportunities for fishing, hiking, and wildlife viewing, attracting visitors to the central Oregon Coast.

Conservation efforts are underway to restore and protect the Siuslaw River estuary's unique habitats. Ongoing major restoration efforts on the Siuslaw River are set to take two years at a cost of $10 million. This work aims to convert almost 200 acres of land back into functional estuarine and wetland habitat that will benefit the environment and wildlife, especially salmon. The work involves filling in drainage ditches, lowering artificial dikes, and breaching tidal channels to restore natural tidal flows. Additionally, a recent land transfer has placed 245 acres at North Fork Bend in permanent protection, expanding the total conservation area to over 1,200 acres.

These restoration efforts are collaborative, involving organizations such as the McKenzie River Trust, the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians, The Nature Conservancy, and various state and federal agencies. The projects aim to enhance the estuary's ability to absorb increased sea level rise impacts, improve water quality, and safeguard communities against climate change effects. They also incorporate cultural elements, such as the inclusion of Siuslaw language place names and the construction of canoe ramps for tribal youth programs.

The Siuslaw River estuary, while smaller and less developed than some of Oregon's larger estuaries, plays a vital role in the local coastal ecosystem. Its ongoing restoration and conservation represent a commitment to preserving this unique coastal environment for future generations, supporting the recovery of salmon populations, and honoring the cultural heritage of the area's Indigenous peoples.

Hazard Risk

The Siuslaw River estuary and its broader floodplain face interconnected natural hazard risks that threaten both ecological integrity and human communities. These risks are amplified by climate change impacts and historical land-use practices.

Riverine and Estuarine Flooding

The Siuslaw River's narrow valley and steep coastal topography make it highly prone to flooding, particularly during winter rain-on-snow events and atmospheric rivers. Historic floods in 1964, 1996, and 1997 caused millions of dollars in damages, with Mapleton, a community along the river's upper reaches, experiencing recurrent inundation due to its location on the constricted floodplain (Lane County, 2021; DOGAMI, 2019). The 1996 flood saw the river rise 9 feet above flood stage in Mapleton, triggering landslides and damaging infrastructure. Low-lying areas of Florence, including the historic Old Town and Port of Siuslaw property, are also vulnerable to combined fluvial and tidal flooding. Climate change is projected to increase flood frequency and severity, with sea level rise exacerbating tidal backwater effects upriver. Anticipated impacts include disruptions to US Highway 101 (a critical coastal corridor), damage to homes and businesses in Mapleton, and contamination of salmon habitats via sediment and pollutant mobilization (OCCRI, 2021; ODOT, 2020).

Sea Level Rise and Habitat Loss

Sea level rise is projected to increase tidal flooding and saltwater intrusion into freshwater wetlands, particularly in the lower estuary near Florence. Under increasing sea level rise scenarios, potential tidal wetland loss will be continuous due to the Siuslaw River’s steep topography. The loss of tidal marshes and eelgrass beds critical for juvenile salmon and Dungeness crab could reduce the estuary's capacity to buffer storm surges. A 7 cm rise in sea level doubles the likelihood of 50-year flood events, threatening tidal wetland restoration efforts aimed at enhancing resilience (OCCRI, 2021). Upstream, the North Fork Siuslaw's steep, erosion-prone slopes face heightened landslide risks during extreme rainfall, increasing sediment loads that smother salmon spawning gravels (DOGAMI, 2019; NMFS, 2016).

Tsunami Inundation

The Siuslaw River estuary faces significant tsunami risk due to its proximity to the CSZ. Modeling indicates that a CSZ earthquake could generate tsunami waves exceeding 3 meters at the river's mouth, propagating up the estuary and inundating Florence's waterfront, including the US Coast Guard Station and marina infrastructure. During the 1964 Alaska tsunami, the Siuslaw River experienced strong currents and a 3.66-meter wave, resulting in costly damages (DOGAMI, 2020). Low-lying areas of Florence, such as the RV parks and commercial docks, are particularly exposed. Tsunami impacts could disrupt critical emergency response infrastructure, including the Coast Guard's boathouse and fuel storage facilities, while also destabilizing contaminated sediment deposits in the estuary (USACE, 2018; NOAA, 2022).

Erosion and Bluff Instability

Chronic erosion threatens the Siuslaw River's shoreline and adjacent infrastructure. The Coast Guard Station near Florence has faced retreat rates of 1–2 feet annually due to natural meandering and human alterations, risking the collapse of a 40-foot sand bluff supporting fuel tanks and utilities (USACE, 2018). Upstream, seven degraded railroad bridges along the mainstem leach toxic lead paint into salmon habitats, with one rivulet near Mapleton recording lead levels 16,000 times the water quality criterion (DEQ, 2021). Erosion of these structures mobilizes heavy metals, exacerbating ecological risks in the low-calcium watershed where acidification and metal toxicity already impair salmon health (NMFS, 2016; USGS, 2020).

Wildfire Risk

While coastal Lane County experiences fewer wildfires than inland areas, the Siuslaw watershed remains vulnerable to fire-related hazards. The steep, forested slopes of the Coast Range can fuel intense fires during dry periods, particularly in areas with dense understory vegetation or beetle-killed trees. The 2020 Sweet Creek Fire near Mapleton burned over 300 acres and threatened nearby communities, highlighting the potential for rapid fire spread in the region (ODF, 2021). Climate projections suggest an increasing likelihood of summer drought conditions, which could extend the fire season and increase ignition risks (OCCRI, 2021). Wildfires in the upper watershed pose significant threats to water quality in the Siuslaw River estuary, as post-fire erosion can lead to excessive sedimentation, increased turbidity, and the release of nutrients and contaminants into the river system. This degradation of water quality can have severe impacts on aquatic ecosystems, particularly for sensitive species like salmon and steelhead (NMFS, 2016). Additionally, wildfire smoke can affect air quality in coastal communities, posing health risks to residents and potentially impacting tourism-dependent economies in Florence and surrounding areas (Lane County, 2021).

Toxic Pollution and Ecological Degradation

The Siuslaw River watershed faces potential ecological challenges related to water quality and pollutants, though the full extent and impacts require further study. The watershed's geology, characterized by relatively low calcium carbonate levels, may increase its sensitivity to acidification and the bioavailability of certain contaminants (USGS, 2020). Historical land use practices, including intensive logging and the use of now-banned pesticides, could have legacy effects (DEQ, 2022). Current water quality concerns include potential runoff from forestry operations and aging infrastructure (ODOT, 2021), which may pose challenges for sensitive species like the Oregon Coast coho salmon (NMFS, 2016). While some localized studies have indicated areas of concern, a basin-wide understanding of pollutant levels, sources, and ecological impacts remains incomplete, though monitoring efforts aim to improve that understanding. Since 2006, the CTCLUSI have continuously monitored water quality in the Siuslaw River estuary and have used this data to analyze trends and support various research projects. In 2024, CTCLUSI adopted Tribal Water Quality Standards in partnership with the EPA,

establishing criteria to protect cultural, ecological, and recreational values within Tribal waters for future generations.

Vulnerable Populations and Assets

Populations throughout the Siuslaw River basin face layered vulnerabilities due to their geographic exposure, economic conditions, and limited access to emergency services. In Mapleton, the approximately 1,000 residents live in a constricted floodplain with limited evacuation routes and face recurring threats from both flooding and wildfire. Many homes are older and less resilient to natural hazards, and the community's isolation, coupled with limited local services and lower median incomes, compounds recovery challenges after disasters.

Key regional assets, including the Coast Guard Station in Florence, Highway 101 bridges, the Port of Siuslaw's docks, and critical wastewater and water infrastructure, may be threatened and are essential for maintaining public safety, transportation, and economic stability during and after hazard events. When these systems are disrupted, both urban and rural populations face increased risk from isolation, service outages, and economic dislocation.

Ecologically, the basin supports 27% of Oregon's coastal coho spawning habitat and key migration routes for lamprey and steelhead. Damage to these systems from floods, sedimentation, or pollution not only threatens fish populations but also undermines cultural values and local food systems important to Tribal communities and rural residents. While wetland restoration and home elevation efforts are underway, persistent gaps in floodplain management, toxic pollutant monitoring, and access to preparedness resources leave vulnerable populations at heightened risk (Lane County, 2021).

Key Themes for Vulnerability

Climate Change and Coastal Hazards: The Siuslaw River estuary faces significant threats from climate change, including sea level rise, increased storm surge, and more frequent extreme weather events. These hazards directly impact coastal communities, infrastructure, and natural habitats. Sea level rise and erosion are chronic issues because the area is naturally vulnerable to flooding and long-term erosion that impacts tidal wetlands and that the existing protective and adaptive infrastructure (such as the dune aquifer) has not been equipped to handle those issues as they get more intense.

Water Quality and Aquifer Vulnerability: Water quality issues, particularly those affecting the sensitive dunal aquifer system, are a major concern for the Siuslaw River region. Pollutants from non-point sources (such as herbicides/pesticides and failing septic systems), and historical land use practices threaten drinking water supplies and aquatic ecosystems. In some areas significant watershed issues result in poor conditions for aquatic life, requiring ongoing and costly efforts to manage sediment and protect water intakes. There has also been an acknowledgement that there will be catastrophic impacts from both short and long-term

effects in reduced water quality in areas due to external stressors such as weather events, habitat diversity and the destabilization of soil and erosion.

Infrastructure Deficiencies and Interdependencies: The existing infrastructure in the Siuslaw River area is often undersized, aging, and vulnerable to natural hazards. Key current and future needs are not being met, and a lack of maintenance is undersizing its potential to handle increased future demand. Limited resources, aging systems, and the impact of storms, erosion, and sedimentation on essential infrastructure, particularly transportation corridors like Highway 126 (Cushman Crossing), are all critical risks.

Socioeconomic and Adaptive Capacity Challenges: The community's adaptive capacity is limited by socioeconomic factors such as an aging population, limited financial resources, and a lack of public awareness and engagement. There is a concern with living in a more remote area that during a disaster they could be “islanded” from support. There is, ultimately, a challenge whereby the area may not have sufficient tax base for necessary upgrades and public involvement may be limited.

Ecological Degradation and Habitat Loss: The Siuslaw River estuary's valuable ecosystems face degradation and habitat loss due to a combination of factors, including climate change, water quality impacts, and historical land use practices. There has been some fear that there would be issues socially and culturally due to irreplaceable assets could also be destroyed, or that rebuilding could take decades. The health of tidal wetlands, salmon populations, and other keystone species are all at risk.

Key Challenges

Habitat Loss and Fragmentation: Approximately 85% of historical tidal wetlands have been lost due to development, significantly reducing critical habitat for salmon and other species. Reduced lateral connectivity between channels and floodplains limits habitat complexity and ecosystem function.

Climate Change Impacts: Sea level rise threatens tidal wetlands and estuarine habitats, potentially reducing critical nursery areas for coho salmon and other important species. Altered precipitation patterns may exacerbate water quality issues, particularly dissolved oxygen levels and temperature.

Water Quality Degradation: The Siuslaw River has over 236 river miles identified as "impaired" due to temperature, bacteria, sedimentation, and dissolved oxygen issues. Legacy pollutants, including toxic metals, pose a significant threat to aquatic life.

Opportunities for Resilience

Restore Tidal Wetlands: Recent conservation efforts, such as the transfer of 245 acres for estuary restoration, provide opportunities to reconnect and protect tidal wetlands, enhancing habitat for coho salmon and improving overall ecosystem resilience.

Implement Strategic Habitat Restoration: The Siuslaw Coho Partnership has developed a Strategic Action Plan identifying specific restoration projects to enhance watershed function and support long-term coho salmon recovery.

Engage Stakeholders: Collaborative efforts involving local residents, tribes, nonprofits, and government agencies, have shown success in conservation and restoration initiatives. Continuing to foster these partnerships will be crucial for implementing effective resilience strategies.

Specific Vulnerability Concerns

Built Infrastructure

Cushman Crossing (OR Highway 126): Cushman Crossing on Highway 126 is a critical transportation link in coastal Lane County that faces significant challenges due to frequent flooding. This low-lying section of the highway, along with the adjacent railroad trestle, is particularly vulnerable to seasonal inundation caused by high rainfall and tidal influences (ODOT, 2021). The crossing serves as a vital connection between coastal communities and inland areas, making its reliability crucial for daily commutes, commerce, and emergency services.

The flooding at Cushman Crossing poses multiple threats to the region's resilience and safety. During high water events, the road often becomes impassable, leading to closures that can last for hours or even days (Lane County Emergency Management, 2020). This disruption not only affects local travel and economic activities but also raises serious safety concerns. Floodwaters on the highway create hazardous driving conditions, increasing the risk of accidents and potentially stranding motorists.

Of particular concern is the crossing's role in emergency preparedness and response. In the event of a major natural disaster such as an earthquake or tsunami, Cushman Crossing represents a critical evacuation route for coastal residents (OEM, 2019). If compromised by flooding during such an event, it could severely hamper evacuation efforts, potentially leaving coastal communities cut off from inland safety.

The recurring flooding issues at Cushman Crossing also highlight the broader challenges faced by coastal infrastructure in the context of climate change. Sea level rise and the potential for more frequent and intense storm events may exacerbate the flooding problems in the future, underscoring the need for long-term resilience planning (OCCRI, 2021).

The vulnerability of Cushman Crossing to flooding represents a significant concern for transportation reliability, public safety, and emergency preparedness in coastal Lane County. Addressing these challenges will require careful consideration of both immediate flood mitigation needs and long-term resilience strategies, while also taking into account the ecological sensitivity of the surrounding estuarine environment.

US Highway 101 & Siuslaw River Bridge: The Siuslaw River Bridge on US Highway 101 in Florence is a critical infrastructure asset that faces significant seismic vulnerability. Built during the Depression era as part of the Oregon Coast Highway completion, this historic bridge plays a vital role in regional transportation and emergency services (Corning, 1989).

The bridge's vulnerability to earthquake damage is a major concern, particularly given its location in a high-risk seismic zone. Oregon's coastal region, including Florence, is susceptible to powerful earthquakes from the CSZ. A magnitude 9.0 earthquake in this zone could generate severe ground shaking and potentially trigger a tsunami, posing a dual threat to the bridge and surrounding areas (ODOT, 2021).

The age of the Siuslaw River Bridge contributes to its vulnerability. Constructed before the implementation of modern seismic design standards, the bridge lacks many of the earthquake-resistant features found in newer structures. This puts it at higher risk of damage or collapse during a major seismic event (ODOT, 2021).

The potential disruption to regional transportation in the event of bridge failure is significant. US Highway 101 serves as a critical north-south corridor along the Oregon Coast, and the Siuslaw River Bridge is an essential link in this route. Its closure or collapse would severely impede traffic flow, potentially isolating communities and hampering emergency response efforts (Lane County Emergency Management, 2020).

Moreover, the bridge's importance extends beyond daily transportation needs. In the event of a major earthquake or tsunami, the Siuslaw River Bridge would be crucial for evacuation and emergency services access. Its failure could leave coastal communities cut off from inland areas, complicating rescue and relief efforts (OEM, 2019).

While efforts have been made to improve the bridge's resilience, including a protection project in 2015 to preserve it from the harsh coastal environment, its fundamental seismic vulnerabilities remain a concern (ODOT, 2015). The potential for a major CSZ earthquake, coupled with the bridge's structural vulnerabilities, underscores the need for ongoing assessment and mitigation strategies to ensure the resilience of this critical infrastructure asset.

Bay Street (Old Town): Bay Street and the surrounding Old Town Florence area face significant vulnerabilities to flooding and sea level rise, posing potential risks to local businesses and

infrastructure. This historic district, situated along the Siuslaw River along Bay Street, is a vital economic and cultural center for the City of Florence.

FEMA updated the Flood Insurance Rate Map for coastal Lane County, including Florence, in 2020. This update, using more accurate data and improved technology, has led to changes in flood hazard zones and base flood elevations for properties within and adjacent to floodways in Florence (City of Florence, 2020).

Sea level rise projections for the Oregon Coast indicate a potential increase of 19 inches (1.7 feet) by 2050 and 56 inches (4.7 feet) by 2100 (Beyond Toxics, 2022). These projections are particularly concerning for low-lying areas like the Historic Old Town district in Florence. A sea level rise of 4 feet would result in significant flooding in parts of the city, potentially impacting the Bay Street area.

The threat of flooding is compounded by the potential for more severe storm surges. Historical data shows that strong El Niño-influenced storms in 1996-1997 raised sea levels by about 1.5 feet, and future winter storms may be similar or more intense (Oregon Shores Conservation Coalition, 2015). This combination of sea level rise and storm surge could lead to more frequent and severe flooding events in the Bay Street area.

The economic impact of these threats could be substantial. Bay Street and Historic Old Town Florence are home to numerous businesses, restaurants, and shops that contribute significantly to the local economy and tourism industry. Flooding and sea level rise could damage buildings, disrupt business operations, and potentially lead to long-term economic losses for the community.

Additionally, critical infrastructure in the area, such as roads, utilities, and stormwater systems, may be at risk. Increased flooding could overwhelm existing stormwater management systems and potentially lead to contamination issues.

Port of Siuslaw: The Port of Siuslaw is a vital economic and recreational asset for the coastal community. The Port manages several key properties and facilities along the Siuslaw River, including a campground, marina, and commercial docks. The Port's RV campground offers 124 sites with full hookups, including 28 waterfront sites and 15 pull-through sites. Its location adjacent to the river and within walking distance of Historic Old Town Florence makes it a popular destination for tourists and recreational visitors. The Port also operates marina facilities, including sport and commercial boat moorage. A boat launch is available near the campground, providing access to the river for fishing, boating, and other water-based activities.

However, the Port's waterfront properties face significant challenges related to flooding and erosion. This flood risk, combined with the effects of winter storms and tides, has led to ongoing issues with shoreline stability. In recent years, the Port has undertaken significant efforts to address these challenges. A conditional use permit was approved in 2022 to install approximately 900 feet of sheet pile wall along the damaged side bank of the Siuslaw River.

This project aimed to stabilize the eroding shoreline and maintain the Port's infrastructure, which is crucial for economic development and water-dependent uses (City of Florence, 2022).

The Port of Siuslaw's properties, including its campground, marina, and commercial facilities, play a significant role in the local economy and recreational offerings of Florence. However, their proximity to the Siuslaw River estuary also exposes them to ongoing environmental challenges that require careful management and mitigation strategies.

Rhododendron Drive: Rhododendron Drive in Florence has undergone significant changes to address ongoing environmental challenges and improve infrastructure resilience. The City recently completed a major realignment and improvement project, shifting the road approximately 15 feet away from the river, particularly in the section south of Wildwinds near the Sea Watch Estates (City of Florence, 2024). This project, which began in 2024, aimed to enhance safety, accessibility, and infrastructure along this critical roadway.

Despite these improvements, the area continues to face geological instability. Active landslides remain a persistent threat, necessitating further intervention. The city is seeking support from congressional delegates to secure funding for a secant wall, which would help stabilize the slope and mitigate the ongoing sliding issues.

The project area also includes important stormwater management infrastructure. A stormwater outfall discharge is present in the vicinity, adding complexity to the site's hydrological dynamics. This outfall requires careful consideration in any future development or stabilization efforts to ensure proper drainage while minimizing environmental impact.

The waterfront along Rhododendron Drive presents both challenges and opportunities. The area has potential for attractive river frontage property development, but it requires sensitive treatment due to its proximity to the river and the ongoing geological instability. Any future development will need to balance the desire for river access with the need for environmental protection and structural stability.

Historical infrastructure in the area is showing signs of deterioration. Marine Manor, located along this stretch, previously had a seawall installed. However, recent observations indicate that this seawall is settling and sinking, highlighting the ongoing challenges of maintaining coastal infrastructure in this dynamic environment.

The Rhododendron Drive project represents a significant step in addressing these complex issues, but it's clear that ongoing monitoring, maintenance, and potentially further interventions will be necessary to ensure the long-term stability and safety of this important coastal roadway.

Florence Wastewater Treatment Plant: The Florence Wastewater Treatment Plant is a critical piece of infrastructure for the City of Florence. This facility plays a vital role in maintaining public health and environmental quality by processing the city's wastewater before it is released back into the environment.

The plant's location along Rhododendron Drive places it in close proximity to the river, which introduces potential vulnerabilities to flooding and sea level rise. During flood events or periods of extreme weather, the wastewater treatment plant could face operational challenges. Inundation of the facility might lead to equipment damage, disruption of treatment processes, or in severe cases, the release of untreated or partially treated wastewater into the environment. Such incidents could have significant implications for both public health and the ecological balance of the Siuslaw River and surrounding areas.

The vulnerability of the wastewater treatment plant to flooding and sea level rise represents a significant concern for the city's long-term resilience and environmental stewardship. As climate change continues to influence weather patterns and sea levels, the challenges faced by this critical infrastructure are likely to intensify, underscoring the importance of ongoing assessment and planning.

Heceta Beach Road: Heceta Beach Road, a critical access route for residents and visitors in the Florence area, faces recurring seasonal flooding issues. These flooding events disrupt transportation, pose safety concerns, and highlight broader infrastructure vulnerabilities in this low-lying coastal region.

Flooding along Heceta Beach Road is largely attributed to the area's high water table, poorly drained soils, and the presence of significant wetlands such as Heceta Junction Lake. These seasonal lakes and wetlands reliably fill during the rainy season, creating standing water that can persist for weeks or even months. The flooding is exacerbated by inadequate drainage infrastructure, as noted by residents who report that water often inundates roadways and properties in the surrounding neighborhoods.

The wetlands near Heceta Junction Lake are identified as "significant wetlands" in the City's local inventory due to their ecological importance in maintaining surface and groundwater quality. However, these same features contribute to the area's flood risk during periods of heavy rainfall. The high water table further complicates drainage efforts, as saturated soils limit the capacity for additional water absorption (Oregon Coast Alliance, 2019).

The flooding not only disrupts transportation along Heceta Beach Road but also poses risks to nearby infrastructure and properties. Residents have expressed concerns about septic systems being submerged during flood events, which could lead to contamination of groundwater and surrounding areas. Additionally, prolonged standing water can damage road surfaces and reduce accessibility for emergency services. The location's vulnerability is compounded by its proximity to US Highway 101. Flooding near this intersection could have broader implications for regional mobility and emergency response capabilities. In addition to flooding, the area faces potential risks from erosion due to its coastal location. Coastal backwater flooding from storm surges or high tides could further exacerbate flood conditions along Heceta Beach Road (DOGAMI, 2017). These combined hazards underscore the challenges of managing infrastructure in a dynamic coastal environment.

Critical/Environmental Infrastructure

Drinking Water: The Siuslaw River estuary area faces unique challenges related to its drinking water sources and aquifers. The North Florence Sole Source Dunal Aquifer (see Figure 7), designated as a "sole source" aquifer by the EPA in 1987, is the primary drinking water source for Florence residents. This designation underscores its critical importance, as contamination of this aquifer would leave the area without an alternative drinking water source (City of Florence, 2025). The interconnected nature of the lower Siuslaw River watershed means that protecting the aquifer also helps safeguard surface waters, including Munsel Creek and the estuary. To address potential risks, the City of Florence has implemented a Groundwater and Surface Water Monitoring Program as part of the Siuslaw Estuary Partnership. This program aims to protect the aquifer and related surface waters from contamination. Ongoing monitoring and proactive protection efforts will be critical to ensure a safe and reliable drinking water supply for the broader Florence community.

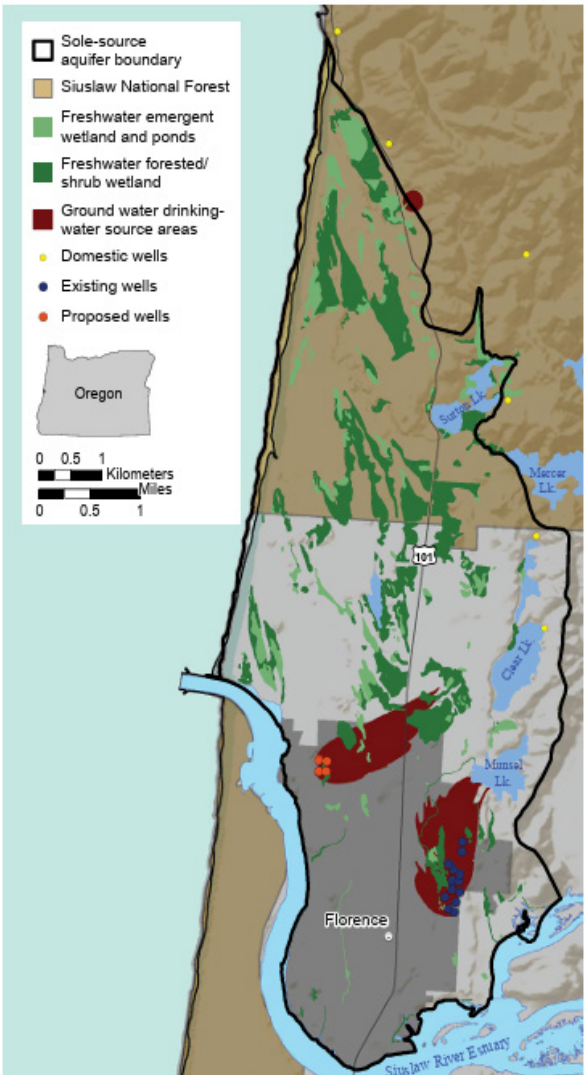


Figure 10. Map of the Florence dunal aquifer. Source: USFS CCVA (2024)

Florence Municipal Airport: Florence Municipal Airport is a vital community lifeline for the Central Oregon Coast, providing essential general aviation services, emergency response capabilities, and economic contributions to the coastal Lane County area. However, the airport is vulnerable to several natural hazards that could disrupt its operations and compromise its critical role in the region.

The airport features a 3,000-foot paved and lighted runway and accommodates approximately 8,000 air operations annually. These include daily UPS overnight service, which underscores its importance for regional logistics and commerce (City of Florence, 2025). Despite its utility, the airport faces significant risks from flooding, seismic activity, and potential land use conflicts.

The airport's proximity to low-lying coastal areas makes it susceptible to flooding during extreme weather events or storm surges. Rising sea levels due to climate change may exacerbate this risk over time. Flooding could damage critical infrastructure such as the runway,

lighting systems, and fueling facilities, disrupting operations and requiring costly repairs (Lane County Emergency Management, 2023).

Situated within the CSZ, Florence Municipal Airport is at risk of severe ground shaking during a major earthquake. Such an event could damage the runway surface, buildings, and other facilities. Additionally, liquefaction (a phenomenon where saturated soils lose strength during shaking), threatens the airport's operational integrity (Oregon Aviation Plan, 2023).

As a critical asset for emergency response during natural disasters or other crises, the airport must remain operational under adverse conditions. Its ability to support evacuation efforts or deliver supplies could be compromised by flooding or earthquake damage. Ensuring resilience in these scenarios is essential for maintaining public safety and regional stability.

Railroad Bridges: The Siuslaw River features six railroad bridges, including the Cushman Railroad Bridge near Florence. These structures are vital components of the Coos Bay Rail Line, a 134-mile shortline railroad that connects the region to the North American rail network and supports both freight and economic activity in Lane County and beyond. However, these bridges face several vulnerabilities tied to natural hazards and aging infrastructure.

The Cushman Railroad Bridge is located just upstream from Florence. This bridge is over a century old and represents an important piece of transportation history. Despite its historical significance, the bridge's age makes it susceptible to structural deterioration, which could compromise its functionality over time.

Flooding presents a significant hazard for these bridges. The Siuslaw River is prone to high water events, particularly during winter storms and heavy rainfall. Floodwaters can increase scour at bridge piers, weakening their foundations and potentially leading to structural instability. Additionally, storm surge and tidal influences near the river's mouth may exacerbate flooding impacts on the lower portions of the river where these bridges are located.

Sea level rise poses a long-term risk to the bridges as well. Projections for the Oregon Coast estimate a rise of approximately 19 inches by 2050 and up to 56 inches by 2100. This gradual increase in water levels could lead to more frequent inundation of low-lying areas near the riverbanks and increase stress on bridge structures (OCCRI, 2021). Earthquake vulnerability is another critical concern. A major CSZ event could cause severe ground shaking and soil liquefaction, further threatening the stability of these century-old bridges (ODOT, 2024).

The Coos Bay Rail Line has recently received funding for rehabilitation projects aimed at improving bridge safety and extending their operational lifespan. This includes repairs to key structures such as the Cushman Railroad Bridge to ensure they meet modern safety standards and continue supporting regional freight operations (Port of Coos Bay, 2023). However, given their age and exposure to multiple natural hazards, these bridges remain vulnerable assets requiring ongoing monitoring and maintenance.

Bonneville Power Administration Substations: The Bonneville Power Administration substations in Lane County, including those near Florence and along the coast, face a range of

natural hazard vulnerabilities that could impact their operations and the broader power distribution network.

Severe winter storms pose a significant threat to these substations and associated transmission lines. The coastal region is particularly susceptible to strong winds and heavy precipitation during winter months. These conditions can lead to downed power lines, damaged transformers, and widespread outages. The January 2024 ice storm demonstrated the potential impact of such events, affecting critical infrastructure and requiring up to two weeks for full power restoration in some areas (Lane County, 2024).

Flooding presents another substantial risk, especially for substations located in low-lying areas or near rivers. The Siuslaw River and its tributaries are prone to flooding during heavy rainfall events, which could inundate substation equipment and disrupt power transmission. Sea level rise and potential storm surges add another layer of vulnerability for coastal substations, potentially exacerbating flood risks over time (OCCRI, 2021).

Wildfire risk, while perhaps less immediate for coastal substations, remains a concern for the Administration's infrastructure in more inland, forested areas of Lane County. The 2023 Lookout Fire highlighted the potential for wildfires to damage transmission structures and force the shutdown of power generation facilities, as seen with the Carmen Smith hydro-electric plant (Lane County, 2024).

Seismic activity poses a long-term risk to all substations in the region. The CSZ's potential for large-magnitude earthquakes means that substations could face severe ground shaking, soil liquefaction, and potential tsunami inundation for coastal facilities. While not frequent, such an event could cause catastrophic damage to power infrastructure (DOGAMI, 2022).

Extreme weather events, including heat waves, are becoming more common and intense due to climate change. High temperatures can lead to increased power demand while simultaneously stressing equipment, potentially causing transformer failures and cable degradation (Lane County, 2024).

Freshwater Marshes: The Siuslaw River estuary marshlands are significant ecological assets on the Oregon Coast. This estuarine system encompasses approximately 3,060 acres and is characterized by extensive wetlands, tidal marshes, and salt marshes that provide crucial habitat for a diverse array of wildlife and fish species (ODFW, 2023).

Flooding is a primary concern for these low-lying coastal wetlands. The Siuslaw River basin is prone to seasonal flooding, particularly from October - April when Pacific storms bring intense rainfall (Lane County Emergency Management, 2024). The combination of heavy rains, potential snowmelt, and tidal influences can lead to significant inundation of marsh areas.

Sea level rise poses a long-term threat to the Siuslaw River's marshy ecosystems. As global sea levels continue to rise, these low-elevation wetlands may experience increased flooding frequency and duration, potentially altering their ecological composition and extent (OCCRI, 2021).

Erosion and sedimentation are ongoing processes that can impact the marshlands. Storm surges and strong tidal currents can erode shorelines and alter sediment distribution, potentially changing the structure and function of these habitats over time (Ecotrust, 2002).

Tsunamis represent a low-frequency but high-impact hazard for the Siuslaw River estuary and its marshes. Given the area's proximity to the CSZ, a major seismic event could generate a tsunami that would inundate these low-lying areas, causing significant ecological disruption (DOGAMI, 2022).

Climate change exacerbates many of these vulnerabilities. Increased storm intensity, changing precipitation patterns, and rising temperatures may stress these ecosystems and alter their ability to provide critical habitat and ecosystem services (OWEB, 2022).

Despite these vulnerabilities, the Siuslaw River's marshlands, including protected areas like North Fork Marsh, play a crucial role in mitigating some natural hazards. These wetlands act as natural buffers against flooding and storm surges, absorbing excess water and reducing the impact on inland areas. They also help filter pollutants and sediments, improving water quality in the estuary.

Fisheries: The Siuslaw River supports a diverse and historically significant fishery, particularly for salmon and steelhead. However, this fishery faces a range of natural hazard vulnerabilities that threaten its long-term viability and ecological balance.

Seasonal flooding, particularly from October through April, can disrupt spawning habitats for salmon and steelhead. These flood events often increase sediment loads in the river, which can smother spawning beds and reduce the availability of clean gravel necessary for successful egg incubation (USFS, 1998). Additionally, extreme flooding events may displace juvenile fish, reducing survival rates.

The Siuslaw River basin has experienced extensive land use changes over the decades, including timber harvesting and road construction, which have destabilized slopes and increased sedimentation in the river. This sedimentation not only degrades water quality but also negatively impacts critical habitat for fish species such as Chinook and coho salmon (ODFW, 1987).

Sea level rise poses a long-term threat to the estuarine habitats in the river, where many fish species rely on tidal wetlands for rearing and feeding. Rising sea levels could inundate these habitats, altering their ecological function and reducing their availability to fish populations (OCCRI, 2021).

Wildfires in the Siuslaw River watershed can exacerbate erosion and sedimentation issues. Post-fire runoff often carries large amounts of ash and debris into streams, degrading water quality and impacting aquatic ecosystems. While wildfires are less frequent in this coastal region compared to inland areas, their increasing prevalence due to climate change remains a concern (USFS, 1998).

Climate change is amplifying many of these hazards. Warmer water temperatures during summer months can stress cold-water species like salmon and steelhead, reducing their growth and survival rates. Changes in precipitation patterns may also alter streamflows, potentially reducing water availability during critical periods for migration and spawning (OCCRI, 2021).

Tsunamis represent a low-frequency but high-impact hazard for the Siuslaw River fisheries. A major CSZ earthquake could generate a tsunami that would inundate estuarine habitats critical for juvenile salmonids. Such an event could cause widespread ecological disruption in the lower river system (DOGAMI, 2022).

Despite these challenges, conservation efforts are ongoing to mitigate the impacts of these hazards on the Siuslaw River fishery. Restoration projects led by organizations like the Siuslaw Watershed Council aim to improve habitat conditions by stabilizing streambanks, enhancing riparian vegetation, and restoring tidal wetlands (Siuslaw Watershed Council, 2019). Additionally, hatchery programs managed by ODFW provide supplemental support for steelhead and salmon populations while minimizing impacts on wild fish.

Munsel Lake: A critical water supply for the City of Florence, Oregon, Munsel Lake faces several natural hazard threats and vulnerabilities that could impact its water quality and availability. This freshwater lake, located within the city limits, plays a vital role in the local water supply system but is at risk from various environmental and anthropogenic factors.

Contamination poses a significant threat to Munsel Lake's water quality. The 1987 EPA Sole Source Aquifer Resource Document identified potential contamination sources including fuel storage tank failures, accidental spills of hazardous materials, septic tank effluent, storm runoff, pesticides, and chemical fertilizers (City of Florence, 2013). More recent concerns have emerged regarding the discharge of pharmaceutical by-products into the lake, adding to the complexity of potential contaminants.

The lake's hydrological connectivity with the groundwater system increases its vulnerability to both surface and subsurface contamination sources. This interconnectedness means that pollutants entering the lake could potentially impact the broader aquifer system, extending the reach of any contamination event (City of Florence, 2013).

Urban runoff presents an ongoing risk to Munsel Lake's water quality. As the lake is situated within an urban area, it receives stormwater runoff from surrounding developed areas, which can introduce a variety of pollutants including oils, heavy metals, and excess nutrients (City of Florence, 2013). This nutrient loading can lead to eutrophication, potentially causing harmful algal blooms that further degrade water quality and pose health risks.

Climate change impacts threaten to exacerbate existing water quality issues in Munsel Lake. Changing precipitation patterns and increasing temperatures could affect water levels, temperature, and overall water quality. These changes may create new challenges for maintaining the lake as a reliable drinking water source (OCCRI, 2021).

While not explicitly mentioned in recent reports, the potential threat of invasive aquatic species remains a concern for lake ecosystems like Munsel Lake. Such species can alter nutrient cycles, affect water clarity, and impact native species, potentially compromising water quality and ecosystem health.

To address these vulnerabilities, the City of Florence has implemented a comprehensive monitoring program to track water quality trends and identify potential contamination issues (City of Florence, 2013). This proactive approach is essential for maintaining Munsel Lake's role as a critical water supply and ensuring its long-term health and sustainability.

Munsel Creek Greenway: The Munsel Creek greenway is a valuable and sensitive habitat that provides ecological benefits such as wildlife corridors, riparian vegetation, and water quality enhancement. However, this greenway faces several natural hazard vulnerabilities that could impact its ecological integrity and functionality.

Erosion is a significant concern along Munsel Creek. Destabilization of the creek's banks, due to heavy rainfall events and urban stormwater runoff, threatens riparian vegetation and contributes to sedimentation (City of Florence, 2025). Landslides pose another hazard in the greenway area. Localized slope failures, following periods of heavy rainfall, can disrupt trails, damage vegetation, and introduce sediment into the creek (USFS, 1998).

Water quality impacts are a persistent issue. The creek is hydrologically connected to groundwater and receives urban stormwater, making it vulnerable to pollutants such as oils, heavy metals, pesticides, and excess nutrients (City of Florence, 2023).

Climate change exacerbates many of these hazards. Increasingly intense rainfall events are expected to heighten erosion and landslide risks. Rising temperatures could also alter the creek's ecological balance (OCCRI, 2021).

Despite these challenges, the Munsel Creek greenway remains a critical natural asset for Florence, helping stabilize streambanks, filter pollutants, and provide recreational opportunities.

Berkshire Creek, Mapleton: Berkshire Creek, a tributary of the Siuslaw River near Mapleton, serves as the primary drinking water source for the Mapleton Water District. However, the creek faces several challenges that impact its water quality and the district's water supply infrastructure:

Erosion is a significant concern affecting Berkshire Creek, particularly along Berkshire Creek Road. The watershed's steep slopes, with many areas exceeding 60 percent grade, contribute to erosion risks. This erosion can lead to increased sediment in the creek, potentially affecting water quality and treatment processes (USFS, 1998).

The Mapleton Water District's treatment plant, which draws water from Berkshire Creek, experienced a failure in 2020. This led to the temporary installation of a rented portable filtration unit while plans for a new treatment plant are underway. The district is working on

replacing approximately half a mile of piping that brings raw water from the Berkshire Creek intake to the treatment plant (CivicLive, 2024).

Climate change impacts are becoming evident in Berkshire Creek. Recent years have shown lower flows within the creek during summer months, indicating potential long-term changes in water availability. This trend may necessitate water conservation measures and infrastructure improvements to address future supply challenges (CivicLive, 2024).

While DEQ's 2001 Source Water Assessment found no potential sources of contamination within the protection area, which lies entirely within public forestland, ongoing monitoring is crucial to maintain water quality (Mapleton Water District, 2023).

The creek's watershed is also vulnerable to natural hazards such as landslides and extreme weather events. These events can impact water quality and disrupt the water supply infrastructure. The Mapleton Water District will need to consider these risks in their long-term planning and infrastructure development (CivicLive, 2024).

Social Factors and Vulnerable Populations

Mapleton: Situated along the upper reaches of the Siuslaw River estuary, Mapleton faces a complex array of natural hazards and infrastructure challenges that collectively threaten the community's resilience and well-being.

Flooding stands out as a primary concern, with the town's commercial core and riverside residences lying within the 100-year floodplain and floodway (Lane Council of Governments, 2019). Historical records show five major flood stage events and 12 moderate floods between 1861 and 2012, with more recent events occurring in 2017, 2019, 2020, and 2021. These floods have caused significant property damage, posed risks to life and safety, and impacted critical infrastructure, including water and wastewater systems, roads, and bridges.

Compounding the flood risk, Mapleton grapples with erosion and landslide hazards. The town's riverside location and surrounding topography make it vulnerable to riverbank erosion, while steep slopes and soil conditions increase the risk of landslides, especially during heavy rainfall events common to the region (DOGAMI, 2020).

Sea level rise, while not an immediate threat, is an emerging concern that could exacerbate flooding and erosion issues in the future, particularly when combined with storm surges and high tide events (OCCRI, 2021).

Wildfire risk adds another layer of vulnerability, with Mapleton classified as a Wildland Urban Interface area (ODF, 2022). This designation reflects the close proximity of homes and buildings to forested areas, increasing the potential impact of wildfires on the community.

Amidst these natural hazards, Mapleton faces significant challenges with its drinking water supply. The town relies on surface water from the Siuslaw River, which is susceptible to contamination during flood events and periods of high turbidity (DEQ, 2018). Aging

infrastructure in the water treatment and distribution system has led to persistent issues, including frequent boil water notices, difficulties meeting water quality standards, service interruptions, and challenges in securing funding for necessary upgrades.

These interconnected vulnerabilities create a complex risk landscape for Mapleton. The town's water supply issues are exacerbated by flooding and erosion risks, while the potential for landslides and wildfires further complicates emergency response and infrastructure resilience efforts. Addressing these challenges will require a comprehensive, integrated approach to hazard mitigation, infrastructure improvement, and long-term community planning to enhance Mapleton's overall resilience in the face of multiple, overlapping threats.

Green Trees and Driftwood Shores Communities: Green Trees Village and Driftwood Shores Resort in Florence are situated in low-lying coastal areas that face significant vulnerabilities to natural hazards, particularly tsunamis and other coastal threats.

Tsunamis pose the most immediate and severe threat to these communities. Both are located within the inundation zone of the CSZ, which has the potential to generate a massive earthquake and subsequent tsunami. These events could inundate low-lying areas within minutes, leaving little time for evacuation. Driftwood Shores Resort, situated directly on Heceta Beach, faces particularly high exposure due to its beachfront location (DOGAMI Industries, 2022).

Coastal erosion is another significant hazard, especially for Driftwood Shores. The resort’s proximity to the shoreline makes it vulnerable to ongoing erosion processes driven by wave action, storm surges, and rising sea levels. Over time, this erosion could threaten infrastructure and reduce the stability of the surrounding land (OCCRI, 2021).

Storm surge and flooding also pose risks during severe coastal storms. Green Trees Village, a residential community described as having secluded lots near water bodies, may experience flooding during extreme weather events or king tides. This risk is compounded by the low elevation of both communities (Lane County Emergency Management, 2024).

Sea level rise represents a long-term hazard that could exacerbate flooding and erosion risks in these areas. As global sea levels continue to rise due to climate change, both Green Trees Village and Driftwood Shores may face increased exposure to chronic flooding and saltwater intrusion (OCCRI, 2021).

Earthquakes present an additional hazard for these coastal communities. Both are at risk from ground shaking during earthquakes. Driftwood Shores’ multi-story structures may be particularly vulnerable to seismic activity if not adequately retrofitted for earthquake resilience (DOGAMI, 2022).

These vulnerabilities highlight the need for proactive hazard mitigation measures. Emergency preparedness plans should prioritize tsunami evacuation routes and community education on disaster response. Additionally, long-term adaptation strategies such as shoreline stabilization

projects and infrastructure upgrades will be critical to reducing risks from erosion, flooding, and sea level rise.

Vulnerable Groups: The Siuslaw River estuary area faces significant natural hazard vulnerabilities, which disproportionately affect certain groups of residents. The region's demographic and socioeconomic characteristics highlight the need for tailored emergency planning and response efforts.

Elderly residents make up a substantial portion of the population in the Siuslaw River estuary area. Florence has a median age of 62.5 years, far above Oregon's statewide median age of 39.1 (US Census Bureau, 2023). This aging population includes many retirees who may have mobility limitations or chronic health conditions that complicate evacuation during emergencies. Flooding, a frequent hazard in the Siuslaw River watershed, poses particular risks to elderly residents who may struggle to leave their homes quickly or access emergency shelters. Additionally, heat waves or power outages caused by severe storms could disrupt essential medical equipment or exacerbate health issues.

Residents reliant on power for medical care are another vulnerable group. Many individuals in the region depend on electrically powered devices such as oxygen concentrators or dialysis machines. The Siuslaw River area is prone to flooding and coastal storms that can lead to prolonged power outages, creating life-threatening situations for these individuals. Furthermore, water quality concerns in the Siuslaw River, including elevated lead levels from degrading infrastructure and pesticide runoff, could impact drinking water supplies during emergencies (Coast NOAA, 2013). These risks emphasize the importance of ensuring reliable backup power systems and access to clean water for medically dependent residents.

Temporary housing occupants, including tourists staying in short-term rentals or seasonal workers living in temporary accommodations, face unique challenges during natural disasters. Coastal areas near the Siuslaw River have seen an increase in second homes and vacation rentals as a percentage of total housing stock (DLCD, 2014). These individuals may be unfamiliar with local hazards such as tsunamis or flooding and unaware of evacuation routes or emergency procedures. Acute events like tsunamis pose severe risks to this group, particularly given the proximity of many temporary housing units to low-lying areas near the coast.

Very low-income residents and those living in remote areas are also highly vulnerable to natural hazards in the Siuslaw River region. Lane County has a poverty rate of 15%, higher than Oregon's statewide average of 12% (US Census Bureau, 2023). Many low-income households lack reliable transportation for evacuation or live in substandard housing that is more susceptible to flood damage or windstorms. Residents in remote areas may face additional challenges accessing emergency services or receiving timely information about developing hazards. Coastal erosion and sea level rise further threaten housing affordability and stability for these communities, as rising property values and increased flood risks compound socioeconomic pressures (DLCD, 2014).

Siltcoos River

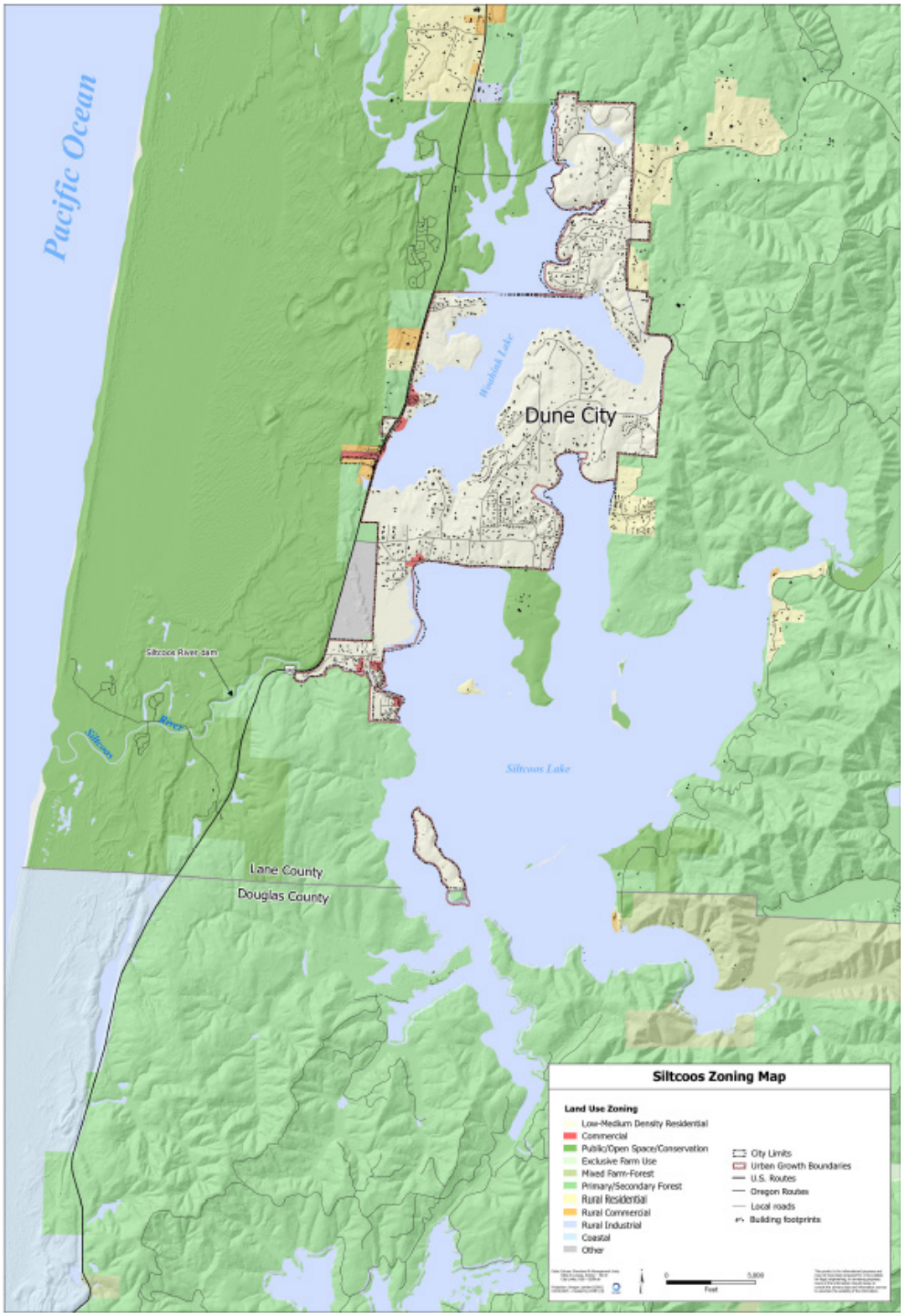


Figure 11. Siltcoos River and Lake estuary zoning map.

The Siltcoos River estuary, located south of Florence, is a unique and ecologically significant ecosystem that serves as a vital link between freshwater and marine environments. This small but important estuary provides a dynamic habitat that supports a diverse array of fish, wildlife, and plant species.

The Siltcoos River estuary is characterized by its shallow waters, tidal flats, and fringing salt marshes, which provide essential habitat for numerous species. The estuary covers approximately 65 acres and is connected to Siltcoos Lake, the largest coastal lake in Oregon (DLCD, 1987). This connection creates a complex system that supports both freshwater and saltwater species, making it an important area for biodiversity and ecological processes.

The estuary plays a crucial role as a migratory corridor for various fish species, including coho salmon, cutthroat trout, steelhead, starry flounder, and sturgeon. These species use the estuary as a transitional zone between their freshwater spawning grounds and the open ocean. The seasonal fish distribution in the Siltcoos River estuary is most diverse in the summer when saltwater is completely flushed with fresh water twice daily (USFS, n.d.).

Siltcoos Lake, which feeds into the estuary, is home to a variety of warm-water fish species, including bass, perch, catfish, crappies, and bluegill. The lake and estuary system also support populations of cutthroat trout and provide habitat for migratory salmon and steelhead (Dunes City, 2016). This diversity of fish species contributes to the area's popularity for recreational fishing and its importance for commercial fisheries.

The Oregon Dunes National Recreation Area, which includes the Siltcoos River estuary, is a significant attraction for visitors and provides opportunities for recreation and wildlife viewing. Historically, the Siltcoos area was inhabited by Native American tribes, including the Siuslaw and Lower Umpqua peoples. These tribes relied on the estuary and surrounding ecosystems for fishing, shellfish gathering, and other resources. The landscape played a crucial role in their cultural practices, traditions, and lifeways (CTCLUSI, n.d.).

In the early 20th century, despite concerns raised by fisheries experts, non-native warmwater fish species were introduced to Siltcoos Lake, creating a popular bass fishery by the 1920s (Dunes City, 2016). This introduction has had lasting effects on the ecosystem and native fish populations, highlighting the complex interplay between human activities and natural systems in the area.

Today, the Siltcoos River estuary faces various environmental challenges, including the impacts of introduced species, habitat alteration, and the effects of climate change. Conservation efforts, such as those undertaken in nearby estuaries like Bandon Marsh National Wildlife Refuge, focus on restoring tidal flows and natural cycles to sustain fish, wildlife, and human communities (USFWS, n.d.).

The Siltcoos River estuary, with its rich biodiversity and cultural significance, remains an important focus for conservation and sustainable management efforts. As part of Oregon's

coastal ecosystem, it plays a vital role in supporting both ecological processes and human activities, embodying the complex relationships between land, water, and communities that characterize the Oregon Coast.

Hazard Risk

The Siltcoos River connects Siltcoos Lake to the Pacific Ocean and is characterized by tidal wetlands, freshwater marshes, and dune ecosystems. While it provides critical habitat for a variety of fish, birds, and wildlife, this area is subject to several natural hazard vulnerabilities that threaten its ecological functions and the surrounding community.

The estuary is particularly susceptible to **sea level rise** and the associated increases in flooding. Low-lying areas face the risk of chronic inundation, especially when compounded by king tides and storm surges. Such events can lead to the loss of tidal wetlands, alteration of hydrological patterns, and a reduction in habitat for species dependent on these environments (ODFW, 2016). This is exacerbated by the effects of **erosion and sedimentation**, which stem from both natural and human-induced causes. The natural stabilization of dunes with non-native European beachgrass has altered sediment transport processes, leading to unintended consequences for estuarine morphology. At the same time, sedimentation from upland activities, including roads and historical logging, can degrade water quality and smother vital aquatic habitats like fish spawning areas (USGS, 2018).

Additionally, the Siltcoos River estuary lies within a region at risk of **tsunamis**. A major tsunami event could have devastating impacts, causing loss of life, destruction of infrastructure, and substantial ecological damage. Limited transportation connectivity in the region could also impede emergency response efforts, leaving communities isolated.

The estuary's water quality is further threatened by **non-point source pollution** from sources such as agricultural runoff and failing septic systems (ODFW, 2016). This pollution can lead to nutrient loading and harmful algal blooms in Siltcoos Lake, with potential downstream impacts on the estuary's water quality and aquatic life. Saltwater intrusion driven by rising sea levels also threatens the estuary's tidal wetlands by altering plant communities and reducing habitat suitability for freshwater-dependent species (USGS, 2018). Finally, while less immediate than other threats, the risk of **wildfires** in the surrounding watershed could lead to increased sedimentation within the estuary, affecting water quality and habitat.

The Siltcoos River estuary supports critical habitats for a variety of species, including salmonids such as coho salmon that rely on its tidal wetlands for rearing habitat. The area also provides nesting grounds for birds like the Western Snowy Plover, which is listed as threatened under the Endangered Species Act. However, habitat degradation from erosion, pollution, and invasive species poses significant challenges to maintaining these ecological functions.

The surrounding infrastructure, including roads and recreational facilities near Siltcoos Lake and along the river's edge, faces risks from flooding, erosion, and tsunamis. Limited transportation connectivity could hinder emergency response efforts during hazard events.

These hazard vulnerabilities highlight the need for a comprehensive and integrated approach to managing the Siltcoos River estuary. The focus should be on enhancing the estuary's resilience to the impacts of climate change, reducing risks from erosion and flooding, and improving water quality to protect critical habitats for the long-term benefit of both natural ecosystems and nearby communities.

Key Themes for Vulnerability

Ecological Fragility: The Siltcoos River estuary's unique ecosystem, including its lake, wetlands, and coastal habitats, is highly sensitive to environmental changes. Water quality issues, invasive species, and habitat alterations threaten the delicate balance of this system.

Climate Change Susceptibility: As a coastal system, Siltcoos River is vulnerable to climate change impacts such as sea level rise, increased storm intensity, and changing precipitation patterns. These factors could significantly alter the estuary's hydrology and ecology.

Water Resource Challenges: The area faces complex water management issues, including the need to balance drinking water supply, recreational use, and ecological needs. The reliance on surface water and septic systems creates additional vulnerabilities.

Infrastructure Vulnerabilities: Key infrastructure, such as the Siltcoos Dam, faces risks from natural hazards and aging. The dam's role in regulating water levels is crucial but also introduces potential failure risks.

Limited Adaptive Capacity: The local community, particularly Dunes City, has limited resources and infrastructure to address environmental and hazard-related challenges. This limitation hampers effective long-term planning and risk mitigation.

Multi-hazard Exposure: The Siltcoos area is exposed to various natural hazards, including earthquakes, tsunamis, and coastal erosion. The combination of these risks with environmental stressors amplifies the overall vulnerability of the region.

Socio-ecological Interdependence: The close relationship between the estuary's ecological health and the community's well-being underscores the need for integrated management approaches that consider both environmental and social factors.

Key Challenges

Climate Change Impacts: Sea level rise and altered precipitation patterns threaten the Siltcoos River's ecological balance. These changes may exacerbate water quality issues, particularly affecting dissolved oxygen levels and temperature in the lake and estuary system.

Water Quality Degradation: Siltcoos Lake has experienced significant water quality problems, including dense algal blooms and excessive growth of non-native aquatic plants. In 2007, a toxic blue-green algal bloom forced residents to find alternative water sources for 52 days. The lake has been placed on Oregon's 303(d) list of impaired water bodies due to violations of the "aquatic weeds and algae" water quality criterion.

Habitat Loss and Fragmentation: Historical changes, including logging and fire, have significantly altered the forest vegetation around Siltcoos Lake.

Opportunities for Resilience

Implement Water Quality Improvement Measures: Dunes City has taken steps to address water quality concerns by issuing a septic tank maintenance ordinance and limiting phosphorus use. Continuing and expanding these efforts could help mitigate water quality issues.

Maintain Optimal Lake Levels: Continue to manage lake levels through careful dam operation to support diverse aquatic habitats, recreational opportunities, and water quality. Maintaining appropriate lake levels can help preserve shoreline vegetation, protect fish spawning areas, and mitigate erosion risks. Regular monitoring and adaptive management of lake levels could enhance ecosystem resilience and support the various ecological and human uses of the Siltcoos system.

Engage Stakeholders: Collaborative efforts involving local residents, water districts, and government agencies have shown success in addressing water quality issues. Continuing to foster these partnerships will be crucial for implementing effective resilience strategies.

Specific Vulnerability Concerns

Siltcoos Dam: The Siltcoos Dam, located approximately half a mile downstream from Siltcoos Lake is a gravity dam built in 1964 to regulate the lake's outflow into the Siltcoos River (Dunes City, 2016). The dam is 130 feet long and 12 feet high, with a spillway capable of discharging up to 10,000 cubic feet per second. Its reservoir has a storage capacity of 15,070 acre-feet and dams a reservoir with a surface area of 3,585 acres (Dams of the World, 2024).

The primary purpose of the dam is not explicitly tied to hydropower or irrigation but rather to manage water levels in Siltcoos Lake (ODFW, n.d.; Dunes City, 2016), and for the water rights associated with past and potential future commercial operations. These water rights are the largest in the Pacific Northwest, permitting up to 15 million gallons of water use per day. The regulations associated with the dam affect both ecological processes and human activities in the surrounding area. Historically, artificial flushing of sandbars at the river's mouth has been used to facilitate fish passage for species such as coho salmon, steelhead trout, and cutthroat trout. These practices have influenced the timing of salmon runs and contributed to extended fishing seasons in the past (USFS, n.d.).

The dam's presence has implications for fish passage. Like many dams in the Pacific Northwest, it poses challenges for migrating fish species by obstructing natural movement between freshwater spawning grounds and ocean habitats. ODFW has emphasized the importance of maintaining connectivity between aquatic habitats to support fisheries management. Efforts to mitigate these impacts include monitoring bar formation at the river's mouth and ensuring compliance with water flow regulations (ODFW, 2013; USFS, n.d.).

Siltcoos Lake has faced significant water quality issues over time, including algal blooms and invasive plants that affect both aquatic ecosystems and human communities relying on the lake for drinking water. These challenges are exacerbated by nutrient loading from residential development and agricultural practices (Dunes City, 2016; ODFW, n.d.). The dam plays a role in managing lake levels but does not directly address these broader environmental concerns.

The Siltcoos Dam serves as a critical infrastructure for regulating water levels while impacting fish passage and ecological dynamics downstream. However, it faces several potential natural hazard threats, which could have significant impacts on its structural integrity and the surrounding environment. The dam is located in a seismically active region along the CSZ, where large earthquakes could cause structural damage to the dam, including cracking or deformation of its gravity structure, potentially leading to failure or reduced functionality.

Intense rainfall events, exacerbated by climate change, pose a risk of overtopping or erosion at the dam site (Lane County NHMP, 2023; CTCLUSI Hazard Mitigation Plan, 2022). Extraordinary rainfall or rapid snowmelt in the watershed could overwhelm the dam’s spillway capacity, increasing pressure on the structure. If overtopping occurs, it could erode the dam's foundation

and lead to failure. While there are no significant downstream settlements at risk, flooding could still disrupt ecosystems and recreational use of the area.

The dam supports recreational activities like fishing and boating on Siltcoos Lake. Damage or failure could reduce these opportunities and affect local tourism and impact residents along the lake. The dam plays a role in regulating water levels for ecological balance and recreational use. Its failure would disrupt this balance and complicate future management efforts.

While these risks are concerning, it is important to note that the Siltcoos Dam is classified as having "low hazard potential" due to its location with minimal downstream human development. However, ongoing monitoring and hazard mitigation planning remain critical to address these potential threats effectively.

Dunes City: A small coastal community on Siltcoos Lake, Dunes City faces a unique set of natural hazard threats, with water-related issues at the forefront of its vulnerabilities. The city's residents primarily rely on surface waters from Woahink and Siltcoos Lakes for their potable water, making them potentially susceptible to water quality and quantity problems (Dunes City, 2014). This dependence has led to significant challenges in recent years, exemplified by a dense bloom of potentially toxigenic blue-green algae (*Anabaena planktonica*) in 2007, which forced residents to seek alternative water sources for nearly two months (PSU, 2010).

The city's water quality issues are compounded by its reliance on subsurface disposal systems for sewage treatment. These septic systems can lead to the migration of nitrates and phosphorus into groundwater and surface water sources, contributing to nutrient enrichment and subsequent algal blooms. In response, Dunes City has implemented a septic tank maintenance ordinance to mitigate these risks (PSU, 2010). However, the challenge persists as nutrients continue to be introduced into surface waters through erosion and runoff, further degrading water quality (Dunes City, 2014).

Dunes City's vulnerability is exacerbated by its limited resources and lack of comprehensive infrastructure. The city lacks a sufficient tax base to support dedicated staff to effectively monitor and address water quality concerns, instead relying heavily on volunteers (NOAA, 2014). This limitation is particularly concerning given the absence of a comprehensive system of ordinances to mitigate the impacts of erosion, sediment, surface water, and storm runoff.

The city's coastal location also exposes it to additional natural hazards. Dunes City falls within an area potentially affected by tsunamis (DOGAMI, 2013). This risk, combined with the potential for coastal erosion and the broader impacts of climate change, underscores the complex array of environmental challenges facing the community.

Most residents rely on wells and may be particularly vulnerable to water quality and quantity issues, including the threat of saltwater intrusion into aquifers, especially during multi-year droughts with no fallback water supply. This threat may be compounded by sea level rise and climate change patterns in the future.

Other Areas

Sutton Creek

Sutton Creek, located just north of Florence, is a small coastal stream that currently takes a sharp turn south before meeting the Pacific Ocean. Historically, the creek flowed more directly to the ocean, but natural coastal processes and human interventions have altered its course over time. Some community members have expressed interest in restoring the creek's historic channel, which raises both opportunities and challenges. In addition, both OPRD and USFS have shown interest in restoring the rare fen and bog habitats found along Sutton Creek, including areas at the Darlingtonia State Natural Site and nearby USFS-managed lands west of US Highway 101. This habitat restoration could provide additional ecological benefits by supporting rare plant communities while creating more space for water storage without posing risks to infrastructure.

Restoring Sutton Creek's historic channel could further improve habitat connectivity for native fish and wildlife species. A more direct path to the ocean might enhance fish passage and support species such as cutthroat trout that rely on coastal streams for spawning and rearing (ODFW, 2021). Additionally, this restoration could improve drainage during high flow events, potentially reducing localized flooding risks in the surrounding area (USFS, 1998).

However, restoring the creek's historic channel would also face significant challenges. The current course of Sutton Creek may play a role in maintaining sediment transport and coastal stability. Altering its flow could disrupt these processes, potentially leading to unintended consequences such as increased beach erosion or changes to nearby dune ecosystems (DOGAMI, 2022). Furthermore, rising sea levels and more intense storms due to climate change could complicate restoration efforts by increasing the risk of tidal inundation and altering hydrological patterns (OCCRI, 2021).

The project would also require extensive regulatory review and permitting to ensure compliance with environmental laws. Coastal restoration projects often involve complex assessments of potential impacts on wetlands, water quality, and endangered species habitats. Additionally, funding such an effort could be a significant barrier given the scale of engineering and long-term maintenance required.

Sutton Creek's current alignment is part of a dynamic dune environment shaped by wind, waves, and sediment deposition. Any restoration effort would need to carefully balance ecological goals with the potential risks to coastal stability and recreational value. The area is part of a popular trail system that attracts hikers and nature enthusiasts, meaning any changes could impact public access or enjoyment of the site (City of Florence, 2025).

While restoring Sutton Creek's historic channel may offer ecological and hydrological benefits, it would require careful study to evaluate its feasibility. Stakeholders and other interested

parties must weigh these benefits against potential risks to coastal dynamics, regulatory complexities, and climate change impacts.

Small Coastal Creeks

The small estuarine creeks of coastal Lane County, including Tenmile Creek, Rock Creek, Big Creek, China Creek, Cape Creek, and Berry Creek, are ecologically significant systems that support a variety of fish, wildlife, and habitats. These creeks face natural hazard threats that could impact their ecological integrity and the resources they provide.

Tenmile Creek

Tenmile Creek is a critical habitat for federally threatened species such as coho salmon, Chinook salmon, and steelhead trout. The nearby Tenmile Creek Sanctuary, a 314-acre reserve managed by the Bird Alliance of Oregon, protects one of the largest intact stands of coastal temperate rainforest in the lower 48 states. This sanctuary also supports species like the Marbled Murrelet and Northern Spotted Owl, both federally listed as threatened (Bird Alliance of Oregon, 2024). The creek is part of a larger ecological corridor connecting the Cummins Creek Wilderness to the north and the Rock Creek Wilderness to the south (Bird Alliance of Oregon, 2024). However, Tenmile Creek is vulnerable to sedimentation from erosion in its steep valleys and potential water quality degradation from upstream land uses.

Rock Creek

Rock Creek flows through a wooded canyon near Cape Perpetua before entering the Pacific Ocean. It is adjacent to the Rock Creek Wilderness Area, which provides critical habitat for wildlife and maintains a relatively pristine environment. The creek supports migratory fish species such as salmon and steelhead trout. However, its proximity to Highway 101 and seasonal recreational use at Rock Creek Campground pose risks of pollution and habitat disturbance (BeachConnection.net, 2022). Additionally, erosion and runoff from nearby development could impact water quality.

Big Creek

Big Creek passes through steep terrain with dense forest cover that provides shade and habitat for aquatic species such as salmonids. Conservation efforts have focused on protecting this creek's ecological value; for example, The Nature Conservancy recently sold land near its mouth to OPRD for preservation (Scharf, n.d.). Despite these efforts, Big Creek remains vulnerable to sedimentation from logging activities in its upper watershed and potential impacts from recreational use.

China Creek

China Creek is a smaller estuarine system with limited documented information but shares similar characteristics with other coastal creeks in Lane County. The creek flows through land designated as a natural area within Carl G. Washburne State Park, managed by OPRD. Its steep

terrain and proximity to forested areas suggest it provides habitat for salmonids and other wildlife, and it is designated as essential fish habitat. While fish are still able to pass through, the culvert under Highway 101 is considered the only major fish passage barrier on the creek. Like other creeks in this region, China Creek may face risks from erosion, sedimentation, and changes in water flow due to upstream land use or climate change.

Cape Creek

Cape Creek flows through a rugged canyon near Heceta Head before reaching the Pacific Ocean. It supports migratory fish species such as coho salmon and steelhead trout and benefits from its location within largely forested areas of the Siuslaw National Forest. However, Cape Creek's proximity to Highway 101 increases its vulnerability to pollution from road runoff. Additionally, erosion from steep slopes could contribute to sedimentation in the creek.

Berry Creek

Berry Creek is another small estuarine system with limited available data but likely provides critical habitat for fish and wildlife similar to other creeks in this region. Its ecological health may be influenced by forestry practices in its watershed as well as potential impacts from climate change.

Vulnerabilities Across All Creeks

The primary vulnerabilities facing these creeks include sedimentation from erosion in steep terrain; water quality degradation due to runoff from roads or upstream land uses; habitat fragmentation; and potential impacts from climate change such as altered flow regimes or increased storm intensity. These factors threaten critical habitats for salmonids, migratory birds like Marbled Murrelets, and other wildlife that depend on these interconnected ecosystems.

Efforts to conserve these creeks focus on protecting riparian zones, limiting sedimentation through sustainable land management practices, and preserving undeveloped forested areas that provide essential ecological functions. Continued monitoring and targeted conservation actions will be essential to mitigate these vulnerabilities and maintain the ecological integrity of these important coastal systems.

Image: US Highway 101 bridge over Tenmile Creek. Courtesy of Oregon ShoreZone.

IV. Resilience Recommendations & Actions

Image: Siuslaw River mouth. Courtesy of Oregon ShoreZone.

This chapter presents a set of recommendations and nature-based resilience actions identified to help strengthen the resilience of Lane 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 Lane 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 Lane 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 Lane 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, scientific data, and community priorities. They are organized into four key categories: Data & Information Needs, Policy & Regulations, Habitat & Land Conservation, and Public Engagement & Funding, providing a roadmap for strategic action across various sectors.

Data & Information Needs

- **Dredging Impacts Research:** Support targeted research to evaluate the impacts of dredging activities on estuarine ecosystems specific to the needs of Dunes City and Florence. Research should consider the purpose of dredging, impacts on sediment disturbance, habitat alteration, water quality effects, and implications for species and habitats.
- **Water Quality Monitoring Strategy:** Improve water quality monitoring throughout the watershed by establishing a robust and sustainable long-term program and strategy for testing and analysis. Focus should be placed on algal blooms (including identifying toxigenic species), heavy metals (consider older plumbing impacts), agricultural contaminants, and *E. coli*. Increase community awareness through signage and outreach programs. Consider both drinking water viability and ecological health of the watershed when developing the program.
- **Aquifer and Hydrology Assessment:** Conduct a comprehensive assessment to improve understanding of the Siuslaw River system's hydrology and aquifer dynamics. Emphasize

a systems-thinking approach, recognizing interconnections between surface water, groundwater, and the estuary. Develop a Siuslaw hydrology map to aid in management decisions.

- **Soil Stability and Sediment Budget Analysis:** Assess and improve understanding of soil stability in upland areas, sediment budgets, and sediment dynamics. Facilitate studies aimed at improving the understanding of soil stability in upland areas and the dynamics of sediment transport within the estuaries.
- **Address Impaired Waters:** Support and coordinate with state agencies in developing and implementing plans to bring impaired waters in Lane County into compliance with established TMDLs, which will help bring water bodies impacted by excessive pollutants back into compliance.
- **Managed Retreat Planning:** Undertake a comprehensive assessment to identify the needs and opportunities associated with managed realignment strategies in vulnerable coastal areas, helping communities adapt to climate and ocean change.
- **Code Needs/Gaps Analysis:** Conduct a comprehensive needs and gaps analysis to assess the state of county codes and zoning regulations, helping ensure all plans are up-to-date.

Policy & Regulation

- **Comprehensive Plan and Code Update:** Conduct a comprehensive needs and gaps analysis of the County Rural Comprehensive Plan and code to identify areas that have not been updated or are inconsistent with climate resilience principles. Develop recommendations for updates and establish a framework for implementation, including consideration of state wildfire code.
- **Update CRMP:** Update the Lane County Coastal Resource Management Plan to include the most current data, management unit descriptions, Landward Migration Zones, tsunami inundation zones, sea level rise projections, and information on habitats. Review existing policies, implement updated code, and conduct a gaps analysis.
- **Hazard Avoidance and Corrective Shoreline Planning:** Develop a county-wide action plan and strategies for addressing slower, longer-term impacts, particularly drought, on the water table, aggregate forest health, prolonged heat stress, species, drinking water, and estuary health. Prioritize understanding of impacts on long-term and catastrophic short term water quality impacts.
- **Address Drinking Water Vulnerabilities:** Identify steps to address drinking water crises in unincorporated areas (e.g., Mapleton) by exploring options such as system upgrades, backups, and addressing saltwater intrusion. This includes identifying specific steps to address crises, upgrading infrastructure, establishing backup water sources, and mitigating saltwater intrusion. Consider policy and non-regulatory incentives to encourage creative approaches, addressing infrastructure needs and Cascadia impacts.

- **Multi-Modal Resilience Planning:** Promote a multi-modal approach to resilience and vulnerability by improving bike and pedestrian infrastructure for emergency evacuations, particularly in Florence. Consider the limitations for distant tsunami events, but emphasize pedestrian infrastructure for the region. Accessibility needs should be addressed in evacuation planning, ensuring redundancies and reducing vulnerability to disasters.
- **Address Railroad Bridge Maintenance:** Identify appropriate actions to ensure the integrity of railroad bridges as crossings, considering erosion and maintenance needs. Determine best routes to encourage compliance if environmental violations occur and engage in communication with DEQ to address concerns.
- **Climate-Resilient Development Standards Guidance:** 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.
- **Promote Climate-Adapted Economy:** Identify and support the development of climate-resilient economic sectors in coastal Lane County. Explore policies and strategies to incorporate greater emphasis on climate-adapted industries, considering employment concentration in dominant sectors and identifying opportunities for diversification. Reference the FEMA Community Resilience Challenge Index[25].

Habitat & Land Conservation

- **Prioritize Watershed and Off-Channel Habitat Restoration:** Emphasize the conservation and restoration of habitats that support off-channel fish recovery and other species reliant on estuarine environments. Prioritize the acquisition and protection of these critical areas, focusing on projects that reconnect rivers and estuaries to their floodplains. This comprehensive approach will enhance watershed restoration for salmon and other species, promote biodiversity, and provide a myriad of benefits for freshwater ecosystems and ecosystem services. By strategically preserving and restoring these habitats, we can significantly improve the resilience and ecological function of the entire estuarine system.
- **Urban Natural Area Preservation:** Create and leverage resources to conserve and restore habitat that supports fish recovery by strategically preserving urban natural areas and forests. This should include acquiring open spaces, utilizing conservation easements, and employing innovative funding mechanisms such as bond measures. This will safeguard vital habitats, provide a refuge for wildlife, improve climate resilience, and maximize the effectiveness of land trusts.
- **Support Beaver Restoration:** Support efforts for beaver restoration by focusing on strategic habitat enhancements, fish and wildlife benefits, and wildfire mitigation.

[25] https://www.fema.gov/sites/default/files/documents/fema_community-resilience-challenges-index-annual-update-2023.pdf

- **Aquaculture Viability Assessment:** Assess habitat viability for, and encourage development of, local aquaculture with a focus on native oyster restoration efforts by new groups.

Public Engagement & Funding

- **Promote Interpretive Center in Florence:** Promote the establishment of an interpretive center, services, and activities in Florence to increase local understanding, awareness, stewardship, and interaction with the estuary. This facility could potentially utilize the Lotus building.
- **Support Grant Writing Assistance:** Support grant writing assistance for local organizations to aid with hazard assessments and coping with impacts, and provide communities with necessary funding for local projects.
- **Support Local Hazard Planning Coordination:** Support coordination for local hazard planning through hosting regular events for rural evacuations, coordination, communications, ham radio, etc. Separate funding streams should be included to address the needs. The state should also be pressured to encourage acknowledgement of funding mechanisms for it.
- **Improve Outreach Efforts:** Improve local outreach and awareness efforts via social media campaigns, photo contests, etc., and ensure that such efforts are expanded statewide, involving more people with environmental protection.
- **Climate Change Funding Streams:** Creatively identify and pursue diverse funding streams to support climate change initiatives with local organizations.
- **Education Program Support:** Provide broader support for education programs and partnerships with organizations such as HMSC, OMSI, OCA, STEM Hub, OSU Extension, and Oregon Sea Grant to engage broad audiences including K-12 and emphasize importance of estuarine health, habitats, environment, climate, and natural hazards.

Resilience Actions

In the summary tables below, details are outlined for each action, including the lead organization and potential partners[26], 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

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

Table 7. Lane County 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	Sutton Cr	**Sutton Creek** - Reestablish the historical stream channel outlet to restore degraded fish habitat, control invasive plant species, enhance habitat for the Western Snowy Plover, and improve conditions for the Oregon Silver Spot Butterfly and native beetle species. This project will also address erosion risks near nearby housing developments, benefiting both ecosystems and local residents.	ODRC	USFS, SWC, TNC, Lane County	Planning phase	n/a	medium	high	$$	medium
2	Siuslaw / Florence	**Heceta Beach Rd** - Explore nature-based solutions to address seasonal flooding risks along Heceta Beach Road, especially in vulnerable neighborhoods, including the mobile home and RV park. The project will aim to reduce flood risks, enhance drainage systems, and protect key infrastructure through nature-based flood management strategies.		Lane County	Idea phase	n/a	high	medium	$$	high
3	Siuslaw / Florence	**Heceta Drinking Water** - Consider acquisition options of four parcels (126 acres) for conservation easement to protect a critical drinking water source and seasonal lake. This effort will maintain the integrity of the water supply, prevent contamination, and ensure long-term environmental and community resilience in the Heceta area.	MRT	PLO, Heceta WD	Planning phase	n/a	high	medium	$	medium
4	Siuslaw / Florence	**Clear Lake** - Remove debris and explore restoration options in the streams connecting Clear Lake to Ackerley and Munsel Lakes, aiming to improve water quality, fish habitat, and stream connectivity. This project will enhance natural hydrology and support ecological restoration in the watershed.	SWC	MRT, volunteers	Idea phase	2025	high	low	$	low
5	Siuslaw / Florence	**Three Mile Prairie** - Assess options for restoration, enhancement, and/or mitigation banking of forested/wetland areas south of inland lakes, including dunes behind Fred Meyer. The goal is to restore wetland areas, enhance biodiversity, and create opportunities for flood control and habitat conservation on a regional scale.	ODRC	City of Florence, BLM, SWC, USFS, Lane County	Planning phase	n/a	medium	medium	$$	low
6	Siuslaw / Florence	**Rhododendron Dr** - Address shoreline erosion issues near the USCG station and below the hospital, using erosion control measures to protect infrastructure and reduce sedimentation. The project will also enhance habitat and contribute to water quality improvement and transportation safety in the surrounding area.		USCG, City of Florence	Planning phase	10 yrs	medium	high	$$	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)
7	Siuslaw / Florence	**Bay Street** - Explore nature-based solutions for addressing flood vulnerabilities along Bay Street, particularly in Old Town areas near the riverfront. The project will reduce flood risks while enhancing the urban resilience of the downtown area through improved stormwater management and flood mitigation strategies.	City of Florence	Port of Siuslaw, PLOs	Idea phase	n/a	high	low	$$	low
8	Siuslaw / Florence	**Saxon Property** - Acquire waterfront property at the mouth of Munsel Creek for tidal wetland restoration and multi-use green space. The project will restore vital estuarine habitat, improve water quality, and create public access to natural areas, enhancing both ecological and community resilience.	City of Florence	PLO	Planning phase		high	medium	$$	medium
9	Siuslaw / Florence	**Munsel Creek** - Explore potential restoration opportunities for salmon and fish passage improvements in conjunction with the expansion of multi-use green space trails. This initiative aims to restore connectivity in the watershed, improving water quality and supporting salmon populations while enhancing public recreational access.	City of Florence	Port of Siuslaw, CTCLUSI, Consultant	Planning phase	2025	high	medium	$$	high
10	North Fork Siuslaw	**North Fork Bend** - Restore 245 acres of tidal marsh to enhance salmon habitat and improve flood resilience. This project will support biodiversity by expanding wetland areas, improving water filtration, and creating critical habitat for migratory species, including salmon and other wildlife.	MRT	TNC, CTCLUSI, SWC, PLO, WWR, WSC	Design Phase		medium	high	$$$	high
11	North Fork Siuslaw	**Site 59 Property** - Restore habitat on a 59-acre property, including breaching a levee, installing large wood debris, and creating trails/boardwalks for multi-purpose greenspace. These actions will enhance wetland and riparian habitats, improve water quality, and provide community access to natural spaces.	MRT	SWC	Design phase		high	high	$$$	high
12	Siuslaw	**Cox Island** - Restore 187 acres of salt marsh by removing invasive saltmeadow cordgrass, which threatens native wetland vegetation. This project will improve ecosystem health by enhancing salt marsh habitats, supporting migratory bird populations, and improving flood resilience.	TNC	MRT			high	medium	$$	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)
13	Siuslaw	**Wilbur Island** - Acquire 283 acres to add to the tidal restoration area and facilitate the transfer of the land to the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians (CTCLUSI). This acquisition will contribute to regional tidal wetland restoration efforts and enhance the conservation of estuarine ecosystems.	MRT	TNC, PLO, CTCLUSI	Planning phase		high	high	$$	medium
14	Siuslaw	**Wren Marsh** - Remove a levee to flood approximately 15 acres, creating a wetland habitat that enhances local biodiversity. This project will restore ecological function, improve floodplain resilience, and create opportunities for waterfowl habitat and water quality improvement.	MRT	SWC, WSC, PLO	Design phase		high	high	$$	high
15	Siuslaw	**Cushman Crossing** - Explore nature-based solutions to compliment other infrastructure upgrades to reduce flooding risks at Cushman Crossing, including potential land acquisitions and restoration activities. These solutions will enhance flood resilience, improve habitat connectivity, and protect vulnerable communities in the area.		Coos RR, ODOT, SWC, PLOs	Idea phase	n/a	low	medium	$$$	medium
16	Siuslaw	**haich ikt'at'uu (Waite Ranch)** - Restore and reconnect 170 acres of tidal wetland and 6 miles of salmon habitat. Key actions include excavating primary and secondary tidal channels, filling agricultural ditches, lowering and breaching a dike, and replacing the tide gate to restore tidal estuarine function and enhance biodiversity for fish species and other wildlife.	CTCLUSI	SWC, MRT, WSC	Construction phase	1 yr to completion, add'l yrs for reveg.	high	high	$$$	high
17	Siuslaw	**Duncan Island** - Acquire 7 acres to add to the Duncan Island conservation easement, expanding the protected area for critical tidal wetland and riparian habitat. This project will further secure the conservation of the island's ecological resources, supporting local biodiversity and water quality.	MRT	PLO	Planning phase		high	medium	$$	medium
18	Siuslaw / Mapleton	**Berkshire Creek** - Address road erosion and stream sedimentation impacting the drinking water source for Mapleton. Restoration efforts will stabilize streambanks, reduce sedimentation, and improve the quality of water flowing into the creek, benefiting both human water use and aquatic ecosystems.		Mapleton WD, USFS	Planning phase	n/a	medium	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)
19	Siuslaw / Mapleton	**Lamb Creek** - Mitigate erosion scars and sediment runoff into Lamb Creek, impacting salmon spawning habitat in Lake Creek. This restoration will reduce sedimentation, stabilize streambanks, and improve water quality, benefiting salmonid populations and local ecosystems.		USFS	Idea phase	n/a	medium	medium	$$	medium
20	Lane County	**Estuary Management Planning** - Update the Lane County Coastal Resource Management Plan, Lane County Comprehensive Plan, Florence Comprehensive Plan, and associated implementing ordinances and maps for estuary, coastal shoreland, and beach and dune areas.	Lane County	City of Florence, DLCD	Planning phase	1-3 yrs	medium	high	$	high

Table 8. Lane County Resilience Action Supplementary Details

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
1	USFS	$500k estimated $50-75k for Cultural Resources Review	NOAA Community Resilience Grant?	- gorse removal - apply for grants - NEPA (USFS? NOAA?) - Cultural Resources Review - USACE permits
2	Lane County			- assess extent of flooding, impacts - assess potential NBS options
3	PLO	$25k for conservation contribution	OWEB DWPP	- sell conservation easement - fund with grant - acquire and donate to trust
4	Lane County			- organize debris cleanup effort - apply for funding
5	BLM, USFS			- secure funding for work plan

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
6	City, USCG		Congressional Direct Spending Authority - $250k for planning	- assess extent of erosion, impacts - assess potential NBS options - 2-3 yrs get consensus on solution, then take to DC - likely 10 yr process
7	City, Port, PLOs			- assess potential NBS options
8	PLO		City submitting grant for acquisition	- obtain acquisition dollars
9	City	$150k - trail, sidewalk, parking lot $450k - whole project	City parks planning budget, OR Recreational Trail Program ($150k)	2024: bid for trail, begin trail construction - acquire part of 8th St right-of-way - connect to Spruce St, install roundabout - pursue fish passage culvert improvement w/ODFW - release coho, steelhead smolt into Munsel, Ackerley Lakes - acquire wetlands for habitat enhancements (MRT) - extend walking paths to Port facilities, WWTP - install ped bridge at Exploding Whale Park
10	TNC -> MRT, PLOs, Bruce Weatherly living trust	Have $750k now for 100% design. Permitting also covered. May need to secure funds for potential levee on Jones property.	America the Beautiful, NOAA Transformational Habitat, private donors, NFWF	- transfer 245 ac parcel to MRT - build levee on bottom land - acquire additional nearby properties - habitat enhancements 2030: project completion
11				- assess how much artificial levee to remove - assess options to install trail, boardwalk along river, install LWD
12	TNC			- remove invasives
13	PLO	Property appraised at $400k	Have private donors - Philanthropy NW	2024: close on purchase - transfer property to CTCLUSI
14	PLO		2024 NFWF application	2024: apply for funding - remove levee - remove homesite and dock

Action #	Ownership	Costs ($)	Funding Source(s)	Timeline & Milestones
15	Coos RR, PLOs			- interface with partners - assess flooding - assess potential options with NBS components
16	MRT, OWEB has conservation easement	- $10 million for geotechnical engineering, design, permitting, two construction phases, and revegetation - Probably $1-2m short to complete project (earthwork)	- OWEB funded $750k for purchase of dairy farm - $5.5m request out (summer 24) thru NOAA Transformational Habitats Program to fully build levee and MTR. CTCLUSI was applicant. - EPA Change Grant, NFWF - Ecostrust, USACE, Greenpoint Consulting, NOAA, ODFW, ODOT, SSNERR, Port of Siuslaw, USFWS, USFS, NFWF	2024: install MTR, breach dike, complete new levee 2025: revegetation
17	PLO		Private donors	2024: negotiate with PLO - acquire property - habitat enhancements
18	USFS owns road, Mapleton WD owns property, intake, and other infrastructure	- $60k for preliminary engineering study - $20m to replace all lines and upgrade plant, tanks		- assess extent of erosion, impacts - assess potential NBS options
19	USFS			- assess extent of erosion, impacts - assess potential NBS options
20	n/a	~$50,000-250,000 depending on scope and level of detail and public engagement	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[27] 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

[27] See Appendix B. for a textual version of Table 9

Table 9. Resilience Action Components and Benefits

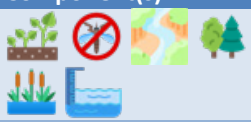
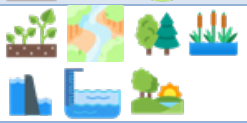
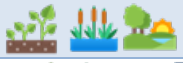
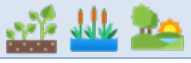
Action #	Estuary / Location	Action	Green Infrastructure Component(s)	Anticipated Resilience Benefits
1	Sutton Cr	**Sutton Creek**		
2	Siuslaw / Florence	**Heceta Beach Rd**		
3	Siuslaw / Florence	**Heceta Drinking Water**		
4	Siuslaw / Florence	**Clear Lake**		
5	Siuslaw / Florence	**Three Mile Prairie**		
6	Siuslaw / Florence	**Rhododendron Dr**		
7	Siuslaw / Florence	**Bay Street**		
8	Siuslaw / Florence	**Saxon Property**		
9	Siuslaw / Florence	**Munsel Creek**		
10	North Fork Siuslaw	**North Fork Bend**		
11	North Fork Siuslaw	**Site 59 Property**		
12	Siuslaw	**Cox Island**		
13	Siuslaw	**Wilbur Island**		
14	Siuslaw	**Wren Marsh**		
15	Siuslaw	**Cushman Crossing**		
16	Siuslaw	**haich ikt'at'uu (Waite Ranch)**		
17	Siuslaw	**Duncan Island**		
18	Siuslaw / Mapleton	**Berkshire Creek**		
19	Siuslaw / Mapleton	**Lamb Creek**		
20	Lane County	**Estuary Management Planning**		

Image: Siuslaw Marina, 2020. By John Bragg.

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Image: Port 1st St, 2011. By M Pezley.

Appendix A. Acronyms

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

ESA	Endangered Species Act	**PMEP**	Pacific Marine and Estuaries Fish Habitat Partnership
EWG	Environmental Working Group	**PROTECT**	Promoting Resilience Operations for Transformative Efficient and Cost-Saving Transportation
FEMA	Federal Emergency Management Agency	**PSU**	Portland State University
FHWA	Federal Highway Administration	**PW**	Public Works
FIP	Focused Investment Partnership	**RCPP**	Regional Conservation Partnership Program
FWA	Family Water Alliance	**RFP**	Request For Proposals
GHG	Greenhouse Gas	**RM**	River Mile
HAB	Harmful Algal Bloom	**RR**	Railroad
HMSC	Hatfield Marine Science Center	**SFINCS**	Super Fast Inundation of Coasts
HOA	Homeowners Association	**SLR**	Sea Level Rise
IIJA	Infrastructure Investment and Jobs Act	**SSNERR**	South Slough National Estuarine Research Reserve
IPCC	Intergovernmental Panel on Climate Change	**STEM**	Science, Technology, Engineering, and Math
IPRE	(University of Oregon) Institute for Policy Research and Engagement	**SWC**	Siuslaw Watershed Council
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	**USCG**	United States Coast Guard
NCRF	(NFWF) National Coastal Resilience Fund	**USDA**	United States Department of Agriculture
NEPA	National Environmental Policy Act	**USDOT**	United States Department of Transportation
NERRS	National Estuarine Research Reserve System	**USFS**	United States Forest Service
NF	National Forest	**USFWS**	United States Fish and Wildlife Service
NFWF	National Fish and Wildlife Foundation	**USGS**	United States Geological Survey
NGO	Non-Governmental Organization	**VA**	Vulnerability Assessment
NHMP	Natural Hazard Mitigation Plan	**VtF**	View the Future
NHRR	(DOGAMI) Natural Hazard Risk Report	**WD**	Water District
NMFS	(NOAA) National Marine Fisheries Service	**WFPO**	Watershed and Flood Prevention Operations
NOAA	National Ocean and Atmospheric Administration	**WID**	Water Improvement District
NOFO	Notice of Funding Opportunity	**WQ**	Water Quality
NPS	(United States) National Park Service	**WSC**	Wild Salmon Center
NRCS	(USDA) Natural Resources Conservation Service	**WWR**	Wolf Water Resources
NWF	National Wildlife Federation	**WWTP**	Wastewater Treatment Plant

Appendix B. Resilience Action Components and Benefits Table

For ease of use, Table 9 is duplicated here with text entries in place of icons.

Table 10. Resilience Action Components and Benefits (text version)

Action #	Estuary / Location	Action	Green Infrastructure Component(s)	Anticipated Resilience Benefits
1	Sutton Cr	**Sutton Creek**	- restoration - invasive species control - riparian/stream channel enhancements - native plants - 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 - erosion control or mitigation
2	Siuslaw / Florence	**Heceta Beach Rd**	- myriad nature-based solution options	- flooding/storm surge reduction - improved community resilience - improved safety and access
3	Siuslaw / Florence	**Heceta Drinking Water**	- natural area/conservation easement	- habitat protection or enhancements - improved community resilience
4	Siuslaw / Florence	**Clear Lake**	- restoration - riparian/stream channel enhancements	- improved waterway connectivity and hydrologic function - habitat protection or enhancements
5	Siuslaw / Florence	**Three Mile Prairie**	- natural area/conservation easement - myriad nature-based solution options	- habitat protection or enhancements - improved community resilience
6	Siuslaw / Florence	**Rhododendron Dr**	- myriad nature-based solution options	- improved community resilience - erosion control or mitigation - improved safety and access
7	Siuslaw / Florence	**Bay Street**	- myriad nature-based solution options	- flooding/storm surge reduction - improved community resilience
8	Siuslaw / Florence	**Saxon Property**	- restoration - natural area/conservation easement - multi-use green space - myriad nature-based solution options	- flooding/storm surge reduction - habitat protection or enhancements - improved community resilience - improved safety and access

9	Siuslaw / Florence	**Munsel Creek**	- restoration - natural area/conservation easement - multi-use green space - myriad nature-based solution options	- habitat protection or enhancements - improved safety and access
10	North Fork Siuslaw	**North Fork Bend**	- restoration - riparian/stream channel enhancements - native plants - wetlands/marsh - levee/dike - water drainage/retention features - natural area/conservation easement	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - habitat protection or enhancements
11	North Fork Siuslaw	**Site 59 Property**	- restoration - native plants - wetlands/marsh - levee/dike - water drainage/retention features - large wood debris/log cribs - natural area/conservation easement	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - habitat protection or enhancements - improved safety and access
12	Siuslaw	**Cox Island**	- restoration - invasive species control - native plants - wetlands/marsh - natural area/conservation easement	- habitat protection or enhancements
13	Siuslaw	**Wilbur Island**	- restoration - wetlands/marsh - natural area/conservation easement	- habitat protection or enhancements
14	Siuslaw	**Wren Marsh**	- restoration - wetlands/marsh - levee/dike - water drainage/retention features	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction - habitat protection or enhancements
15	Siuslaw	**Cushman Crossing**	- myriad nature-based solution options	- flooding/storm surge reduction - improved community resilience - improved safety and access
16	Siuslaw	**haich ikt'at'uu (Waite Ranch)**	- restoration - invasive species control - riparian/stream channel	- improved waterway connectivity and hydrologic function - flooding/storm surge reduction

			enhancements - native plants - wetlands/marsh - levee/dike - water drainage/retention features - natural area/conservation easement	- improved fish passage - habitat protection or enhancements
17	Siuslaw	**Duncan Island**	- restoration - wetlands/marsh - natural area/conservation easement	- habitat protection or enhancements
18	Siuslaw / Mapleton	**Berkshire Creek**	- myriad nature-based solution options	- improved waterway connectivity and hydrologic function - habitat protection or enhancements - erosion control or mitigation - improved community resilience - improved safety and access
19	Siuslaw / Mapleton	**Lamb Creek**	- myriad nature-based solution options	- improved waterway connectivity and hydrologic function - habitat protection or enhancements - erosion control or mitigation - improved safety and access
20	Lane 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 11. 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.)	10%	6%	10%	23%	35%	16%	3%
Climate (changes in precipitation, drought, or other weather patterns)	0%	3%	6%	6%	26%	45%	19%
Earthquake and/or Tsunami	0%	3%	13%	3%	16%	32%	35%
Flooding (storm surge, heavy rains, king tides, river flooding, etc.)	0%	0%	6%	0%	23%	42%	32%
Land (landslides, erosion, accretion, sedimentation, subsidence, or deposition of soils, sediments, beaches, or dunes)	3%	3%	3%	3%	23%	45%	23%
Sea Level (sea level rise, saltwater intrusion, landward migration)	3%	10%	10%	13%	19%	23%	29%
Species and/or Habitats (population changes, invasive species, pests, loss of habitat or biodiversity, etc.)	3%	10%	3%	16%	23%	32%	13%
Temperature (changes to temperature averages in air or water, heat waves, cold snaps, etc.)	0%	3%	13%	19%	32%	32%	6%
Water (changes in quality or availability, runoff, ocean acidification, turbidity, water table issues)	0%	6%	3%	16%	23%	32%	19%
Wildfire	3%	0%	16%	13%	26%	26%	19%

*Colored shading indicates highest percent ranking for each hazard category. *n*=32

Table 12. Average risk rating (0-5) for natural hazard threat categories.

Natural Hazard Threat Category	Average Rating /5 (*n=32*)
Flooding (storm surge, heavy rains, king tides, river flooding, etc.)	3.89
Land (landslides, erosion, accretion, sedimentation, subsidence, or deposition of soils, sediments, beaches, or dunes)	3.68
Earthquake and/or Tsunami	3.63
Climate (changes in precipitation, drought, or other weather patterns)	3.45
Water (changes in quality or availability, runoff, ocean acidification, turbidity, water table issues)	3.29
Wildfire	3.18
Sea Level (sea level rise, saltwater intrusion, landward migration)	3.10
Species and/or Habitats (population changes, invasive species, pests, loss of habitat or biodiversity, etc.)	3.07
Temperature (changes to temperature averages in air or water, heat waves, cold snaps, etc.)	2.87
Air (decreased air quality, increased pollutants, ozone, smoke, pollen, etc.)	2.59
Flooding (storm surge, heavy rains, king tides, river flooding, etc.)	3.89

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 13. Count and percent of natural hazard priority selections.

Natural Hazard of Concern	Count of Priority Selections (*n*=32)	Percent (composite)
Earthquakes	15	16.9%
Climate change	9	10.1%
Tsunami	9	10.1%
Wildfire	9	10.1%
King tides, tidal flooding	6	6.7%
River flooding, heavy rains	6	6.7%
Sea level rise, saltwater intrusion	6	6.7%
Severe weather (strong winds, storm surge)	6	6.7%
Landslides	5	5.6%
Other (enter below)	4	4.5%
Erosion, subsidence, accretion, or deposition of beaches, dunes, or soils	3	3.4%
Water quality hazards (chemistry, temperature, ocean acidification)	3	3.4%

Air quality hazards (pollutants, pollen, etc.)	2	2.2%
Ocean cycles changing	2	2.2%
Water table issues	2	2.2%
Drought	1	1.1%
Heat waves	1	1.1%
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:** Hwy 126, Cushman crossing/railroad trestle, US Hwy 101, slough on hill between near Bray Point, Siuslaw River Bridge, road network connectivity, north tunnel (Sea Lion Caves), east tunnel (Linslaw), North Fork bridge, Old Town, Hwy 36, infrastructure built on sand, Coast Guard station, jetty
- **Critical/Environmental Infrastructure:** native estuarine organisms, North Fork marsh, freshwater marshes, fisheries, sensitive aquifer, power lines/infrastructure, stormwater drains, agriculture near estuaries, sensitive dune ecosystem
- **Social Factors:** Dunes City residents reliant on wells, temporary housing, recreation, areas of cultural significance
- **Vulnerable Populations:** Green Trees, Driftwood Shores, Dunes City, Mapelton, elderly, residents reliant on power for medical care

What are the potential impacts that most concern you?

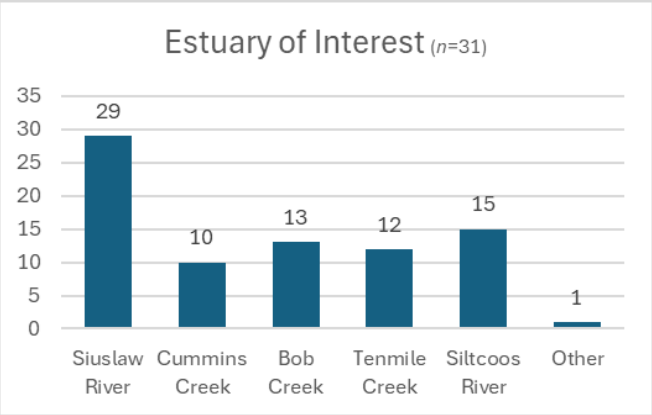
- **Built Infrastructure:** structural damage, erosion/landslides, flooding, destruction/long-term disruptions
- **Critical/Environmental Infrastructure:** habitat degradation or loss, loss of sensitive species (eg coho, Marbled murrelet), saltwater intrusion, ecosystem collapse, water quality impacts, energy loss, environmental pollution, soil movement blocking streams, slope instability, loss of drinking water, loss of services, watershed impacts
- **Social Factors:** loss of life, delayed access to food and medical services, business losses, running out of fuel, economic impacts, emergency evacuation, medical emergencies, poor mental health
- **Vulnerable Populations:** isolation, flooded homes, increased poverty

Demographics

There were a total of 32 respondents to the survey.

The majority of respondents were from Florence, with others spread throughout Lane County and beyond. The average respondent had lived in their community ~22 years, with an average of ~23 years in any Oregon coastal community. The average age of respondents was 61, which aligns with the age of the average coastal resident (61).

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



Question: 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.

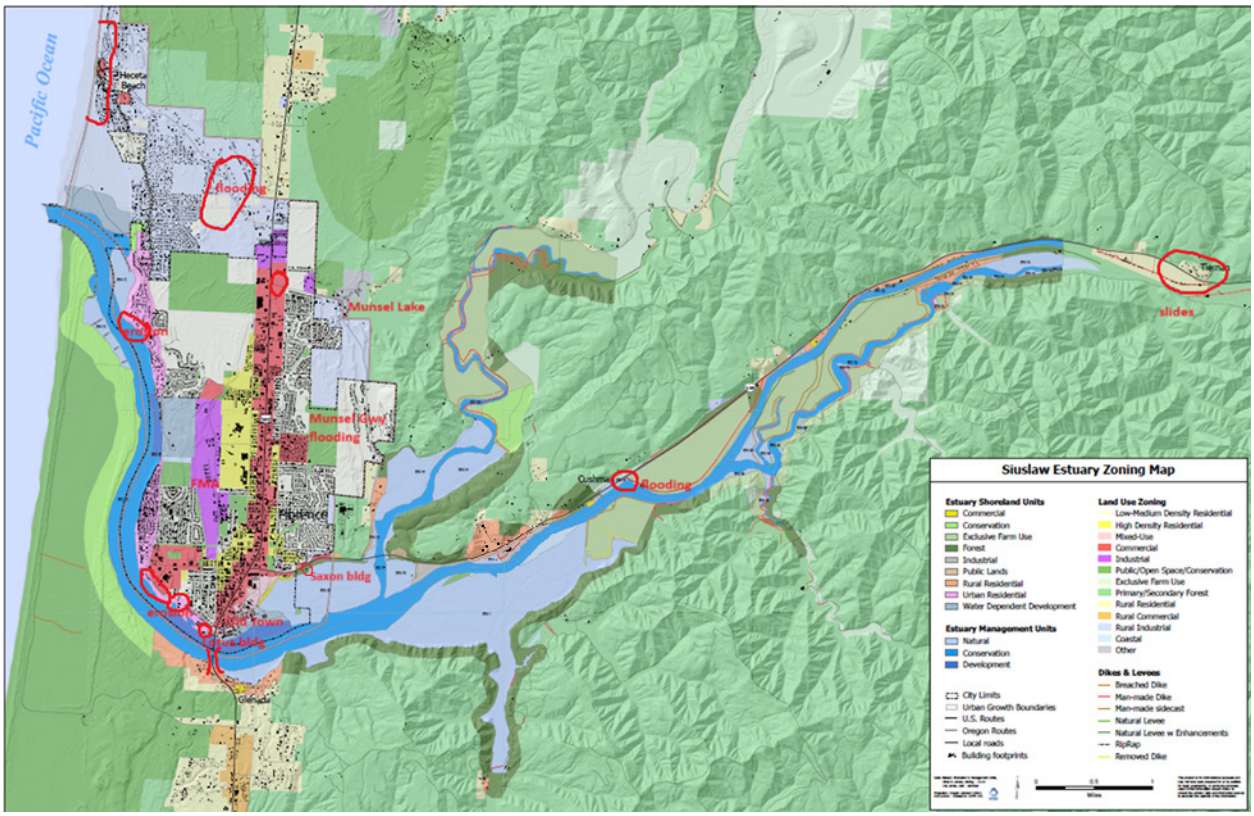
Table 14. Count of self-identified participant sector selections.

Sector	Number of Responses (*n*=32)
Agriculture	2
Forestry and Wood Products	2
Fishing and Aquaculture	0
Natural Resources	8
Transportation (e.g., roads, ports, shipping, etc.)	2
Emergency Services	5
Health Services	2
Social Services (e.g., low-income, housing, job placement, childcare, etc.)	4
Utilities	1
Parks/Open Space	1
Education	3
Community Organizations and Cultural Centers	5
Business (e.g., retail, tourism, hospitality, services, finance, etc.)	2
Industry (e.g., trades, manufacturing, materials, construction, maintenance, etc.)	0
Local Government and Land Use Planning	10
Other	7

Listening Session Summary

Vulnerabilities

Siuslaw River



- **Hwy 126:** Cushman crossing - frequent flooding and vulnerable railroad trestle
- **US Hwy 101:** Siuslaw River Bridge vulnerable to earthquake
- **Rhododendron Dr:** bank erosion below hospital and stretch near USCG station
- **Bay St:** Old Town areas near riverfront vulnerable to flooding
- **Heceta Beach Rd:** seasonal flooding
- **Driftwood Shores:** community vulnerable to tsunami
- **Munsel Lake:** water supply for the city, disc golf course going in with NBS opportunities
- **Munsel Cr greenway:** valuable/sensitive habitat/natural resources
- **Florence Municipal Airport:** community lifeline
- **Florence Wastewater Treatment Plant:** vulnerable to flooding
- **Tiernan Rd:** possible erosion issues
- **Mapleton:** buildings vulnerable to flooding, SLR
- **Wendson Canyon, Mapleton, Walton:** BPA substations community lifeline

- **Lake Cr:** water quality concerns

Other Concerns

- **Transportation networks:** limited redundancies, vulnerability to isolation
- Aquifers: shallow, slowly drying, WQ concerns, saltwater intrusion, aquifers drying near Woahink, Siltcoos
- **Surface drinking water:** threats to local supply
- **Water quality:** HABs, low DO, increased temps in drinking water supply
- **Railroad:** 6 bridges degrading, Pb paint leaching
- **Docks and boat launches:** critical infrastructure
- **Septics:** leaking tanks throughout region
- **Electrical infrastructure:** limited redundancies
- Fisheries, wildlife, ecosystem conditions
- Eelgrass, shellfish, wetlands vulnerable
- Invasive green crabs
- Need for outreach/awareness/education
- Lack of coordinated disaster planning
- Unincorporated communities more isolated, vulnerable

Listening Session Themes

Nearly 30 people participated in two listening sessions (one virtual and one in-person in Florence).

Sensitivity & Impacts

Critical Hazards

Table 15. Top natural hazard concerns for each listening session.

Listening Session	Critical Hazards Focus
Virtual	Earthquake/Tsunami, Water Quality, Sea Level Rise
Florence	Flooding, Water Quality, Erosion

The major hazard concerns expressed for coastal Lane County 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 **HIGH** risk to adverse hazard impacts. Overall, the anticipated impact of the most concerning hazards was viewed as **VERY HIGH**.

Stressors

Participants were concerned about the instability of soils and steep slopes due to the fact that a lot of development is built in sand areas. In addition to other flood-related factors, concern was expressed that these stressors would exacerbate flooding and contribute to local isolation. The limitations on the transportation systems were also a major concern, with several areas that experience frequent flooding (such as Cushman Crossing) that can isolate communities for several days each year. Additional stressors include climate change-driven factors such as extreme weather events (e.g. marine heat waves, drought) that impact ecosystems, species, and local aquifers.

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. Major infrastructure (e.g. Siuslaw River Bridge) and community lifelines (e.g. electrical infrastructure, drinking and sewer water infrastructure) were also frequently mentioned. The combination of those impacts during an extended islanding event are the most concerning vulnerability. Concerning environmental impacts include reductions in water quality and availability, particularly with respect to local aquifers, and 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 or recreationally important such as shellfish. 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, and costs to repair/rebuild infrastructure could have permanent impacts on local economies. 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) capacity of critical infrastructure is undersized for current needs and is underprepared to handle increased future demand, and 2) lack of capacity, whether funding, staffing, or otherwise, for preparation, build-up, and maintenance of existing resources to increasing communities' ability to buffer hazard impacts. Many systems (such as drinking water) are already in crisis with a variety of alternative strategies, such as tank trucks and rain gardens,

are being utilized on an individual basis but there are no backups or alternatives in place or planned. There is general awareness that the aquifers are slowly drying up and infrastructure is sized for the needs of 20-30 years ago. Implementing solutions will require funding, staffing, and planning to maintain and upgrade existing resources, and build up supplies and redundancies. Upgrading key infrastructure such as water treatment plants and sewage will take time to upgrade and expand operations. 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 modeling and understanding impacts from a major earthquake and tsunami, planning and coordination to address water and food insecurities, and ecological restoration to improve local resilience.

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 **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. Public understanding and awareness and its effects on politics and decision-making is seen as a major barrier to addressing these issues. Bureaucratic hurdles are also perceived as challenging to progress, including zoning, permitting, conflicting property rights, and other regulatory barriers. Other factors include 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), governance systems (cities, counties, state and federal agencies), drinking water, transportation (e.g., transit, freight, highways, non-motorized), and energy (e.g. electricity, transmission/distribution, natural gas, gasoline/diesel, biofuels). Key system interdependencies identified include business/industry, drinking water,

and food (e.g. agriculture, processing, distribution/storage, wholesale/retail). Other interdependent systems frequently mentioned include drinking water, storm water, and public safety (e.g., fire/EMS, police). Concerns for these interdependencies focused on redundancies, particularly when it comes to emergency and first responders, 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 the planning efforts from Lane Council of Governments and other local efforts. While some emergency and disaster plans do exist (such as for the City of Florence), they often don't address preparations such as stockpiles of food and water, tents for displaced residents, etc, or how to meet those needs when e.g. communications have been lost. 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 addressing the issues with drinking water, particularly the dunal aquifer system which is highly sensitive and increasingly being impacted by water quality issues such as saltwater intrusion.