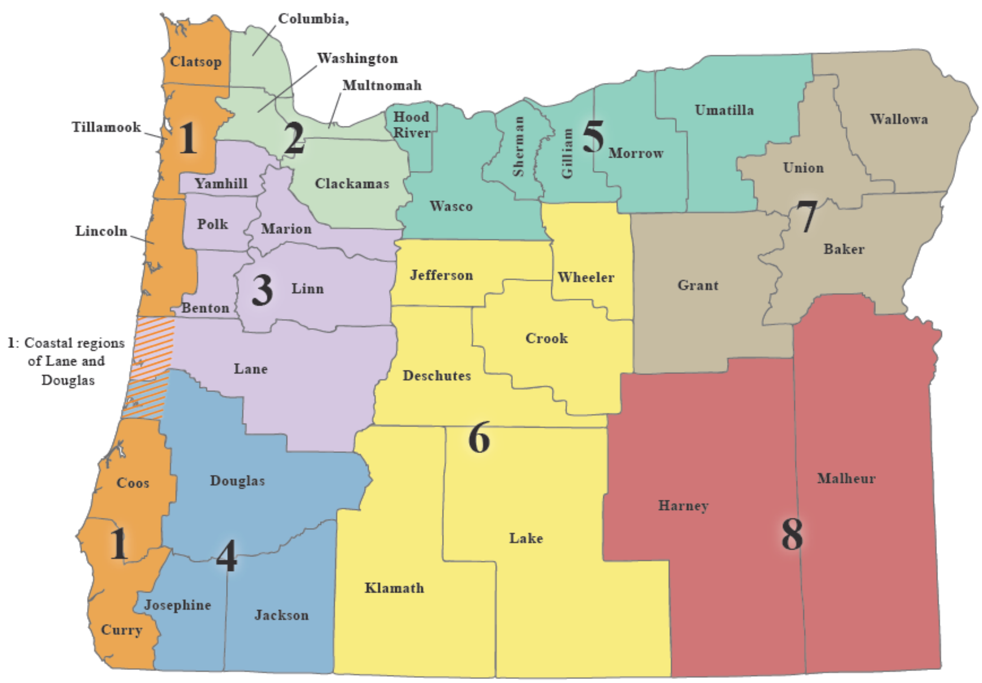
2.3 Regional Risk Assessments

The purpose of the Regional Risk Assessment is to assess risks at a regional scale by profiling the characteristics, natural hazards, and vulnerabilities within the eight Oregon NHMP Natural Hazard Regions (Figure 2-115). Each region has its own Risk Assessment. Together, the eight Regional Risk Assessments combine to describe the State's overall risk to natural hazards.

Figure 2-115. Oregon NHMP Natural Hazards Regions



Each Regional Risk Assessment includes three sections:

1. The **Summary** provides a general overview of (a) the Regional Profile, (b) the Regional Hazards and Vulnerability, and (c) how climate change models predict hazards in the region will be impacted based on statewide data.
2. The **Profile** section provides an overview of the region's unique characteristics including profiles of the natural environment, social and demographic situation, economic environment, infrastructure, and built environment.

   The research of Susan Cutter, Professor of Geography at the University of South Carolina, Columbia, on vulnerability and environmental hazards provides the framework for discussion of vulnerability in the Regional Profile section. Cutter's framework helps to illustrate the geographic variability of vulnerability and allows policy makers to better understand how to prepare for, mitigate, and reduce vulnerability (Cutter, Boruff, & Shirley, 2003); (Cutter S. L., 2006).

Margin of Error (MOE)

The sociodemographic data in the regional profiles are primarily sourced from the U.S. Census Bureau's American Community Survey (ACS). The ACS's estimates are subject to sampling and nonsampling errors. Nonsampling errors are the product of survey design and measurement flaws, "while sampling error is when the characteristics of the survey group vary from those of the larger population of interest...causing the true value to fall within a range bounded by a margin of error" (Quinterno, 2014).

Through adding and subtracting the MOE from the estimate, users can calculate the 90% confidence interval for that estimate (U.S. Census Bureau, 2018). For example, in **Table 2-81. People with a Disability by Age Group in Region 1**, data from the 2017 ACS 5-year estimates indicate that 19.1% of all people in Clatsop County have a disability with a MOE of 1.4%. Through adding and subtracting the MOE from the estimate, the user can calculate the 90% confidence interval for that estimate (U.S. Census Bureau, 2018). Doing so indicates that we can be 90 percent confident that the true share of residents in Clatsop County with a disability in the 2013-2017 period falls between 17.7% and 20.5%.

Period Estimates

It should also be noted that the ACS estimates in the plan are period estimates, rather than point-in-time or cumulative counts. “A period estimate shows the average value of the variable over a specific reference period” (Quinterno, 2014). The ACS uses period estimates “to compensate for the fact [that] the sampling frame includes too few households to yield reliable annual estimates for small geographies and small population subgroups” (Quinterno, 2014). If the value presented in a table is a period estimate, the period is noted in the table’s source data.

Coefficient of Variation (CV)

In addition to a MOE, many of the estimates in the plan have a coefficient of variation (CV). “The CV is a relative measure of uncertainty and expresses uncertainty as a percentage of the census estimate” (Jurjevich, et al., 2018). Generally, the lower the CV, the more reliable the data. According to the U.S. Census Bureau, there are “no hard-and-fast rules for determining an acceptable range of error in ACS estimates. Instead, data users must evaluate each application to determine the level of precision that is needed for an ACS estimate to be useful” (U.S. Census Bureau, 2018). This plan adopts CV ranges and data reporting methods recommended by the Population Research Center at Portland State University (Jurjevich, et al., 2018).

Icons are used to indicate the reliability of each estimate using the CV. High reliability (CV <15%) is shown with a green check mark, medium reliability (CV 15–30% — be careful) is shown with a yellow exclamation point, and low reliability (CV >30% — use with extreme caution) is shown with a red cross. However, as mentioned above, there are no precise rules and users should consider the MOE and their need for precision (Jurjevich, et al., 2018).

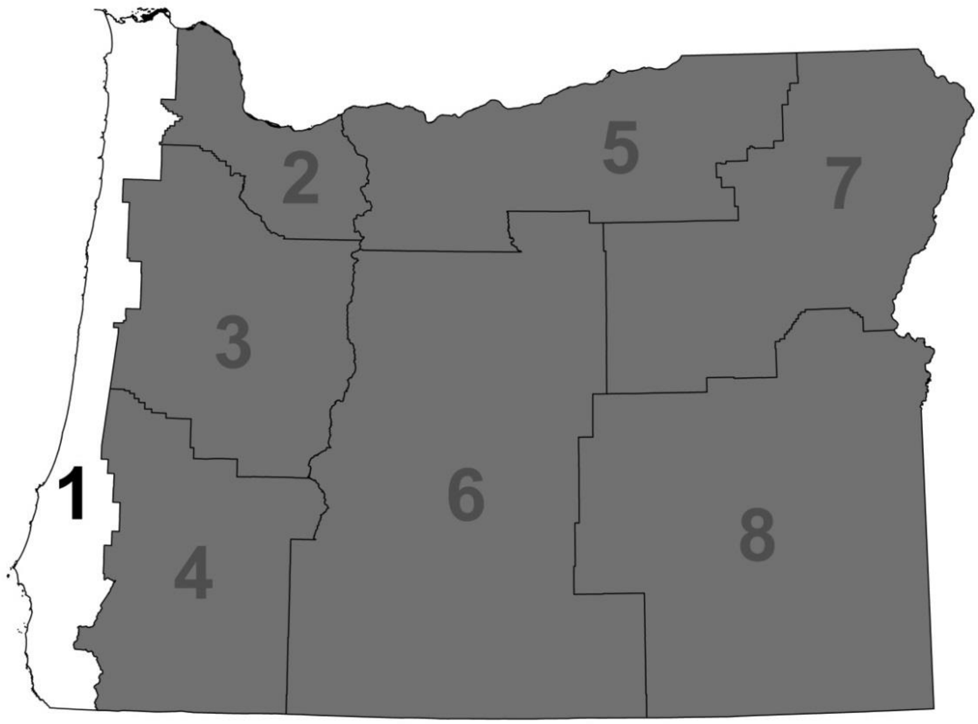
3. The **Hazards and Vulnerability** section first identifies each hazard and its characteristics in the region. Then, the historical events that have impacted the region are listed. Lastly, probabilities and vulnerabilities are discussed as identified by local and state risk assessments. Vulnerabilities

to and potential impacts from each hazard in the region are described including the identification and analysis of the region's State owned/leased facilities and critical/essential facilities located within hazard zones and seismic lifeline vulnerabilities.

Regional Risk Assessments add to the current body of literature and technical resource guides available to Oregon communities. The three levels of government — federal, state, and local — will find the Regional Risk Assessments useful when assessing natural hazards and vulnerabilities and when planning mitigation activities. Local governments can use the Regional Risk Assessments in the development of their jurisdiction's natural hazards mitigation plan. Information from these assessments is intended to be used as a springboard for more detailed community profiles. Likewise, information from local plans helps to inform the Oregon NHMP risk assessment overall.

2.3.1 Region 1: Oregon Coast

Clatsop, Coos, Curry, Lincoln, and Tillamook Counties and coastal areas of *Douglas and *Lane Counties



*Note: Where data specific to the coastal areas of Douglas and Lane Counties are available, the data are used in the Region 1 Risk Assessment. Where data are available only for the county as a whole, the data are reported in the Region 3 (Lane County) and Region 4 (Douglas County) Risk Assessments.

2.3.1.1 Summary

Profile

The region's demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed toward these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability in Region 1 is driven in part by a high percentage of tourists, homeless persons, seniors, and disabled populations. Coos County is the most socially vulnerable due to lack of access to a vehicle, unemployment rates, and the percentage of residents with a disability. In addition, Curry County is in the 90th percentile for the share of residents at least age 65 and for the share of residents with a disability. In addition, education levels and median household incomes across the region are below statewide numbers. Conversely, communities along the coast have high levels of homeownership, indicating an ability to better withstand economic hardship during natural disaster events. Coastal communities were hit particularly hard by the financial crisis that began in 2007 and continue to suffer from low job recovery rates, especially in Curry, Coos, and Lincoln Counties. They suffer as well from the financial effects of the 2020 pandemic. There are relatively few key industries and employment sectors in the region, and they employ relatively few people. Wages are lower than the state average. Coastal economies are becoming more reliant upon tourism, which peaks in the spring and summer months. Consequently, the area is particularly vulnerable during winter months when fewer employment opportunities exist.

A Cascadia Subduction Zone (CSZ) earthquake will be catastrophic to infrastructure along the coast. Following a CSZ event, access to and from coastal communities will be limited along US-101, major roadways, and bridges. Railroads that support transport of freight and cargo and access to the Southwest Oregon Regional Airport (OTH) will also be compromised and will have implications statewide.

Currently, there are no power plants or major dams in the region, requiring energy to be transmitted long distances from other states and Canada. These energy conveyance systems are vulnerable to severe but infrequent natural hazards, such as a Cascadia Subduction Zone (CSZ) event. Older, centralized storm and wastewater infrastructure is also vulnerable to flood events.

Most of the region's drinking water is sourced from surface water that is vulnerable to flooding, erosion, and landslides. These hazard events could result in pollution entering waterways that supply the region with drinking water.

Development in Region 1 has significantly lagged behind the rest of the state. Growth that is occurring is primarily in Tillamook and Lincoln Counties. The region has a high number of manufactured home units. Almost half of all housing in Clatsop and Curry Counties was built before current seismic and floodplain management standards, creating a greater risk to damage to loss. Due to the coast's geology and geomorphology, development is limited to low-lying areas often subject to coastal hazards. Tsunami risk information and development guidance developed by the State are helping communities develop land use planning strategies to reduce tsunami hazard risk.

Hazards and Vulnerability

Region 1 is affected by 10 of the 11 natural hazards that affect Oregon communities. Volcanic hazards, with the possible exception of ash fall, do not directly impact the area.

Coastal Hazards: The Oregon coast is increasingly threatened by wave-induced erosion, wave runup and overtopping, wind-blown sand, and coastal landslides. Clatsop, Tillamook, Lincoln, and Curry Counties are principally vulnerable to these hazards. Development in low-lying areas subject to erosion or adjacent to estuaries is of particular concern. In Region 1, there is a potential loss of over $232M in state building and critical facility assets to a CSZ event. Almost half of that is in Clatsop County alone. There is a far greater potential loss in local critical facilities: over $685M. Coos County stands to lose the most, about 51% of that total, followed by Clatsop County with about 20%.

Droughts: The region is affected by droughts to a lesser extent than other areas in the state. While uncommon, when they do occur they can be problematic — impacting community water supplies and creating forest conditions conducive to wildfires.

Earthquakes and Tsunamis: Three types of earthquakes affect Region 1: (a) shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, and (c) the offshore Cascadia fault. The CSZ is the chief earthquake hazard for coastal communities. The return rate for this type of catastrophic event is 530 years. The probability of such an event occurring in the next 50 years is 7–12%.

Tsunamis may take the form of distant or local events. The CSZ earthquake and local tsunami event have the potential to affect the entire coastline through severe ground shaking, liquefaction of fine-grained soils, landslides, and flooding. In addition to causing significant loss of lives and development, a CSZ earthquake and local tsunami would dramatically affect the region's critical infrastructure, including principal roads and highways, bridges, tunnels, dams, and coastal ports. The region has the most seismically vulnerable highway system in the state. Seismic lifelines will be fragmented along US-101 and along east-west routes that connect the region to the rest of the state. There is value of over $248M in state facilities and critical facilities in the tsunami zone in Region 1. There is about a third more than that in local critical facilities.

Extreme Heat: Extreme temperatures are rare on the coast. Most years do not have temperatures above 90°F and years that do, generally only have one or two days. Extreme temperatures will continue to be rare under future climate change. However, Region 1 counties may begin to experience extreme heat days with heat index over 90°F within the next thirty years. Because extreme heat is rare in Region 1, many people may not be accustomed or prepared when an extreme heat event occurs. The value of state-owned and leased buildings and critical facilities in Region 1 is approximately $535,054,000 representing the total potential for loss of state assets due to extreme heat. The value of locally owned critical facilities is $1,294,655,000.

Floods: Coastal communities are impacted by riverine flooding, tsunami flooding, and ocean flooding from high tides and wind-driven waves. Low lying areas adjacent to bays or the ocean are more susceptible to flooding, which can be intensified by high tides. Northern counties are considered highly vulnerable to riverine flood damage because the area is more densely populated and has more of the region's infrastructure. Local highways are susceptible to wave action because of their location and geology. Almost $19M of state facilities and critical facilities are in the tsunami hazard zone and over $73M in local critical facilities. The vast majority of the value exposed is in local critical facilities in Coos County.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Many landslides occur along the coast and Coast Range Mountains. Rain-induced landslides can occur during winter months, and earthquakes can trigger landslides at any time. US-101, principal roadways, and rail lines are exposed to landslides. Landslides have the potential to cause injuries and fatalities along these transportation systems. Landslides can also sever transportation systems, causing temporary but significant economic damage regionally and beyond. Almost $56M in value of state facilities is exposed to landslide hazards in Region 1, close to 30% of it in Lincoln County followed by Clatsop, Tillamook, and the coastal portion of Lane County. The coastal portion of Douglas County has no state facilities at potential loss from landslides. In contrast, the region has critical facilities representing over $209M in value in landslide hazard areas. Together, Coos and Clatsop Counties have almost two-thirds of the value of local critical facilities followed by Lincoln and Tillamook Counties.

Volcanoes: Though the volcanic Cascade Range is outside the region, there is some risk that volcanic ashfall, lahars, and mud flows may impact communities within Region 1 following a volcanic event.

Wildfires: Though cool moist weather makes the region less susceptible to wildfire than some other areas in the state, some of the largest fires have occurred in Region 1. Wildfire events typically take place in late summer. Areas with high levels of dry vegetation (gorse, timber, etc.) are most susceptible to wildfire. Based on the 2020 Risk Assessment, Coos County and the coastal portions of Lane and Douglas Counties have a moderate risk of wildfire while the rest of Region 1 has a very low risk. In Region 1, there is a potential loss of almost $5M in state building and critical facility assets, 96% of it in Curry County. The other 4% is divided almost equally between the coastal portion of Douglas County and Coos County. There is a far greater potential loss in local critical facilities: over $11M, over twice as much. A little less than half that value is located in Coos County; a little more than half in Curry County. There are no state buildings or critical facilities exposed to wildfire hazards in Clatsop County, the coastal portion of Lane County, Lincoln or Tillamook Counties. The same is true for local critical facilities with the addition of the coastal portion of Douglas County.

Windstorms: In general, winds generated offshore and traveling inland in a northeasterly direction can create windstorms in all counties along the coast. Windstorms affect the region annually, especially between October and March. They can impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as the coastline, grasslands, and farmland. Two tornadoes touched down in Tillamook County in 2016. One caused estimated damages of $1M; The other caused no damage.

Winter Storms: Colder weather, snow, ice, sleet, higher precipitation, and high winds can impact the Oregon Coast annually. Heavy ice can down trees causing widespread power outages and road closures that can isolate communities. Communities that are particularly susceptible to winter storms include Astoria, Cannon Beach, Rockaway Beach, Oceanside, Lincoln City, Depot Bay, and Newport.

Climate Change

The hazards faced by Region 1 that are projected to be influenced by climate change include coastal hazards, drought, wildfire, flooding, landslides, and extreme heat.

It is *very likely* (>90%) that the Oregon coast will experience an increase in coastal erosion and flooding hazards due to climate change induced sea level rise (*high confidence*) and possible changes to wave dynamics (*medium confidence*). Local sea level rise will be greatest on the central Oregon coast; however, the north and south coasts of Oregon will see local sea level rise surpass the current rate of vertical land movement.

In addition, climate models project warmer, drier summers for Oregon, including coastal areas. In Region 1, climate change would result in increased frequency of drought due to low summer runoff (*likely*, >66%) and low summer precipitation and low summer soil moisture (*more likely than not*, >50%). It is *very likely* (>90%) that the Coast Range in Region 1 will experience increasing wildfire frequency and intensity due to warmer, drier summers coupled with warmer winters that facilitate greater cold-season growth.

It is *extremely likely* (>95%) that the frequency and severity of extreme heat events will increase over the next several decades across Oregon due to human-induced climate warming (*very high confidence*). While extreme temperatures are rare on the coast and will continue to be rare under future climate change, Region 1 counties may begin to experience novel extreme heat conditions.

Furthermore, flooding and landslides are projected to occur more frequently throughout western Oregon. It is *very likely* (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (*high confidence*) that is *more likely than not* (>50%) to lead to an increase in the incidence and magnitude of damaging floods (*low confidence*). However, large increases in extreme flows are least likely along the Lower Columbia Basin (northern border of Region 1). Because landslide risk depends on a variety of site-specific factors, it is *more likely than not* (>50%) that climate change, through increasing frequency of extreme precipitation events, will result in increased frequency of landslides.

While winter storms and windstorms affect Region 1, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the Section 2.2.1.2, **Introduction to Climate Change**.

2.3.1.2 Profile

Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

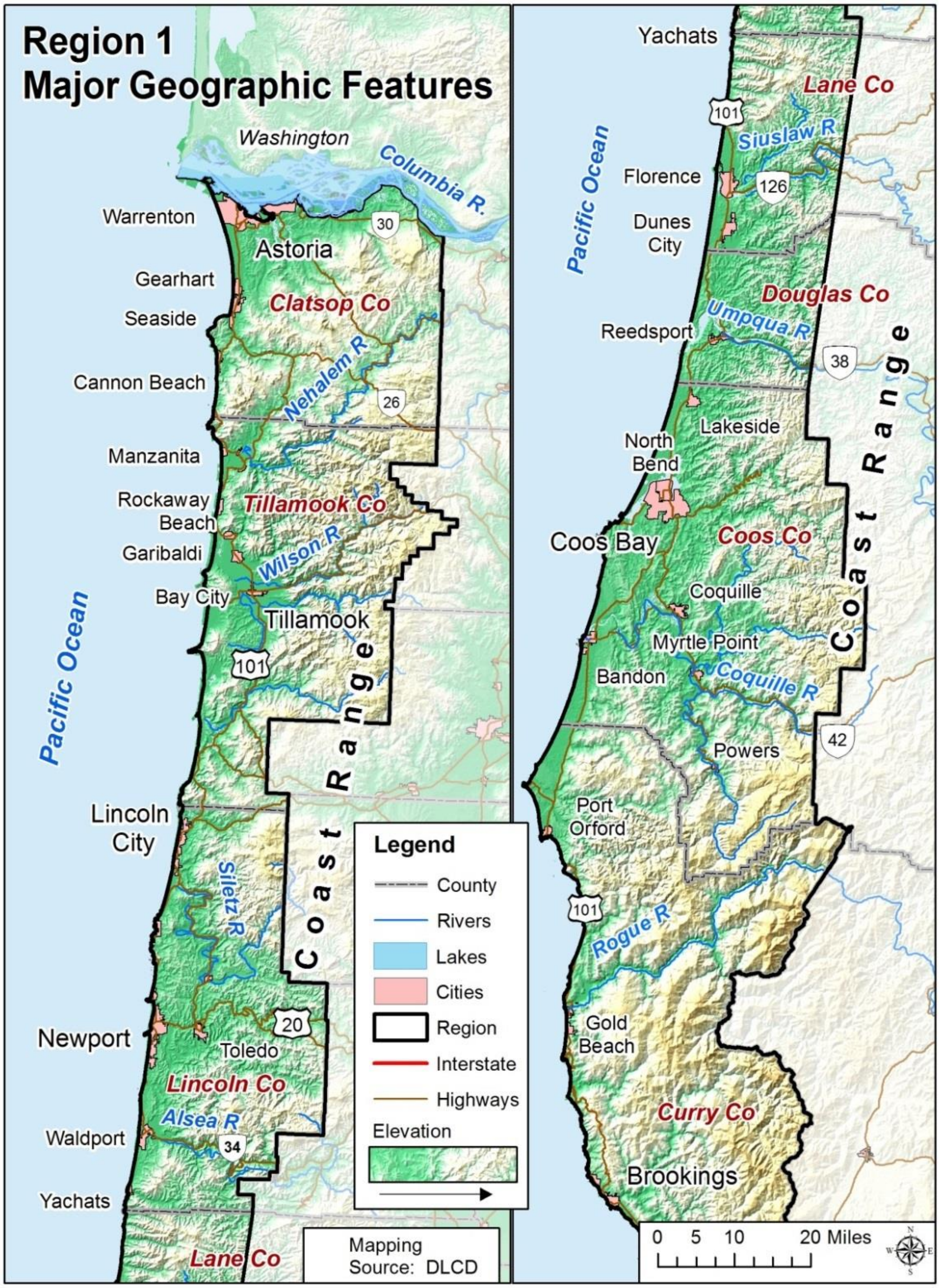
Natural Environment

Geography

The Oregon Coast is approximately 17,063 square miles in size, and includes Clatsop, Coos, Curry, Lincoln and Tillamook Counties, and coastal areas of Douglas and Lane Counties. The Coast Range mountains and waterways shape the region's topography. Region 1 begins at the Pacific Ocean on the west side and continues eastward beyond the Coast Range to the major valleys in the east. It extends from Washington State in the North to the California border in the south. Major rivers in the region include the Siuslaw, Umpqua, Nehalem, Rogue, Yaquina, Siletz, Nestucca, Trask, Wilson, Coos, and Coquille. **Figure 2-116** shows the dominant mountain ranges, major watersheds, and political boundaries of Region 1.

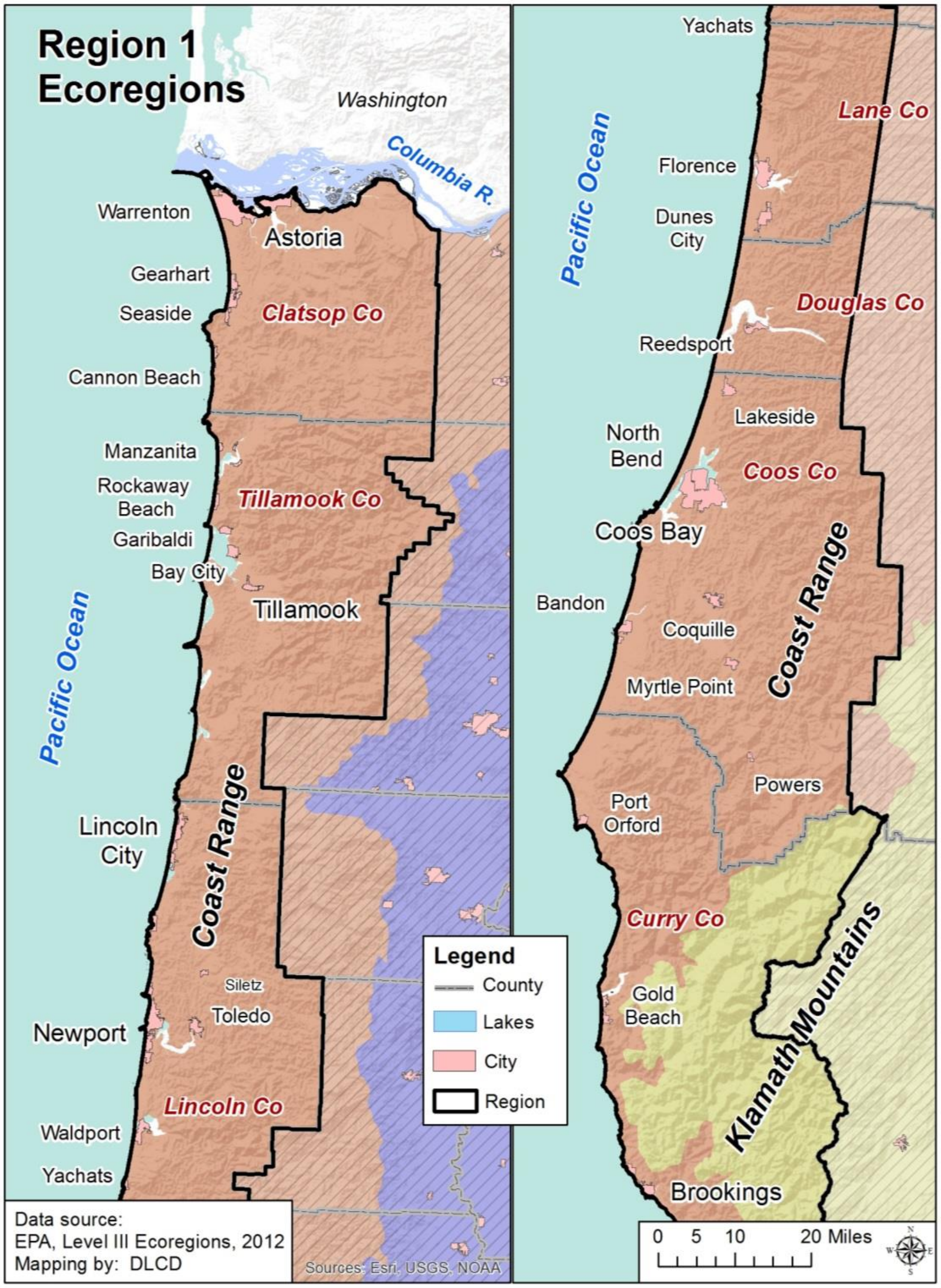
The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 1 comprises two ecoregions: the Coast Range and a smaller area of the Klamath Mountains (**Figure 2-117**).

Figure 2-116. Region 1 Major Geographic Features



Source: USGS, NGA, NASA, CGIAR

Figure 2-117. Region 1 Ecoregions



Coast Range: The Coast Range is Region 1's dominant ecoregion. Mountains in the Coast Range are low in elevation and high in precipitation, creating lush evergreen forests. Naturally occurring diverse forests have given way to monocrop plantings for timber harvest. The Oregon Coast Range is volcanic in origin and is drained by hundreds of creeks, streams, rivers, and lakes. Sedimentary soils are more prone to failure following clear cuts and road building than are areas with volcanic soils, which may be of concern as commercial Douglas fir forests are highly productive commercial logging areas. Landslides can impact the safety of nearby infrastructure and health of the region's waterways. Sedimentary soils create more concerns for stream sedimentation than areas with volcanic soils. Low lands include beaches, dunes, forests, lakes, marshes, and streams. Many wetlands in the ecoregion have been converted to dairy pastures (Thorson, et al., 2003).

Klamath Mountains: The majority of the Klamath Mountains found in Region 1 are classified as the Coastal Siskiyous. This area has a wet, mild maritime climate. Land cover is a mix of hard- and soft-wood forests, which is far more diverse than the predominantly coniferous forests of the Coast Range. Logging, recreation, rural residential development, and mining activities are common in this ecoregion (Thorson, et al., 2003).

Climate

This section covers historic climate information. For estimated future climate conditions and possible statewide impacts refer to the **State Risk Assessment**.

The Oregon Coast has a predominantly mild climate with average January minimum temperatures in the mid-30s and average July maximum temperatures in the low 70s. The Oregon Coast receives copious precipitation that falls predominantly in the winter months, mostly in the form of rain due to the region's low elevation. The region's wet winters can lead to flood and landslide risks while dry summers can lead to drought and wildfire risks. Winter storms are often accompanied by high winds. Localized variations in temperature and precipitation exist across the region's microclimates. **Table 2-78** displays 1981–2010 average precipitation and temperature for counties and climate divisions within Region 1 based on data from the NOAA National Centers for Environmental Information.

Table 2-78. Average Precipitation and Temperature in Region 1 Counties and Climate Divisions

Sub-Region	Annual Precipitation Mean & Range (1981–2010)	January & July Mean Precipitation (1981–2010)	Annual Mean Temperature (1981–2010)	January & July Average Min/Max Temperature (1981–2010)
Clatsop County	87.85" (60.53"–119.57")	Jan: 13.36" Jul: 1.21"	49.8°F	Jan: 35/46.7 Jul: 50.7/71
Coos County	69.1" (46.95"–108.37")	Jan: 10.62" Jul: 0.47"	52.6°F	Jan: 37/51.4 Jul: 51.8/74.3
Curry County	84.57" (51.85"–132.66")	Jan: 13.38" Jul: 0.42"	52.7°F	Jan: 37.1/50 Jul: 52.3/77.4
Lincoln County	89.58" (63.7"–134.28")	Jan: 13.7" Jul: 0.98"	51.2°F	Jan: 36.8/48.2 Jul: 50.7/72.5
Tillamook County	100.29" (70.77"–145.93")	Jan: 15.22" Jul: 1.29"	49.5°F	Jan: 35.4/45.6 Jul: 50.4/70.9
Climate Division 1 Coastal Area"	83.05" (56.17"–124.60")	Jan: 12.8" Jul: 0.77"	51.4°F	Jan: 36.3°/48.5° Jul: 51.4°/73.8°

Source: NOAA National Centers for Environmental Information, Climate at a Glance: County & Divisional Time Series, published August 2019, retrieved on August 8, 2019 from https://www.ncdc.noaa.gov/cag/

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter, Boruff, & Shirley, 2003). Population change includes two major components: natural increase (births minus deaths) and net migration (in-migrants minus out-migrants) (USDA, 2020). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

Between 2010 and 2018 the regional growth rate lagged behind the state by six percentage points. Growth in Coos County, the region's largest county, has remained relatively flat, while Clatsop County saw the greatest percent increase in population. The population in all coastal counties is aging. Some counties are experiencing slowing natural increase (the ratio of births to deaths), while others are experiencing natural decrease (more deaths than births) (Population Research Center, Portland State University , 2017 & 2018). Since 2010, population increase in all Region 1 counties has been a product of net in-migration (Population Research Center, Portland State University , 2017 & 2018).. Over the next decade, coastal counties are projected to continue to grow at a slower rate than the state as a whole, with Lincoln County projected to experience the greatest growth in the region and Coos County projected to experience the least. Across the region, in-migration is projected to continue to be the primary driver of population growth (Population Research Center, Portland State University , 2017 & 2018).

Table 2-79. Population Estimate and Forecast for Region 1

	2010	2018	Percent Change (2010 to 2018)	2030 Projected	Percent Change (2018 to 2030)
Oregon	3,831,074	4,195,300	9.5%	4,694,000	11.9%
Region 1	193,730	199,995	3.2%	208,066	4.0%
Clatsop	37,039	39,200	5.8%	40,079	2.2%
Coos	63,043	63,275	0.4%	63,855	0.9%
Curry	22,364	22,915	2.5%	23,976	4.6%
Lincoln	46,034	48,210	4.7%	51,909	7.7%
Tillamook	25,250	26,395	4.5%	28,247	7.0%

Sources: Population Research Center, Portland State University, 2019; U.S. Census Bureau, 2010 Decennial Census. Table DP-1

Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. More than 15.5 million tourists visited and stayed at least one night at the Oregon Coast in 2018. The average travel party along the Oregon Coast contained three people (Longwoods International, 2017a). Approximately 57% of overnight trips occur from April to September (Longwoods International, 2017a). Communities in the northern and central coast attracted more tourists than the southern communities, and Lincoln County received the largest single-county share of tourists. Between 2016 and 2018, visitors in Region 1 mostly lodged in hotels, motels, campgrounds, or vacation homes rather than in private homes (Dean Runyan Associates, 2019).

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-80. Annual Visitor Estimates in Person Nights (x1000) in Region 1

	2016		2017		2018	
	Number	Percent	Number	Percent	Number	Percent
Region 1	15,635	—	15,535	—	15,695	—
North Coast	6,463	100%	6,420	100%	6,473	100%
Hotel/Motel	3,152	48.8%	3,098	48.3%	3,118	48.2%
Private Home	750	11.6%	763	11.9%	777	12.0%
Other	2,561	39.6%	2,559	39.9%	2,578	39.8%
Clatsop	3,914	100%	3,871	100%	3,903	100%
Hotel/Motel	2,401	61.3%	2,358	61%	2,371	60.7%
Private Home	495	12.6%	498	13%	507	13.0%
Other	1,018	26.0%	1,016	26%	1,025	26.3%
Tillamook	2,549	100%	2,548	100%	2,570	100%
Hotel/Motel	751	29.5%	740	29.0%	747	29.1%
Private Home	255	10.0%	265	10.4%	270	10.5%
Other	1,543	60.5%	1,543	60.6%	1,553	60.4%
Central Coast*	4,981	100%	4,971	100%	5,029	100%
Hotel/Motel	2,644	53.1%	2,633	53.0%	2,672	53.1%
Private Home	625	12.5%	624	12.6%	634	12.6%
Other	1,712	34.4%	1,714	34.5%	1,723	34.3%
Lincoln	4,981	100%	4,971	100%	5,029	100%
Hotel/Motel	2,644	53.1%	2,633	53.0%	2,672	53.1%
Private Home	625	12.5%	624	12.6%	634	12.6%
Other	1,712	34.4%	1,714	34.5%	1,723	34.3%
South Coast	4,191	100%	4,144	100%	4,193	100%
Hotel/Motel	1,570	37.5%	1,551	37.4%	1,555	37.1%
Private Home	1,044	24.9%	1,038	25.0%	1,054	25.1%
Other	1,577	37.6%	1,555	37.5%	1,584	37.8%
Coos	2,592	100%	2,567	100%	2,591	100%
Hotel/Motel	1,109	42.8%	1,096	42.7%	1,096	42.3%
Private Home	816	31.5%	813	31.7%	825	31.8%
Other	667	25.7%	658	25.6%	670	25.9%
Curry	1,599	100%	1,577	100%	1,602	100%
Hotel/Motel	461	28.8%	455	28.9%	459	29%
Private Home	228	14.3%	225	14.3%	229	14%
Other	910	56.9%	897	56.9%	914	57%

*Central Coast also includes the coastal portions of Douglas and Lane Counties; data is not aggregated for coastal portions of these counties within the report. See Region 3 (Lane) and Region 4 (Douglas) profiles for the entire county tourism data.

Source: Oregon Travel Impacts: 1992–2018, March 2019. (Dean Runyan Associates, 2019), http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations are disproportionately affected during disasters and can be difficult to identify and measure (Cutter, Boruff, & Shirley, 2003).

Compared to the state as a whole, more people in Region 1 identify as having a disability. The region also has a disproportionate share of younger people (< 18) and older adults (≥ 65) with a disability. Within the region, Coos County has the largest share of older adults with a disability—approximately nine percentage points higher than the state average. Accurately measuring the number of children with a disability is challenging, especially in counties with a smaller overall population. For example, the estimate of young people with a disability for Curry County has low reliability, and estimates for all other coastal counties should be used with caution.

Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events. Planning professionals might take a number of steps to mitigate risk for disabled community members. Inaccessible shelter facilities can pose challenges in a disaster event. Local officials should also strengthen partnerships with the disability community, and work with local media organizations to ensure emergency preparedness and response communications are accessible for all.

Table 2-81. People with a Disability by Age Group in Region 1

	With a Disability (Total Population)			Under 18 Years with a Disability			65 Years and Over with a Disability		
	Estimate	CV**	MOE (+/−)	Estimate	CV**	MOE (+/−)	Estimate	CV**	MOE (+/−)
Oregon	14.6%	☑	0.1%	4.6%	☑	0.2%	37.1%	☑	0.4%
Region 1	21.7%	☑	0.7%	6.9%	☑	1.0%	41.5%	☑	1.5%
Clatsop	19.1%	☑	1.4%	5.6%	⊙	1.6%	38.5%	☑	3.1%
Coos	23.4%	☑	1.5%	8.0%	⊙	2.3%	46.3%	☑	3.0%
Curry	23.4%	☑	2.1%	6.5%	⊗	4.2%	42.0%	☑	4.4%
Lincoln	21.7%	☑	1.1%	6.7%	⊙	1.7%	39.0%	☑	2.4%
Tillamook	20.2%	☑	1.7%	6.6%	⊙	1.8%	37.8%	☑	3.7%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% – use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau, 20013–2017 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

The U.S. Department of Housing and Urban Development requires Continuums of Care to conduct the Point-in-Time Count (PIT), a biennial count of both sheltered and unsheltered people experiencing homelessness. These are rough estimates and can fluctuate with many factors. They should be understood as the absolute minimum number of people experiencing homelessness in the area (Oregon Housing and Community Services, 2019, Nov. 21). Moreover, the PIT does not fully depict the extent of housing insecurity, as it excludes families or individuals that might be staying with friends or family due to economic hardship. The count also obscures the demographic composition of the houseless population, frequently undercounting people of color, for example (Oregon Housing and Community Services, 2019, Nov. 21).

The majority of families experiencing homelessness—over 3,000 people—live in coastal counties or southern Oregon (Oregon Housing and Community Services, 2019, Nov. 21). Additionally, both Coos and Clatsop Counties have concentrations of children living on their own and experiencing homelessness (Oregon Housing and Community Services, 2019, Nov. 21). According to the PIT, between 2015 and 2019 the region reported a 34.1% increase in its unhoused population. Homelessness in Lincoln County grew most quickly, vastly outpacing other regional counties. However, Coos and Clatsop counties have the largest absolute number of people experiencing homelessness. Coos County reported a drop in its unhoused population in 2017 but reported a similar number in 2019 as in 2015.

People experiencing homelessness are typically more physically and psychologically vulnerable compared to the general population and natural hazard events exacerbate their vulnerability. Local emergency management professionals should take a trauma-informed approach to providing services and include people with expertise in providing support to people experiencing homelessness in planning for natural events (U.S. Department of Housing and Urban Development, 2016). Additionally, it is important to plan for episodic natural hazards as well as chronic events. For example, year-around access to shelter is becoming increasingly important as wildfire smoke becomes more common across the state.

Table 2-82. Homeless Population Estimate for Region 1

	2015	2017	2019	Period Average
Oregon	13,077	13,953	15,800	14,277
Region 1	1,540	1,655	2,065	1,753
Clatsop	682	680	894	752
Coos	612	397	613	541
Curry	86	161	118	122
Lincoln	54	186	260	167
Tillamook	106	231	180	172

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services.

Biological Sex and Gender

The concepts of sex and gender are often used interchangeably but are distinct; sex is based on biological attributes (chromosomes, anatomy, hormones) and gender is a social construction that may differ across time, cultures, and among people within a culture (U.S. Census Bureau, 2019, Apr. 3). Moreover, the two may or may not correspond (U.S. Census Bureau, 2019, Apr. 3).

The American Community Survey question was specifically designed to capture biological sex and there are no questions on the survey about gender (U.S. Census Bureau, 2019, Apr. 3). According to the survey, there are slightly more women than men in Region 1 (96.6 men to every 100 women) (U.S. Census Bureau, 2019, Mar. 31). This is true for all counties in the region, except Tillamook, which has a more even split. The regional ratio is slightly below the statewide split (98.3 men to every 100 women) (U.S. Census Bureau, 2019, Mar. 31).

Primarily empirical research has begun to emerge about the ways in which gender influences resilience to disasters. It indicates that gender influence is much more pervasive and expressed differently among men, women, LGBTQ+, and non-binary populations than has generally been recognized (Enarson, 2017). This is an area deserving of more attention as the field develops.

Age

Older adults, those 65 and older, comprise a larger share of the population in Region 1 than they do in the state as a whole. This is true for all counties in the region, and is likely influenced by a high number of retirees in the region. An older population requires special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, older people may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to all ages and abilities (Morrow, 1999).

Children also represent a vulnerable segment of the population. Though the share of children in Region 1 is less than the share statewide, at least 15% of all people in each coastal county are under 18 years old. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. In addition, parents might lose time and money when their children's childcare facilities and schools are impacted by disasters.

Table 2-83. Population by Vulnerable Age Group, in Region 1

	Total Population	Under 18 Years Old			65 Years and Older		
	Estimate	Estimate	CV**	MOE (+/−)	Estimate	CV**	MOE (+/−)
Oregon	4,025,127	21.5%	☑	0.1%	16.3%	☑	0.1%
Region 1	196,466	18.1%	☑	0.1%	24.7%	☑	0.2%
Clatsop	38,021	19.6%	☑	0.2%	20.1%	☑	0.3%
Coos	62,921	18.6%	☑	0.1%	24.4%	☑	0.2%
Curry	22,377	15.2%	☑	0.3%	32.3%	☑	0.4%
Lincoln	47,307	17.2%	☑	0.1%	25.9%	☑	0.1%
Tillamook	25,840	19.1%	☑	0.3%	23.7%	☑	0.3%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% – use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau, 20013–2017 American Community Survey 5-Year Estimates, Table DP05

Language

Special consideration in hazard mitigation should be given to populations who do not speak English as their primary language. These populations are less likely to be prepared for a natural disaster if special attention is not given to language and culturally appropriate outreach materials. In the Oregon Coast Region, most residents speak English as their primary language. Due to sampling techniques employed by the American Community Survey, some estimates for Region 1 should be used with caution. Including the margin of error, however, it is clear that from 0.7% to 3.9% of each county does not speak English "very well." Communities creating outreach materials used to communicate with and plan for populations who do not speak English very well should take into consideration the language needs of these populations.

Table 2-84. English Usage in Region 1

	Speak English Less Than "Very Well"				
	Estimate	MOE (+/−)	CV**	Percent	% MOE (+/−)
Oregon	222,428	4,116	☑	5.9%	0.1%
Region 1	4,008	1,063	⦿	2.1%	0.6%
Clatsop	957	226	☑	2.7%	0.6%
Coos	902	235	⦿	1.5%	0.4%
Curry	308	144	⦿	1.4%	0.7%
Lincoln	1,131	224	☑	2.5%	0.5%
Tillamook	710	234	⦿	2.9%	1.0%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% – use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

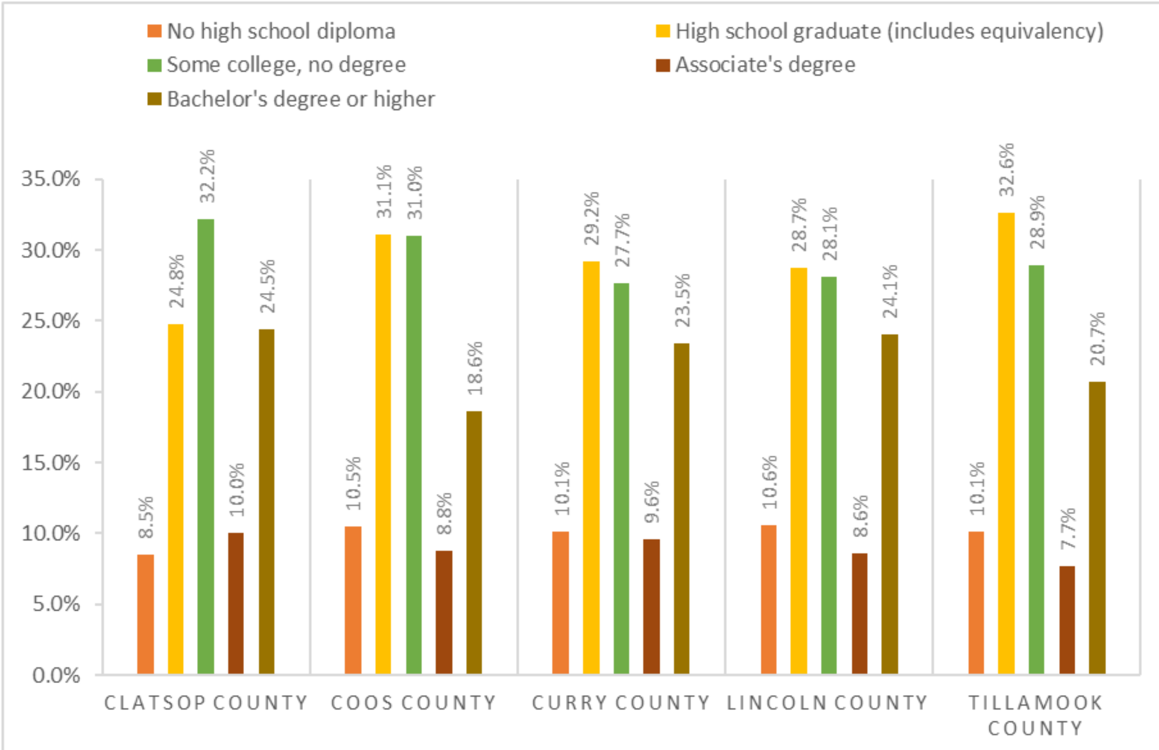
Source: U.S. Census Bureau, 20013–2017 American Community Survey 5-Year Estimates, Table DP02

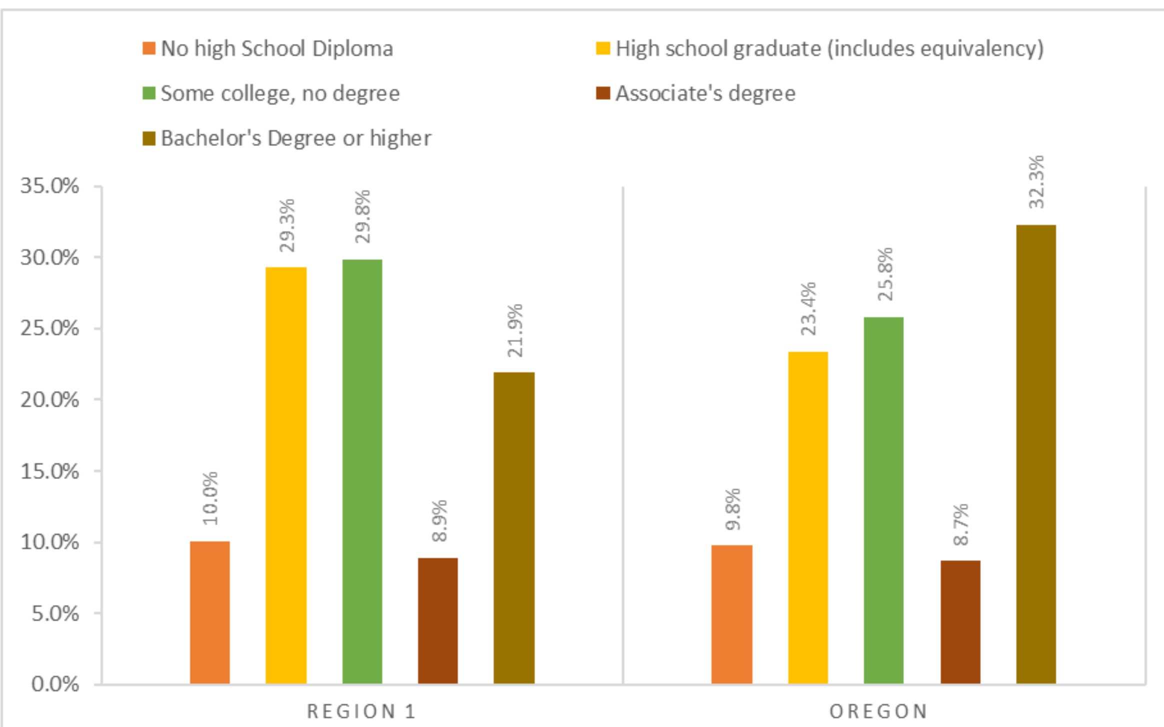
Education Level

Studies show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings (Cutter, Boruff, & Shirley, 2003). Furthermore, education can influence an individual's ability to understand and act on warning information, navigate bureaucratic systems, and to access resources before and after a natural disaster (Masozera, Bailey, & Kerchner, 2007).

Nearly 22 % of the population in Region 1 has a bachelor's degree or higher, which is ten percentage points lower than the statewide estimate. The portion of the population without a high school diploma closely matches the statewide number, and approximately one third of the population in each coastal county has received some college credit. Within the region, Clatsop and Lincoln Counties have the highest levels of attainment, with a greater share of residents holding a degree at the associate's level or higher.

Figure 2-118. Educational Attainment in Region 1





Source: U.S. Census Bureau, 2013-2017 American Community Survey 5-Year Estimates, Table DP02

Income and Poverty

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter S. L., 2006). Historically, 80% of the disaster burden falls on the public (Stahl, P., 2000). Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, and less likely to have the savings to rebuild after a disaster. They are also less likely to have access to transportation and medical care.

Across the region, median household income is approximately $6,000 to $15,000 lower than the statewide median. Additionally, from 2012 to 2017, no county in the region experienced a statistically significant change in median household income.

Table 2-85. Median Household Income in Region 1

	2008–2012			2013–2017			Statistically Different*
	Estimate	CV**	MOE (+/−)	Estimate	CV**	MOE (+/−)	
Oregon	$53,427	☑	$338	$56,119	☑	$370	Yes
Region 1	—	—	—	—	—	—	—
Clatsop	$47,325	☑	$1,892	$49,828	☑	$1,932	No
Coos	$40,647	☑	$2,175	$40,848	☑	$1,581	No
Curry	$41,020	☑	$2,433	$42,519	☑	$6,221	No
Lincoln	$44,678	☑	$1,930	$43,291	☑	$1,854	No
Tillamook	$45,102	☑	$1,776	$45,061	☑	$2,463	No

Notes: 2012 dollars are adjusted for 2017 dollars. Data not aggregated at the regional level.

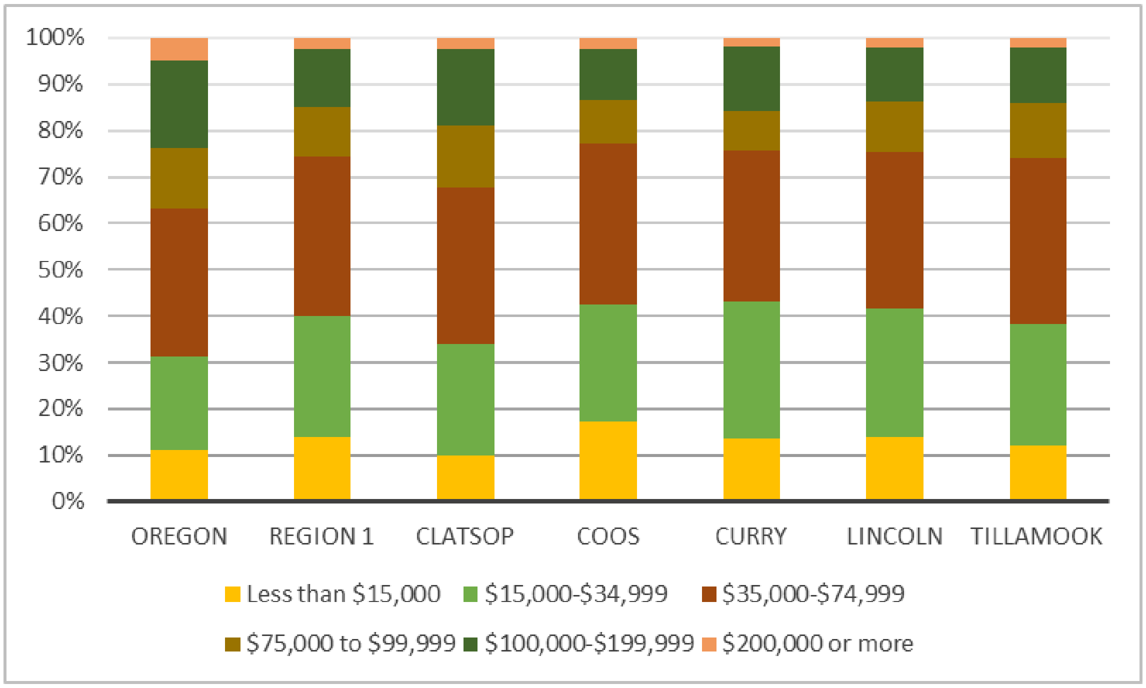
*Yes indicates that the 2013-2018 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates the two estimates are not statistically different.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% – use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau. 2008-2002 and 2013-2017. American Community Survey – 5-Year Estimates. Table CP03.

Approximately 40% of Region 1 households earn less than $35,000 per year. Clatsop County has the highest percentage of households in the top income brackets, earning more than $75,000. Compared to the statewide estimate, a smaller percentage—by approximately eleven percentage points—of households in coastal counties are in the top income brackets.

Figure 2-119. Median Household Income Distribution in Region 1



Source: U.S. Census Bureau, 2013-2017, American Community Survey 5-Year Estimates, Table DP03

The American Community Survey uses a set of dollar value thresholds that vary by family size and composition to determine who is in poverty (U.S. Census Bureau, 2018). Moreover, poverty thresholds for people living in nonfamily households vary by age—under 65 years or 65 years and older (U.S. Census Bureau, 2018). A greater share of the regional population is living in poverty compared to the state as a whole. The same is true for all counties in the region, with the exception of Clatsop County. Among the coastal counties, Lincoln County has the greatest percentage of residents living in poverty. The county share increased by more than two percentage points from 2012 to 2017. Conversely, poverty in Clatsop County declined by a statistically significant amount—approximately three and a half percentage points—during that same period.

A greater proportion of children in coastal communities are living in poverty than in the state as a whole; there is a four percentage point difference between the coastal and the statewide share. From 2012 to 2017, child poverty decreased by over ten percentage points in Clatsop County—a statistically significant amount. Conversely, in Lincoln County, child poverty increased by ten percentage points.

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster, mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources.

Table 2-86. Poverty Rates in Region 1

	Total Population in Poverty						
	2008–2012			2013–2017			Statistical Difference?*
	Estimate	CV**	MOE (+/–)	Estimate	CV**	MOE (+/–)	
Oregon	15.5%	✓	0.3%	14.9%	✓	0.3%	No
Region 1	16.3%	✓	0.9%	16.3%	✓	1.0%	No
Clatsop	15.8%	✓	1.8%	12.2%	✓	1.6%	Yes
Coos	17.3%	✓	1.7%	17.9%	✓	2.1%	No
Curry	13.7%	✓	2.4%	15.5%	✓	2.7%	No
Lincoln	16.0%	✓	1.6%	18.4%	✓	1.7%	Yes
Tillamook	17.2%	✓	2.6%	15.5%	✓	2.4%	No

*Yes indicates that the 2013-2017 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates that the 2013-2017 estimate is not significantly different from the 2008-2012 estimate.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau. 2008-2012 and 2013-2017. American Community Survey – 5-Year Estimates, Table S1701

Table 2-87. Child Poverty in Region 1

	Children Under 18 in Poverty						
	2008–2012			2013–2017			Statistical Difference?*
	Estimate	CV**	MOE (+/–)	Estimate	CV**	MOE (+/–)	
Oregon	20.6%	✓	0.5%	19.0%	✓	0.6%	Yes
Region 1	22.6%	✓	2.2%	23.4%	✓	2.6%	No
Clatsop	25.0%	✓	4.8%	14.6%	⊙	3.7%	Yes
Coos	23.1%	✓	3.9%	25.2%	✓	5.6%	No
Curry	14.8%	⊙	5.6%	20.6%	⊙	9.6%	No
Lincoln	20.5%	✓	4.4%	30.4%	✓	4.9%	Yes
Tillamook	26.7%	⊙	6.8%	22.9%	⊙	5.7%	No

* Yes indicates that the 2013-2017 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates that the 2013-2017 estimate is not significantly different from the 2008-2012 estimate.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau. 2008-2012 and 2013-2017. American Community Survey – 5-Year Estimates, Table S1701

Housing Tenure

Housing tenure, which captures whether someone owns or rents their home, has long been understood as a determinant of social vulnerability (Cutter, Boruff, & Shirley, 2003). Renters generally experience more housing challenges than homeowners; natural disasters frequently exacerbate those hardships (Lee & Van Zandt, 2019).

Homeownership is correlated with greater wealth, which can increase the ability to recover following a natural disaster (Cutter, Boruff, & Shirley, 2003). Renters often do not have personal financial resources or insurance to help recover post-disaster; they also frequently cannot access the same federal monies homeowners typically leverage following a disaster. They also might lack social resources, such as the ability to influence neighborhood decisions (Lee & Van Zandt, 2019).

Renters tend to be more mobile and have fewer assets at risk, however those assets might be more difficult to replace due to insufficient income. Renters typically have fewer options in terms of temporary shelter following a disaster and are less likely to stay with a relative or friend than in a public or mass shelter (Lee & Van Zandt, 2019).

The quality of construction for multi-family housing—more often rental—tends to be lower and is therefore more vulnerable to destruction during a disaster (Lee & Van Zandt, 2019). Moreover, renters have less ability to make improvements or alterations to their dwellings to enhance durability and structural safety (Lee & Van Zandt, 2019). Following a disaster, rental housing—especially affordable and subsidized housing—is frequently rebuilt more slowly, if at all (Lee & Van Zandt, 2019).

Oregon's coastal counties have a slightly greater percentages of homes that are owner-occupied than the state as a whole. Tillamook County has the greatest percentage of owner-occupied homes in the region. Clatsop County has the greatest percentage of renters.

Table 2-88. Housing Tenure in Region 1

	Total Occupied Units	Owner Occupied			Renter Occupied		
		Estimate	CV**	MOE (+/−)	Estimate	CV**	MOE (+/−)
Oregon	1,571,631	61.7%	☑	0.3%	38.3%	☑	0.3%
Region 1	83,959	64.8%	☑	1.2%	35.2%	☑	1.1%
Clatsop	15,976	61.1%	☑	2.1%	38.9%	☑	2.1%
Coos	26,473	65.2%	☑	1.9%	34.8%	☑	1.9%
Curry	10,382	67.5%	☑	2.9%	32.5%	☑	2.9%
Lincoln	20,674	63.6%	☑	1.9%	36.4%	☑	1.9%
Tillamook	10,454	69.2%	☑	2.5%	30.8%	☑	2.5%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table DP04: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from: data.census.gov

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Living alone can also be a risk factor—especially in poorer communities that lack adequate social infrastructure (Klinenberg, 2016). The American Community Survey defines a family household as one that contains a householder and one or more other people living in the same unit who are related by birth, marriage, or adoption. Conversely, a nonfamily household is one where someone is either living alone, or with nonrelatives only. While the majority of households in Region 1 are family households, every county in the region has a smaller proportion of family households compared to the statewide estimate. The region also has a smaller share of households with children compared to the statewide proportion; roughly one fifth of all family households in the region have children versus a quarter of all households in the state. The region's percentage of single-parent households is slightly lower than the state average but is still approximately 7% of family households

Table 2-89. Family vs. Non-Family Households in Region 1

	Total Households	Family Households			Nonfamily Households			Householder Living Alone		
	Estimate	Estimate	CV**	MOE (+/−)	Estimate	CV**	MOE (+/−)	Estimate	CV**	MOE (+/−)
Oregon	1,571,631	63.3%	☑	0.2%	36.7%	☑	0.2%	27.7%	☑	0.2%
Region 1	83,959	60.6%	☑	1.2%	39.4%	☑	1.2%	32.4%	☑	1.1%
Clatsop	15,976	60.6%	☑	2.1%	39.4%	☑	2.1%	32.2%	☑	1.8%
Coos	26,473	62.5%	☑	1.9%	37.5%	☑	1.9%	32.1%	☑	1.9%
Curry	10,382	55.8%	☑	3.3%	44.2%	☑	3.3%	36.3%	☑	3.5%
Lincoln	20,674	59.8%	☑	1.8%	40.2%	☑	1.8%	31.9%	☑	1.7%
Tillamook	10,454	62.1%	☑	3.3%	37.9%	☑	3.3%	30.8%	☑	3.1%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau. 2013-2017 American Community Survey. https://data.census.gov/cedsci/. Table DP02: Selected Social Characteristics

Table 2-90. Family Households with Children by Head of Household in Region 1

	Family Households with Children			Single Parent (Male or Female)		
	Estimate	CV**	MOE (+/−)	Estimate	CV**	MOE (+/−)
Oregon	26.2%	✓	0.2%	8.1%	✓	0.2%
Region 1	19.2%	✓	0.8%	7.1%	✓	0.6%
Clatsop	22.6%	✓	1.6%	7.7%	✓	1.3%
Coos	21.1%	✓	1.5%	7.4%	✓	1.3%
Curry	14.5%	✓	2.7%	5.2%	⊙	1.9%
Lincoln	15.9%	✓	1.2%	6.8%	✓	1.0%
Tillamook	20.3%	✓	1.9%	7.5%	✓	1.6%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau. 2013-2017 American Community Survey. https://data.census.gov/cedsci/. Table DP02: Selected Social Characteristics. 2013-2017 American Community Survey 5-Year Estimates

Social and Demographic Trends

The demographic analysis shows Region 1 is particularly vulnerable to a hazard event in the following ways:

- The region has a large number of tourists, with Lincoln County receiving the largest single-county share.
- A higher percentage of the overall population has a disability compared to the statewide estimates. Moreover, a higher percentage of vulnerable age groups (< 18) and (≥ 65) have a disability compared to the statewide estimates.
- Homelessness has increased in the region over the past three years. Moreover, the majority of families experiencing homelessness—over 3,000 people—live in coastal counties and southern Oregon.
- The region has a higher percentage of older adults (≥ 65) compared to the state
- Educational attainment is lower in all coastal counties compared to statewide estimates.
- Median household income is approximately $6,000 to $15,000 lower than the statewide median. Moreover, no county in the region has experienced a statistically significant change in median income.
- A higher percentage of Region 1 residents are in the bottom income brackets, earning less than $35,000 annually, compared to the state

Economy

The impact of natural hazards on economic conditions depends on many variables. For example the vulnerability of businesses' labor, capital, suppliers, and customers are all relevant factors (Zhang, Lindell, & Prater, 2009). Some industries rebound quickly and even thrive following a disaster, manufacturing and construction, for example. Others, like wholesale and retail, rebound more slowly or never recover (Zhang, Lindell, & Prater, 2009). Economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how employment sectors, workforce participants, financial and natural resources, and critical infrastructure are interconnected and interdependent.

Employment and Unemployment

Natural disasters do not impact all labor market participants equally. Unemployed and underemployed populations are disproportionately affected by disaster events. Research shows that employment outcomes can be especially bad for people physically displaced by a disaster (Karoly & Zissimopoulos, 2010). Moreover, those who are unemployed and many employed in low-wage positions lack access to employee benefit plans that provide income and healthcare supports (Flanagan, Gregory, Hallisey, Heitgerd, & Lewis, 2011). Income deprivation and inaccessible healthcare, ruinous in the best of times, are felt more severely following a disaster. It is important for local policy makers to understand existing labor force characteristics and existing market trends to build a resilient workforce and mitigate the scope and intensity of disruptions and economic pain.

Unemployment rates across Region 1 have been steadily declining since they peaked in 2010 during the Great Recession. The counties in the north coast consistently have lower rates than the counties in the central and southern parts of the state; however, rates in these counties are near record lows (2019, May 29). Nevertheless, Curry County has the highest unemployment rate in the region and the smallest labor force. Coos County has the largest labor force in the region but has the second highest unemployment rate.

Table 2-91. Civilian Labor Force in Region 1, 2018

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	2,104,516	2,017,155	95.8%	87,361	4.2%
Region 1	87,824	83,491	95.1%	4,333	4.9%
Clatsop	19,344	18,549	95.9%	795	4.1%
Coos	26,460	25,027	94.6%	1,433	5.4%
Curry	8,948	8,399	93.9%	549	6.1%
Lincoln	21,215	20,184	95.1%	1,031	4.9%
Tillamook	11,857	11,332	95.6%	525	4.4%

Source: Oregon Employment Department, 2019

Table 2-92. Civilian Unemployment Rates in Region 1, 2014-2018

	2014	2015	2016	2017	2018	Change (2014-2018)
Oregon	6.8%	5.6%	4.8%	4.1%	4.2%	−2.6%
Region 1	8.0%	6.7%	5.7%	4.9%	4.9%	−3.1%
Clatsop	6.6%	5.5%	4.7%	4.1%	4.1%	−2.5%
Coos	9.0%	7.4%	6.4%	5.5%	5.4%	−3.6%
Curry	10.1%	8.2%	6.7%	6.1%	6.1%	−4.0%
Lincoln	7.8%	6.6%	5.6%	4.8%	4.9%	−2.9%
Tillamook	6.9%	5.6%	4.9%	4.2%	4.4%	−2.5%

Source: Oregon Employment Department, 2019

Supersectors and Subsectors

The North American Industry Classification System (NAICS) is a framework used by the United States, Canada, and Mexico to collect, analyze, and publish data about the North American economy. The classification system groups “economic units that have similar production processes” according to a six-digit hierarchical structure (Office of Management and Budget, n.d.). “The first two digits of the code designate the sector, the third digit designates the subsector, the fourth digit designates the industry group, the fifth digit designates the NAICS industry, and the sixth digit designates the national industry” (Office of Management and Budget, n.d.). The U.S. Bureau of Labor Statistics through its Quarterly Census of Employment and Wages program adds to the NAICS hierarchy by grouping NAICS sectors into supersectors (U.S. Bureau of Labor Statistics, 2019, Dec. 20). This plan looks at regional economic activity through these supersectors and then through three-digit NIAICS subsectors.

In 2018 the five major supersectors by share of employment in Region 1 were:

1. Leisure and Hospitality
2. Trade, Transportation and Utilities
3. Local Government
4. Education and Health Services
5. Manufacturing

Identifying supersectors with a large number of business establishments and targeting mitigation strategies to support them can help the region’s resiliency. A business establishment is an “economic unit… that produces goods or provides services. It is typically at a single physical location and engaged in one, or predominantly one, type of economic activity” (U.S. Bureau of Labor Statistics, 2019, Sept. 4). In Region 1, the following supersectors comprise a significant share of all business establishments.

- The Trade, Transportation, and Utilities supersector includes the highest number of establishments in Region 1, 18% of all business units (QCEW, 2018).
- Other Services is the second largest, with 15.5% of all business establishments (QCEW, 2018).
- The Leisure and Hospitality supersector follows closely with 15.1% of the regional share (QCEW, 2018).
- Professional and Business comprises 10% of all business establishments (QCEW, 2018)

- The Construction sector is the fifth largest, making up 9% of all establishments (QCEW, 2018).

While supersectors are useful abstractions, it's important to remember that within each supersector are many small businesses employing fewer than 20 employees (Valdovinos, 2020). Due to their small size, these businesses are particularly sensitive to disruptions that may occur following a natural hazard event.

Table 2-93. Covered Employment by Sector in Region 1

	Region 1	Clatsop County		Coos County		Curry County		Lincoln County		Tillamook County	
Industry	Percent	Employment	Percent	Employment	Percent	Employment	Percent	Employment	Percent	Employment	Percent
Total All Ownerships	100.0%	18,808	100.0%	23,091	100.0%	6,579	100.0%	18,516	100.0%	9,654	100.0%
Total Private Coverage	80.6%	16,120	85.7%	17,647	76.4%	5,338	81.1%	14,804	80.0%	7,856	81.4%
Natural Resources & Mining	3.4%	334	1.8%	944	4.1%	288	4.4%	306	1.7%	751	7.8%
Construction	4.5%	947	5.0%	959	4.2%	398	6.0%	814	4.4%	367	3.8%
Manufacturing	8.9%	1,757	9.3%	1,726	7.5%	669	10.2%	1,098	5.9%	1,555	16.1%
Trade, Transportation & Utilities	17.9%	3,514	18.7%	4,265	18.5%	1,180	17.9%	3,358	18.1%	1,425	14.8%
Information	0.7%	143	0.8%	173	0.7%	54	0.8%	149	0.8%	50	0.5%
Financial Activities	3.0%	607	3.2%	672	2.9%	210	3.2%	615	3.3%	199	2.1%
Professional & Business Services	6.0%	828	4.4%	2,063	8.9%	276	4.2%	1,055	5.7%	403	4.2%
Education & Health Services	12.8%	2,386	12.7%	3,341	14.5%	793	12.1%	2,117	11.4%	1,148	11.9%
Leisure & Hospitality	19.5%	4,873	25.9%	2,704	11.7%	1,222	18.6%	4,659	25.2%	1,506	15.6%
Other Services	3.7%	726	3.9%	798	3.5%	245	3.7%	620	3.3%	451	4.7%
Unclassified	0.0%	5	0.0%	2	0.0%	3	0.0%	14	0.1%	2	0.0%
Total All Government	19.4%	2,689	14.3%	5,443	23.6%	1,241	18.9%	3,711	20.0%	1,799	18.6%
Total Federal Government	1.3%	203	1.1%	313	1.4%	90	1.4%	319	1.7%	106	1.1%
Total State Government	1.9%	309	1.6%	459	2.0%	112	1.7%	292	1.6%	306	3.2%
Total Local Government	16.1%	2,177	11.6%	4,672	20.2%	1,038	15.8%	3,100	16.7%	1,387	14.4%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department. (2019). Quarterly Census of Employment and Wages. Retrieved from Qualityinfo.org

Each supersector faces distinct vulnerabilities to natural hazards. Identifying a region's dominant supersectors and the underlying industries enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment supersectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Retail businesses are concentrated in the larger cities of the region and disruption of the transportation system could sever the connectivity between people living throughout the region and these retail hubs.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. Following a natural disaster, residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Education and Health Services: The importance of Health and Social Assistance industries is underscored in Region 1 because of the significant share of older adults and individuals with a disability. Health care is a relatively stable revenue sector regionally with an abundant distribution of businesses primarily serving a local population. Following a disaster, Health and Social Assistance industries will play important roles in emergency response and recovery.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons, the manufacturing sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are frequently less dependent on local markets for sales, which may contribute to the economic resilience of this sector.

Looking at industrial subsectors (three-digit NAICS) provides greater detail about the regional economy while maintaining a level of aggregation useful for analysis. The table below shows the top ten industries by share of employment within the region. In Region 1, the two largest subsectors by share of employment are Food Services and Drinking Places and Accommodation; both subsectors fit within the region's largest supersector by share of employment, Leisure and Hospitality. These subsectors also constitute the largest employers across the states. More unique to the region is the high percentage of employment in Food Manufacturing subsector.

Table 2-94. Industries with Greatest Share of Employment in Region 1, 2018

Industry	Employment Share	Employment (2018)
Food Services and Drinking Places	14%	11,587
Accommodation	9%	7,388
Educational Services	6%	5,106
Administrative and Support Services	5%	3,734
Ambulatory Health Care Services	4%	3,419
Hospitals	4%	3,297
Food Manufacturing	4%	2,918
Food and Beverage Stores	3%	2,714
Social Assistance	3%	2,609
Executive, Legislative, and Other General Government Support	3%	2,567

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for employment share and average employment by DLCD

Industry Concentration and Employment Change

A location quotient (LQ) is a metric used to identify a region's area of industrial specialization. It is calculated by comparing an industry's share of regional employment with its share of employment in a reference economy (Quinterno, 2014). If a LQ is higher than 1.0, employment in that industry is more concentrated in that region than in the reference economy. In this case, the reference economy is the United States as a whole. Industries with a high LQ indicate the region might have a competitive advantage and that the industry is potentially—but not always—exporting goods and services. Understanding regional competitiveness and targeting mitigation strategies that make exporting industries less vulnerable can help the region's resiliency. Location quotients, however, require careful interpretation; analysis of employment data should be paired with local knowledge of regional business dynamics.

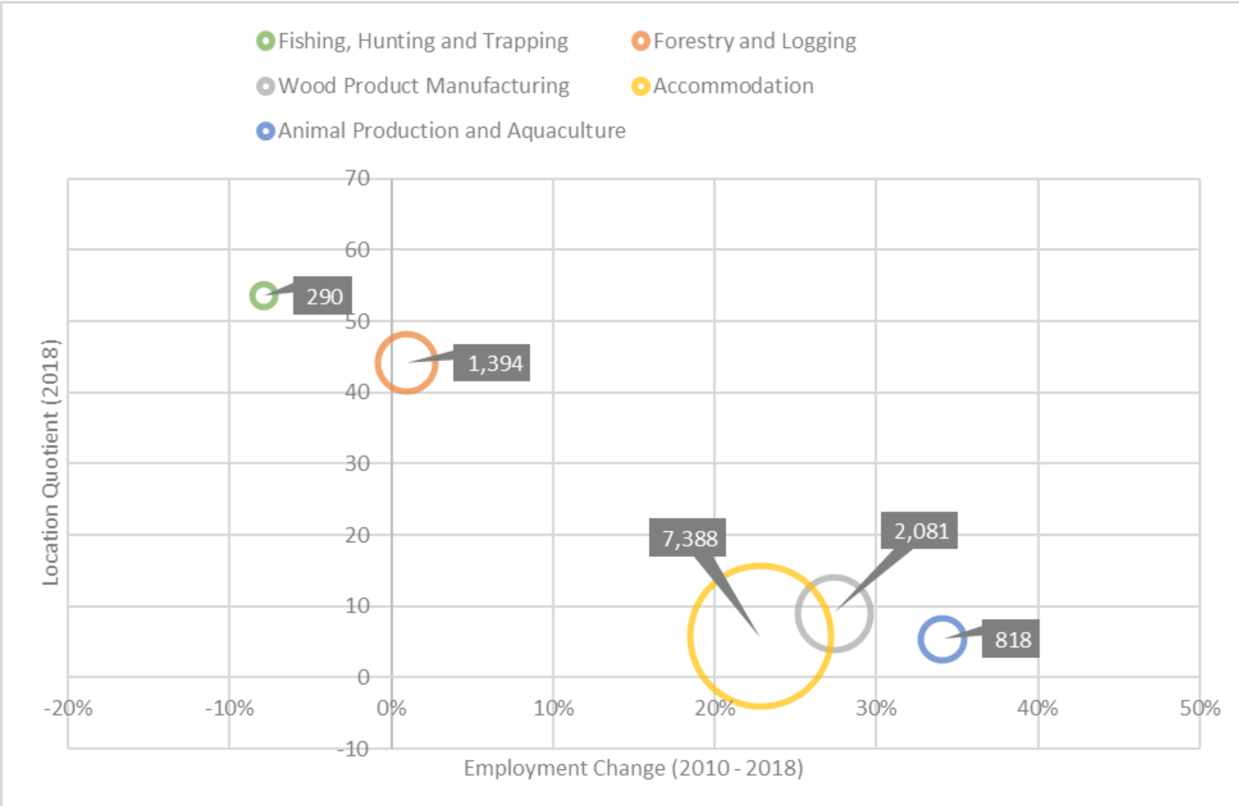
Table 2-95. Most Concentrated Industries and Employment Change in Region 1, 2018

Industry	Location Quotient	Employment	Employment Change (2010–2018)
Fishing, Hunting and Trapping	53.6	290	−8%
Forestry and Logging	44.1	1,394	1%
Wood Product Manufacturing	8.9	2,081	27%
Accommodation	5.9	7,388	23%
Animal Production and Aquaculture	5.4	818	34%

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018), Retrieved from: https://ledextract.ces.census.gov/static/data.html; Calculations for location quotient, average employment, and employment change by DLCD

In addition to an industry's LQ value, it is important to consider the number of jobs and whether the industry is growing or declining. The scatter plot below presents this information for the five industries in Region 1 with the highest LQ values. It shows the percent change in employment over the last eight years, the total number of employees in the industry, and the LQ value.

Figure 2-120. Location Quotients, Employment Change, and Total Employment in Region 1, 2018



Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018), Retrieved from: https://ledextract.ces.census.gov/static/data.html; Calculations for location quotient, average employment, and employment change by DLCD

Four of the region's five most concentrated industries are natural resource based. Fishing, Hunting, and Trapping is much more concentrated in the region vis-à-vis the nation. The sector represents a small share of overall regional employment, however, and shed jobs over the last eight years. The Forestry and Logging industry is also much more concentrated in Region 1 than the nation. From 2010 to 2018, employment remained relatively constant in the sector. Wood Manufacturing is a related area of competitive advantage; moreover, the industry is one of the larger employers and experienced significant growth in the past eight years.

Fastest Growing and Declining Industries

Empirical analysis suggests that natural disasters can accelerate preexisting economic trends (Zhang, Lindell, & Prater, 2009). Therefore, it is important for local planners to understand their region's existing economic context, which industries are growing and which are declining. Between 2010 and 2018, the Private Households and Beverage and Tobacco Product Manufacturing industries experienced significant increases in employment within the region—both also have more than one-hundred employees. Growth in the Beverage and Tobacco Product Manufacturing industry is likely driven by Oregon's thriving craft-beer scene, which continues to grow despite a crowded market (Lehner, 2020). The Private Households industry employs workers "that work on or about the household premises…such as cooks, maids, butlers, gardeners, personal caretakers, and other maintenance workers" (Wallis, 2019). The increase in employment in the Private Households industry mirrors a statewide trend (Wallis, 2019). Demand is driven in part by an aging population's need for in-home care workers (Wallis, 2019). Continuing a decade's long statewide trend, the Paper Manufacturing industry in Region 1 shed nearly nine-hundred positions from 2010 to 2018 (Knoder, Paper cuts: Oregon's declining paper industry, 2018, December 6). Increased competition from abroad is a key driver of employment loss statewide (Knoder, Paper cuts: Oregon's declining paper industry, 2018, December 6).

Table 2-96. Fastest Growing and Declining Industries in Region 1, 2010-2018

Industry	Employment Change	Employment (2010)	Employment (2018)
Fastest Growing			
Warehousing and Storage	497%	8	48
Performing Arts, Spectator Sports, & Related Industries	387%	13	65
Other Information Services	127%	37	83
Private Households	127%	333	757
Beverage and Tobacco Product Manufacturing	126%	120	270
Fastest Declining			
Paper Manufacturing	−100%	875	0
Air Transportation	−100%	68	0
Plastics and Rubber Products Manufacturing	−100%	31	0
Textile Product Mills	−100%	25	0
Furniture and Related Product Manufacturing	−72%	23	6

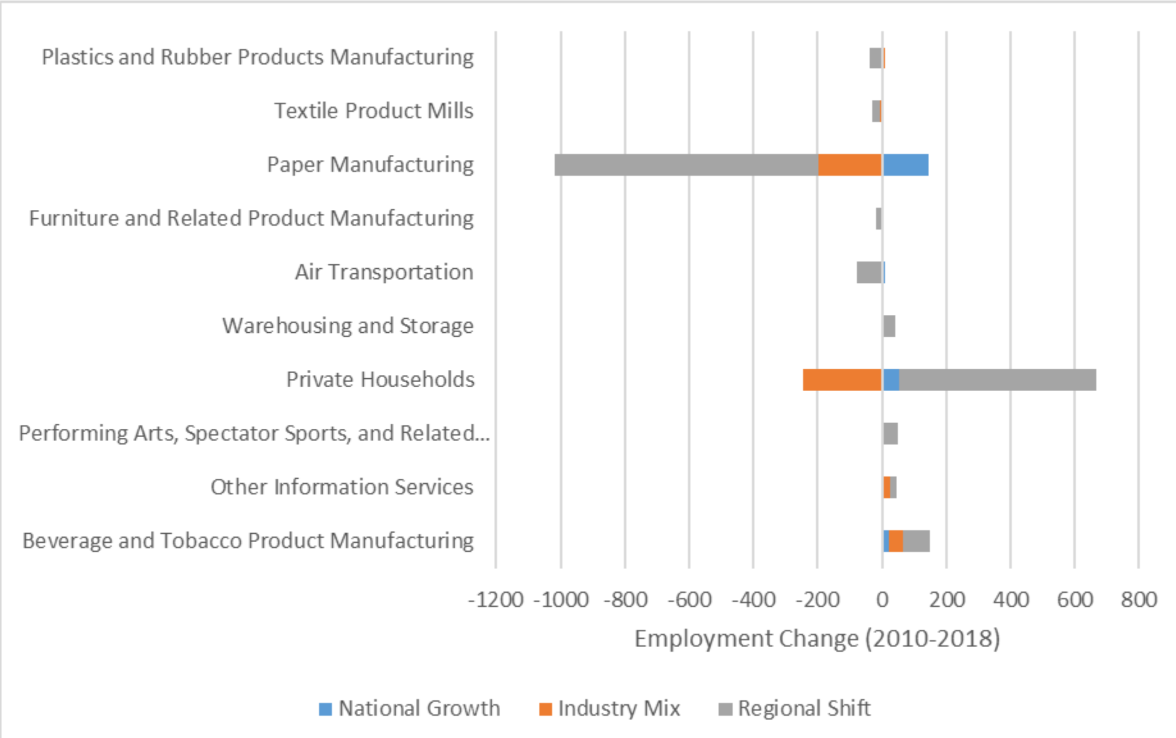
U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for average annual employment, and employment change by DLCD

Employment change can be caused by internal and external factors. The shift-share analysis helps us understand and separate regional and national influences on a local industry. There are three separate elements to the analysis that attempt to account for local and national forces. The national-share controls for the broad growth of the national economy; the industry-mix controls for broad national changes within an industry being analyzed; and the local-factor tries to explain what portion of employment change can be attributed to local factors.

The bar chart below depicts a shift-share analysis for Region 1's fastest growing and declining industries. As mentioned previously, the paper manufacturing industry shed 875 jobs from 2010 to 2018. If during this period the industry had kept pace with national economic growth (across all industries), the region would have 144 additional Paper Manufacturing jobs. If employment losses had mirrored changes in the Paper Manufacturing industry nationwide, there would only be 199 fewer Paper Manufacturing jobs in the region. This indicates that vast majority, 821 positions, were lost due to some regional factors, such as a factory closing.

Much of the growth (613 jobs) in the regional Private Household industries can be attributed to regional factors, again, likely driven by an aging population. Although some of the expansion in the Beverage and Tobacco Product Manufacturing industry can be understood by growth in the industry nationwide (44 jobs), the majority of employment was unique to the region (87 jobs); again, this is likely an indication of Oregon's booming craft beer business.

Figure 2-121. Shift-Share-Analysis of Fastest Growing and Declining Industries in Region 1, 2010-2018



U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for shift share by DLCD

Table 2-97. Shift-Share-Analysis of Fastest Growing and Declining Industries in Region 1, 2010-2018

Industry	Employment Change	National Growth	Industry Mix	Regional Shift
Fastest Growing				
Beverage and Tobacco Product Manufacturing	151	20	44	87
Other Information Services	47	6	19	22
Performing Arts, Spectator Sports, and Related Industries	51	2	1	48
Private Households	423	55	-245	613
Warehousing and Storage	40	1	6	32
Fastest Declining				
Air Transportation	−68	11	−4	−75
Furniture and Related Product Manufacturing	−16	4	−1	−19
Paper Manufacturing	−875	144	−199	−821
Textile Product Mills	−25	4	−5	−25
Plastics and Rubber Products Manufacturing	−31	5	1	−37

U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for shift share by

Economic Trends and Issues

Because a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly, current and anticipated financial conditions of a community are strong determinants of community resilience. The economic analysis of the region shows the following situations increase Oregon Coastal communities' level of vulnerability to natural hazard events:

- Unemployment rates are higher than the state average in Curry, Coos, and Lincoln and Tillamook Counties;
- The region's most competitive industries (according to LQ) employ a small share of the overall population;
- The regional economy is heavily dependent on tourism and seasonal employment;
- The regional economy is lacking in opportunities for highly skilled employees, limiting the income potential of coastal residents;
- Many of the region's most concentrated industries are natural resource-based or depend on natural resource industries. These sectors are especially vulnerable to the impacts of climate change;
- From 2010 to 2018, the decade's long trend of declining employment in the Paper Manufacturing subsector continued—shedding skilled manufacturing jobs in the region.

Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl, et al., 2000).

Infrastructure

Transportation

There are two primary modes of transportation in the region: highways and railroad. There are also many small airports scattered throughout the region that are used for passenger and freight service.

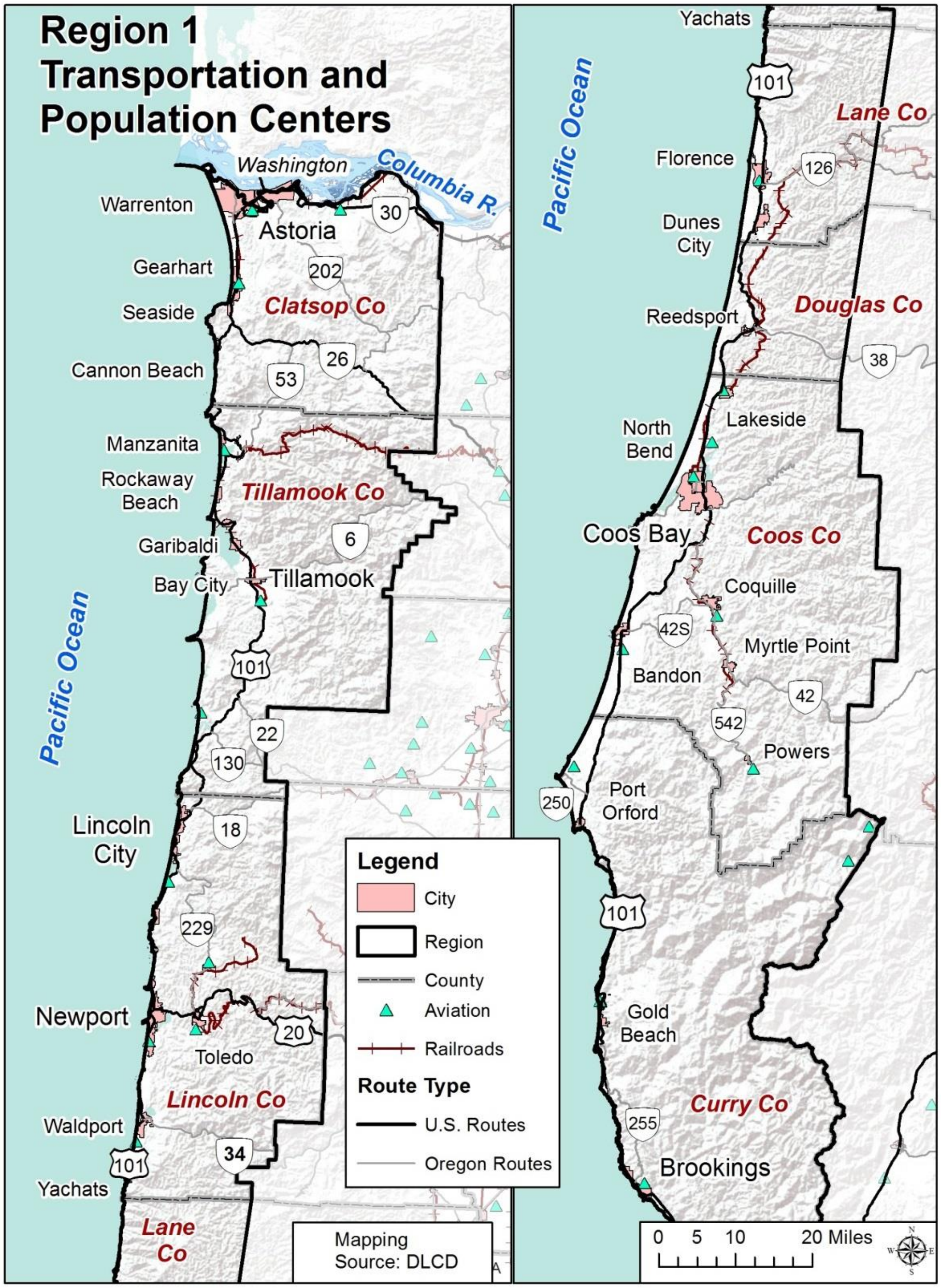
Roads

Most of the population bases in Region 1 are located along the region's major freeway, US-101. US-101 runs north-south and is the only continuous passage for automobiles and trucks traveling along the Oregon Coast. Coastal communities are connected to the interior of the state by many routes.

Natural hazards and emergency events disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuations and other emergency operations difficult. Localized flooding can render roads unusable. A severe winter storm or tsunami has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (2014, October)Seismic Plus Report (Appendix **9.1.13**), the region has high exposure to earthquakes, especially a Cascadia Subduction Zone event. Therefore, the seismic vulnerability of the region's lifelines, including roadways and bridges, is an important issue. For information on ODOT's 2012 Seismic Lifelines Report findings for Region 1, see **Seismic Lifelines**.

Figure 2-122. Region 1 Transportation and Population Centers



Source: Department of Land Conservation and Development, 2014

Bridges

ODOT lists 750 bridges in the counties that comprise Region 1.

As mentioned, the region's bridges are highly vulnerable to seismic activity. Non-functional bridges disrupt local and freight traffic, emergency operations, and sever lifelines. These disruptions exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or that are part of regional and local systems maintained by the region's counties and cities.

Table 2-98 shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. The ratings do not imply that a bridge is unsafe (ODOT, 2020). A significant improvement in the condition of the region's bridges reduced to 6% (from 29% in 2012 and 2013) the percentage of the region's bridges that are distressed or deficient. About 2% (from 42% in 2012 and 2013) of the region's ODOT bridges are distressed.

Table 2-98. Bridge Inventory for Region 1

	State Owned			County Owned			City Owned			Other Owned			Area Total		
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D
Oregon	42	2,760	2%	258	3,442	7%	30	643	5%	16	121	13%	346	6,966	5%
Region 1	6	313	2%	29	374	8%	4	22	18%	3	41	7%	42	750	6%
Clatsop	2	73	3%	4	52	8%	1	17	6%	3	9	33%	10	151	7%
Coos	0	62	0%	3	114	3%	1	2	50%	0	11	0%	4	189	2%
Curry	0	29	0%	3	31	10%	0	0	N/A	0	0	N/A	3	60	5%
Lincoln	2	73	3%	10	85	12%	2	2	100%	0	6	0%	14	166	8%
Tillamook	2	76	3%	9	92	10%	0	1	0%	0	15	0%	11	184	6%

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total of Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2020)

Railroads

Railroads that run throughout Region 1 support cargo and trade flows. All of the region's rail lines are short lines and freight routes, connecting the coast to larger rail lines and inland metropolitan areas. Curry County is the only coastal community without rail service. The region's rail providers are the Portland & Western Railroad (PNWR), Port of Tillamook Bay Railroad (POTB), and the Coos Bay Rail Link (CBRL). The PNWR lines in Clatsop County connect Astoria and the Portland Metro Area. The POTB line connects Tillamook to inland railways operated by PNWR. Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and products from other states that are shipped to and through Oregon by rail (Cambridge Systematics, 2014). Though there is no commuter rail line in the region, there is a local passenger line.

Rails are sensitive to storms. Disruptions in the rail system can result in economic losses. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

Southwest Oregon Regional Airport is the only commercial airport in the region and is the fifth busiest airport in Oregon (Federal Aviation Administration [FAA], 2012). The airport is owned, operated and administered by Coos County Airport District. It serves two hubs and two air carriers (Southwest Oregon Regional Airport, n.d.).

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-99. Public and Private Airports in Region 1

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Heliport	Private Heliport	Total
Region 1	16	6	0	10	32
Clatsop	2	1	0	4	7
Coos	4	2	0	2	8
Curry	3	2	0	1	6
Lincoln	4	1	0	2	7
Tillamook	3	0	0	1	4

Source: FAA Airport Master Record (Form 5010) (2014)

Ports

Ports in the Oregon Coast Region are a major contributor to the local, regional, and national economies. Oregon's ports have historically been used for timber transport and commercial and recreational fishing. With the decline in the timber industry, ports have evolved to embrace economic development and tourism by offering industrial land and infrastructure (river, rail, road, and air) and by promoting fresh seafood, fishing trips, and ecotourism. Oregon's coastal ports are divided by region: north, central and south (Coastal Oregon Marine Experiment Station, n.d.). The North Coast ports include: Astoria, Nehalem, and Garibaldi (including Tillamook Bay). The Astoria

Port includes facilities for cruise ships while the Port of Garibaldi/Tillamook Bay encompass more than 1,600 acres of industrial zoned land. The central coast ports include: Newport, Toledo, Alsea, and Siuslaw. The Newport and Siuslaw are active fishing ports that also provide an array of businesses catering to tourists. South coast ports include Umpqua, Coos Bay, Bandon, Port Orford, Gold Beach, and Brookings-Harbor. The Port of Coos Bay is Oregon's largest coastal deep-draft harbor and supports cargo ships that link to the Coos Bay Rail Link (Coastal Oregon Marine Experiment Station, n.d.). The Port of Brookings-Harbor is the busiest recreational port in Oregon with more than 31,000 visitor trips for more than 95,000 recreational boaters (Port of Brookings-Harbor, http://www.port-brookings-harbor.com).

Figure 2-123. Liquefied Natural Gas Pipelines in Region 1

Source: Retrieved from http://gs-press.com.au/images/news_articles/cache/Pacific_Connector_Gas_Pipeline_Route-0x600.jpg

Energy

Electricity

There are no power plants in Region 1. The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area's wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the largest investor-owned utility company serving the region. The Blachly-Lane Electric Cooperative, Coos-Curry Electric Cooperative, and Western Oregon Electric Cooperative serve portions of the region. The Bandon Municipal Utility District serves an area around the City of Bandon in Coos County. In addition, the Tillamook People's Utility District, Central Lincoln People's Utility District, and Consumers Power Inc. provide electricity for portions of Region 1.

Hydropower

There are no major dams in the Oregon Coast region, but just east of the region, in the Cascades, there are several major dams — Bonneville, Round Butte, Lookout Point, Carmen-Smith, Detroit, and Pelton dams — that combined have maximum generating capacities of over 100 megawatts of electricity that service the state (Loy, 2001).

Natural Gas

Natural gas provides about 12% of the region's energy. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. The Jordan Cove Energy Project is a proposed liquefied natural gas (LNG) storage facility and power plant within the Port of Coos Bay. If built, this facility would provide LNG storage (320,000 cubic meters), liquefaction capacity (6 million metric tons per year), and sendout capacity (1,000,000 decatherms per day) via the Pacific Connector Gas Pipeline. It would include marine facilities — a single LNG marine berth and a dedicated tractor tug dock —

and the South Dunes Power Plant capable of providing energy for the facility and the local grid (Jordan Cove Energy Project, L.P., n.d.). If developed, the pipeline would extend 235 miles through both public and private lands. **Figure 2-123** shows existing LNG pipelines (in blue) and the proposed Pacific Connector Gas Pipeline (in red) (Oregon Department of Environmental Quality, 2014). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life, safety, and environmental impacts in the case of a spill.

Utility Lifelines

Most of the Oregon Coast's oil and gas pipelines are connected to main lines that run through the Willamette Valley. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy, and is therefore crucial to consider during the natural hazard planning process. A network of electrical transmission lines, owned by Bonneville Power Administration and Pacific Power, runs through the region. Most of the natural gas Oregon uses originates in Alberta, Canada. Northwest Natural Gas serves the central portion of the Oregon Coast (Loy, 2001). These electric, oil, and gas lines may be vulnerable to severe, but infrequent, natural hazards such as earthquakes. If these lines fail or are disrupted, the essential functions of the community can become severely impaired.

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Parts of Region 1 are included in the Southern Oregon, the South Valley, and the North Coast Operational Areas under The Oregon State Emergency Alert System Plan (OEM, 2013), which also includes parts Jackson, Josephine and Klamath Counties. There is a memorandum of understanding between these counties that facilitates the launching of emergency messages for counties by Jackson County. Counties in this area can launch emergency messages by contacting the Oregon Emergency Response System (OERS) that in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communications capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The local primary stations identified as emergency messengers by the Oregon State Emergency Alert System Plan are:

- KOBI-TV Channel 36, Coos Bay;
- KOBI-TV Channel 8, Coos Bay;
- KOBI-TV Channel 25, Coos Bay; and
- KOBI-TV Channel 7, Coos Bay.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband providers serve Region 1. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is becoming more readily available in the region with a greater number of providers and service types available within major communities and along major transportation corridors such as I-5, US-199, etc. (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 1 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for Region 1 are (Oregon OEM, 2013):

- KIX-37, 162.550 MHZ, Brookings;
- WIX-32, 162.400 MHZ, Coos Bay;
- WNG-596, 162.425 MHZ, Port Orford;
- WNG-674, 162.525 MHZ, Florence;

- WZ-2509, 162.525 MHZ, Reedsport;
- KIH-33, 162.550 MHZ, Newport;
- WWF-95, 162.475 MHZ, Tillamook;
- KOGL, 89.3 MHZ, Gleneden Beach;
- KTMK, 91.1 MHZ, Tillamook; and
- KWAX-FM, 91.3 MHZ, Toledo.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 1 is served by Amateur Radio Emergency Service (ARES) District 5. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 1 include (American Relay Radio League Oregon Chapter, www.arrloregon.org):

- Clatsop County: WA7FIV, KD7IBA;
- Tillamook County: KF7ARK;
- Lincoln County: none available at this time;
- West Lane County: K7BHB;
- Douglas County: K7AZW;
- Coos County: KE7EIB; and
- Curry County: W7VN.

Water

Drinking water, stormwater, and wastewater systems all possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 1 the majority of the municipal drinking water supply is primarily obtained from surface water. Each county's water is drawn from several major waterways, including the Youngs, Nehalem, Wilson, Nestucca, Siletz, Yaquina, Alsea, Siuslaw, Umpqua, Coos, Coquille, and Rogue Rivers. Most urbanized areas also have infrastructure for groundwater wells in case of a surface water shortage. Because of high levels of turbidity in streams during heavy rain events, many communities are investing in new well fields. However, groundwater drawn within the floodplain is often heavy in iron, causing undesirable odor and taste, although no health risks have been associated with heavy iron levels. Earthquakes pose a major threat to the region's water supply because of the risk of dam failure at the region's reservoirs.

Rural residents may get water primarily from groundwater wells. These wells generally have low flow levels due to the region's predominantly volcanic soils. Areas with sedimentary and volcanic soils may be subject to high levels of arsenic, hydrogen sulfide, and fecal coliform bacteria, which can impact the safety of groundwater sources, although the coast is less subject to concerns about arsenic than inland areas of Oregon.

Water rights for rivers and streams in the region have reached a tipping point due to low summer water flows. New water rights cannot be purchased in Region 1. However, conservation approaches now allow landowners to share or sell a portion of their water rights to downstream users. To supplement high demand during summer irrigation, many farmers in the region are turning to above-ground water storage gathered from streams in the winter.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion, and sedimentation. DEQ, ODA, and ODF have programs in place to address water quality concerns caused by land management practices that are nonpoint sources of pollution. However, there continue to be on the 303d list and the Pesticide Stewardship Partnerships identified waterbodies that are not meeting water quality standards and pesticide benchmarks. More work is needed to address these. In general ODA's water quality rules and plans and its Confined Animal Feeding Operations (CAFO) program do provide some protection. However, the CAFO program is designed to provide water quality protection for up to a certain design storm, not for a major flood or other natural hazard event. In addition, the data defining the design storm need to be updated to provide the intended protection. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways.

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, thus limiting access to potable water. This can lead to unsanitary conditions that may threaten human health and limit fire suppression. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enters surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers) flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 1, most local building codes and stormwater management plans emphasize use of centralized storm sewer systems to manage stormwater. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, lower speeds, and lower temperatures. No jurisdictions in Region 1 refer to LID techniques in their stormwater management plans. Requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to flooding and seismic events, among other hazards.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack, or poor condition, of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance in infrastructure systems help create system resiliency (Meadows, 2008).

The effects of road, bridge, rail, and airport failures on the economy and residents could be devastating. Of special concern is the impact to US-101 and bridges following a Cascadia earthquake event and resulting tsunami. This infrastructure is at risk of damage, collapse, and blockage by landslides, flooding, and debris.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. Transmission lines extend long distances to provide the region with power, making the system and region more vulnerable to possible disruptions and infrastructure damage during a disaster event. The proposed Jordan Cove LNG facility, if developed, would provide a local energy supply.

Multiple telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services do not cover many rural areas of the region that are distant from the region's major transportation corridor along US-101. This may present a communication challenge in the wake of a disaster. Encouraging residents to keep AM/FM radios available for emergency situations could aid in communicating important messages throughout the region.

Older centralized water systems are particularly vulnerable to hazard events. The region is also at risk of pollutants entering waterways through stormwater runoff and combined sewer overflows (CSOs) during high-water events. The implementation of decentralized LID stormwater systems can increase the region's capacity to better manage high-precipitation events.

Built Environment

Settlement and Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is the 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (DLCD, https://www.oregon.gov/lcd/OP/Pages/Goal-7.aspx).

Urbanization and Population Distribution

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Jurisdictions are designated urban or rural after each decennial census. The 2020 Census is currently underway; therefore, the data in **Table 2-100**and **Table 2-101** remain from the 2010 Census.

Over the 10 year period between 2000 and 2010, growth in urban areas in Region 1 was only half that of the state. However, two counties — Curry and Tillamook — experienced more than 30% urban growth. Rural development in the coastal communities decreased by 3% overall, growing only slightly in Lincoln and Coos Counties. Notably, rural populations declined by 22% in Curry County.

The percent growth of housing units in urban areas was twice that in rural areas. Curry and Tillamook Counties experienced at least 3 times more urban growth than other counties in the region. Lincoln and Tillamook Counties experienced the most growth in rural housing units.

Unsurprisingly, populations tend to cluster around major road corridors and waterways. Population centers include the Cities of Astoria, Tillamook, Newport, Florence, Coos Bay, Brookings, and some unincorporated areas. The population distribution in Region 1 is presented in **Figure 2-124.**

Table 2-100. Urban and Rural Populations in Region 1, 2010

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	−0.1%
Region 1	103,534	111,575	7.8%	84,753	82,155	−3.1%
Clatsop	20,976	22,604	7.8%	14,654	14,435	−1.5%
Coos	38,999	38,864	-0.3%	23,780	24,179	1.7%
Curry	10,030	13,702	36.6%	11,107	8,662	−22.0%
Lincoln	27,640	28,730	3.9%	16,839	17,304	2.8%
Tillamook	5,889	7,675	30.3%	18,373	17,575	−4.3%

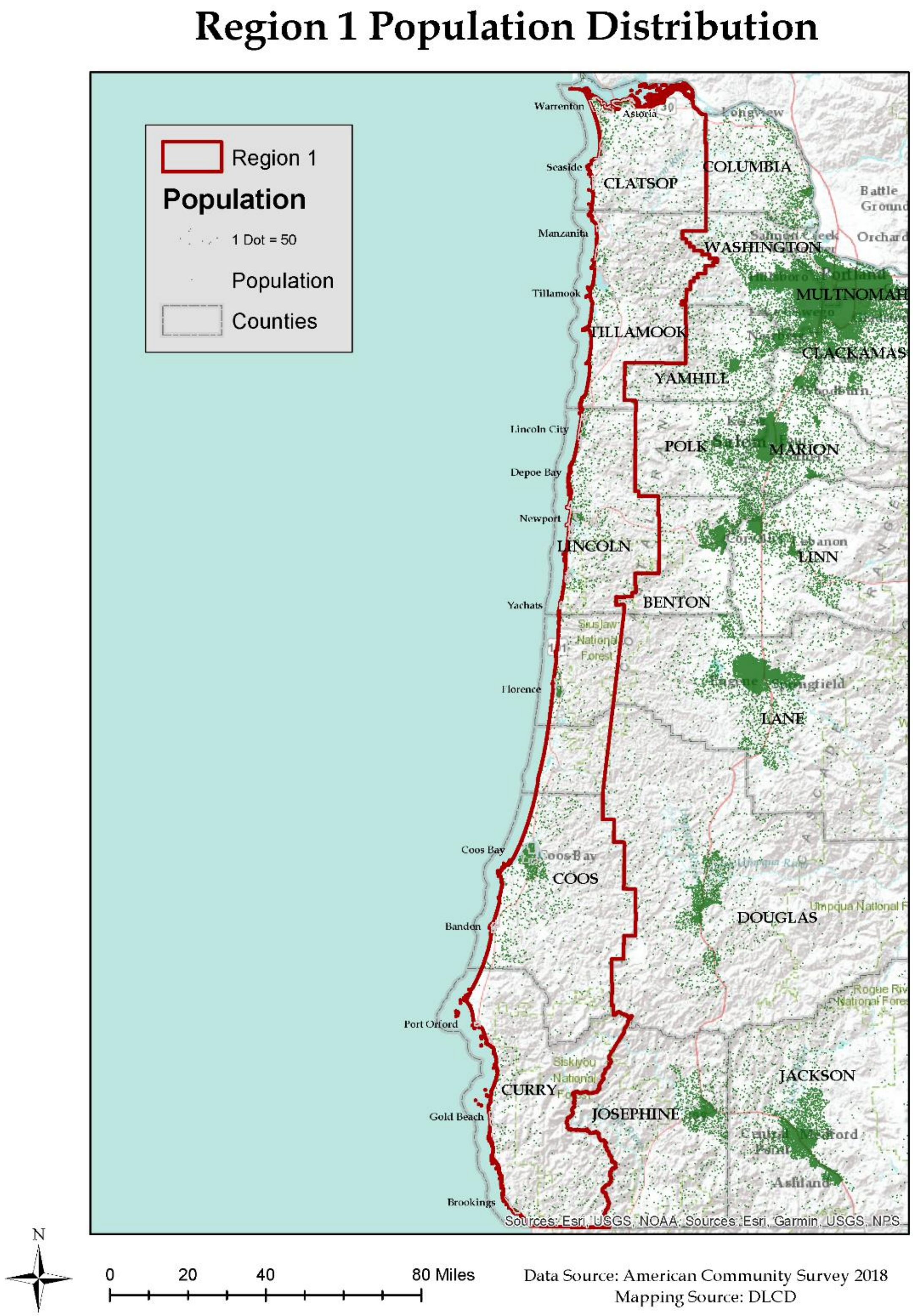
U.S. Census Bureau (n.d.). 2010 Decennial Census, Table P2

Table 2-101. Urban and Rural Housing Units in Region 1, 2010

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 1	54,599	61,938	13.4%	48,534	51,783	6.7%
Clatsop	11,639	12,866	10.5%	8,046	8,680	7.9%
Coos	17,957	18,578	3.5%	11,290	12,015	6.4%
Curry	5,331	7,428	39.3%	6,075	5,185	−14.7%
Lincoln	17,152	19,534	13.9%	9,737	11,076	13.8%
Tillamook	2,520	3,532	40.2%	13,386	14,827	10.8%

Source: Source: U.S. Census Bureau (n.d.). 2010 Decennial Census, Table H2

Figure 2-124. Region 1 Population Distribution



Source: U.S. Census Bureau, American Community Survey, 2014-2018 5YR

Housing Development

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. **Table 2-102** provides a breakdown by county of housing types: single-family, multi-family, and manufactured housing. Note: The total housing units value also includes boats, RVs, vans, etc. that are used as a residence. These homes are not included in the table as a separate category because they represent a small percentage of the overall housing profile. Consequently, adding the percentages horizontally for the state, region, and each county will not equal 100%.

Approximately 72% of the region's housing stock is single-family homes. The share of multi-family units is slightly above the share of manufactured homes across the region. In Curry County, nearly one-fifth of all homes are manufactured units. In natural hazard events such as earthquakes and floods, manufactured homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of Emergency Services, 1997). The concern is especially acute for occupants of older manufactured housing in the tsunami zone. Once shifted off of their foundations, egress can be severely compromised, potentially delaying occupants' departure for tsunami safety.

Table 2-102. Housing Profile for Region 1

	Total Housing Units	Single Family			Multi-Family			Manufactured Homes		
		Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,733,041	68.1%	✓	0.3%	23.5%	✓	0.3%	8.2%	✓	0.1%
Region 1	115,880	72.0%	✓	0.9%	14.7%	✓	0.8%	12.7%	✓	0.7%
Clatsop	22,174	73.1%	✓	2.0%	21.1%	✓	0.8%	5.6%	✓	0.8%
Coos	30,870	71.4%	✓	2.0%	12.5%	✓	1.5%	15.5%	✓	1.7%
Curry	12,847	63.5%	✓	3.3%	15.0%	✓	2.6%	19.7%	✓	2.7%
Lincoln	31,200	71.1%	✓	1.6%	15.4%	✓	1.3%	12.6%	✓	1.1%
Tillamook	18,789	79.2%	✓	2.0%	9.1%	✓	1.5%	11.5%	✓	1.4%

Notes: **Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau (2018). Table B25024: Units in Structure, 2013-2017 American Community Survey 5-year estimates. Retrieved from https://data.census.gov/cedsci/

Table 2-103. Housing Vacancy in Region 1

		Vacant^		
	Total Housing Units	**Estimate**	**CV ****	**MOE (+/−)**
Oregon	1,733,041	5.6%	✓	0.2%
Region 1	115,880	7.9%	✓	0.7%
Clatsop	22,174	8.9%	✓	1.8%
Coos	30,870	9.1%	✓	1.4%
Curry	12,847	10.2%	⊙	2.6%
Lincoln	31,200	6.6%	✓	1.0%
Tillamook	18,789	5.5%	✓	1.2%

Notes: ^ Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.
**Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau (2018), 2013-2017 American Community Survey 5-Year Estimates. https://data.census.gov/cedsci/. Table B25004: Vacancy Status

Aside from location and type of housing, the year structures were built (**Table 2-104**) has implications for level of vulnerability to natural hazards. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for a Cascadia Subduction Zone (CSZ) catastrophic earthquake event (Judson, 2012). Therefore, homes built before 1994 within an earthquake hazard zone are more vulnerable to damage and loss caused by seismic events. Less than one third of the region's housing stock was built after 1990 and the codification of seismic building standards. Note: This does not reflect the number of structures that are exposed to seismic activity. Moreover, the Judson report did not include manufactured housing in its study, but more recent research concludes that manufactured homes installed prior to 2003 lack adequate anchoring and bracing, and are therefore more vulnerable to damage and loss caused by seismic events (Bauer, et al., 2020).

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Almost 40% of the region's housing stock was built prior to 1970, before the implementation of floodplain management ordinances. More than 47% of homes in Clatsop and Coos Counties were built prior to 1970. Note: This does not reflect the number of structures that are built within special flood hazard areas. Additionally, as shown in **Table 2-105**, many communities did not adopt their initial FIRM—and therefore did not adopt floodplain management ordinances—until the late 1970s or mid-1980s. This means that some structures built after 1970 could still be at increased risk.

Table 2-104. Age of Housing Stock in Region 1

	Total Housing Units	Pre 1970			1970 to 1989			1990 or Later		
		Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,733,041	34.6%	☑	0.3%	30.5%	☑	0.3%	34.9%	☑	0.3%
Region 1	115,880	38.7%	☑	1.2%	30.6%	☑	1.0%	30.7%	☑	1.0%
Clatsop	22,174	46.5%	☑	3.0%	23.9%	☑	2.0%	29.6%	☑	2.0%
Coos	30,870	44.9%	☑	2.9%	31.0%	☑	2.3%	24.1%	☑	1.8%
Curry	12,847	27.5%	☑	3.2%	35.6%	☑	4.1%	36.9%	☑	3.8%
Lincoln	31,200	32.9%	☑	1.9%	34.4%	☑	1.9%	32.6%	☑	1.6%
Tillamook	18,789	36.7%	☑	2.7%	28.1%	☑	2.3%	35.2%	☑	2.6%

** Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau (2018). Table B25034: Year Structure Built, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from https://data.census.gov/cedsci/

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood damage is minimized. **Table 2-105** shows the initial and current FIRM effective dates for Region 1 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-105. Community Flood Map History in Region 1

	Initial FIRM	Current FIRM
Clatsop County	July 3, 1978	June 20, 2018
Astoria	Aug. 1, 1978	Sep. 17, 2010
Cannon Beach	Sep. 1, 1978	June 20, 2018
Gearhart	May 15, 1978	June 20, 2018
Seaside	Sep. 5, 1979	June 20, 2018
Warrenton	May 15, 1978	June 20, 2018
Coos County	Nov. 15, 1984	Dec. 7, 2018
Bandon	Aug. 15, 1984	Dec. 7, 2018
Coos Bay	Aug. 1, 1984	Dec. 7, 2018
Coquille	Sep. 28, 1984	Dec. 7, 2018
Lakeside	Aug. 1, 1984	Dec. 7, 2018
Myrtle Point	July 16, 1984	Dec. 7, 2018
North Bend	Aug. 1, 1984	Dec. 7, 2018
Curry County	Apr. 3, 1978	Nov. 16, 2018
Brookings	Sep. 18, 1985	Nov. 16, 2018
Gold Beach	Nov. 15, 1985	Nov. 16, 2018
Port Orford	Jan. 29, 1980	Nov. 16, 2018
Douglas County	Dec. 15, 1978	Feb. 17, 2010
Reedsport	Apr. 3, 1984	Feb. 17, 2010
Lane County	Dec. 18, 1985	June 2, 1999
Dunes City	Mar. 24, 1981	June 2, 1999 (M)
Florence	May 17, 1982	June 2, 1999
Lincoln County	Sep. 30, 1980	Oct. 18, 2019
Depoe Bay	Oct. 15, 1980	Oct. 18, 2019
Lincoln City	Apr. 17, 1978	Oct. 18, 2019
Newport	Apr. 15, 1980	Oct. 18, 2019
Siletz	Mar. 1, 1979	Oct. 18, 2019
Toledo	Mar. 1, 1979	Oct. 18, 2019
Waldport	Mar. 15, 1979	Oct. 18, 2019
Yachats	March 1, 1979	Oct. 18, 2019
Tillamook County	Aug. 1, 1978	Sep. 28, 2018
Bay City	Aug. 1, 1978	Sep. 28, 2018
Garibaldi	April 17, 1978	Sep. 28, 2018
Manzanita	May 1, 1978	Sep. 28, 2018
Nehalem	Apr. 3, 1978	Sep. 28, 2018
Rockaway	Sep. 29, 1978	Sep. 28, 2018
Tillamook, City	May 1, 1978	Sep. 28, 2018
Wheeler	Nov. 16, 1977	Sep. 28, 2018

Note: M means no base flood elevation.

Source: Federal Emergency Management Agency (2019), Community Status Book Report, https://www.fema.gov/cis/OR.pdf

State-Owned/Leased and Critical/Essential Facilities

In 2020 the Department of Geology and Mineral Industries updated the 2015 Oregon NHMP inventory and analysis of state-owned and –leased buildings, state-owned and –leased critical facilities, and local critical facilities. Results from this report relative to Region 1 can be found in **Table 2-106**. The region contains 5.5% of the total value of all identified local critical facilities and state-owned and –leased critical and non-critical facilities in the state. Cumulatively, these assets are valued at nearly two billion dollars.

Table 2-106. Value of State-Owned/Leased Critical and Essential Facilities in Region 1

Value of Local and State-Owned/Leased Facilities					
	State Non-Critical	State Critical	Local Critical	State + Local Total	Percent of Total
Oregon	$2,630,306,288	$4,622,433,011	$ 26,285,277,425	$ 33,538,016,724	100%
Region 1	$ 282,477,153	$ 252,576,890	$ 1,294,654,689	$ 1,829,708,732	5.5%
Clatsop	$ 62,556,375	$ 157,741,272	$ 237,032,454	$ 457,330,101	1.4%
Coos	$ 1,590,339	$ 2,297,303	$ 30,193,508	$ 34,081,150	0.1%
Curry	$ 39,128,292	$ 7,580,255	$ 65,128,199	$ 111,836,746	0.3%
Douglas	$ 39,904,416	$ 40,013,590	$ 586,411,664	$ 666,329,670	2.0%
Lane	$ 25,605,268	$ 1,766,898	$ 85,170,579	$ 112,542,745	0.3%
Lincoln	$ 47,815,308	$ 15,378,931	$ 197,176,497	$ 260,370,736	0.8%
Tillamook	$ 65,877,155	$ 27,798,641	$ 93,541,788	$ 187,217,584	0.6%

Source: DOGAMI, 2020

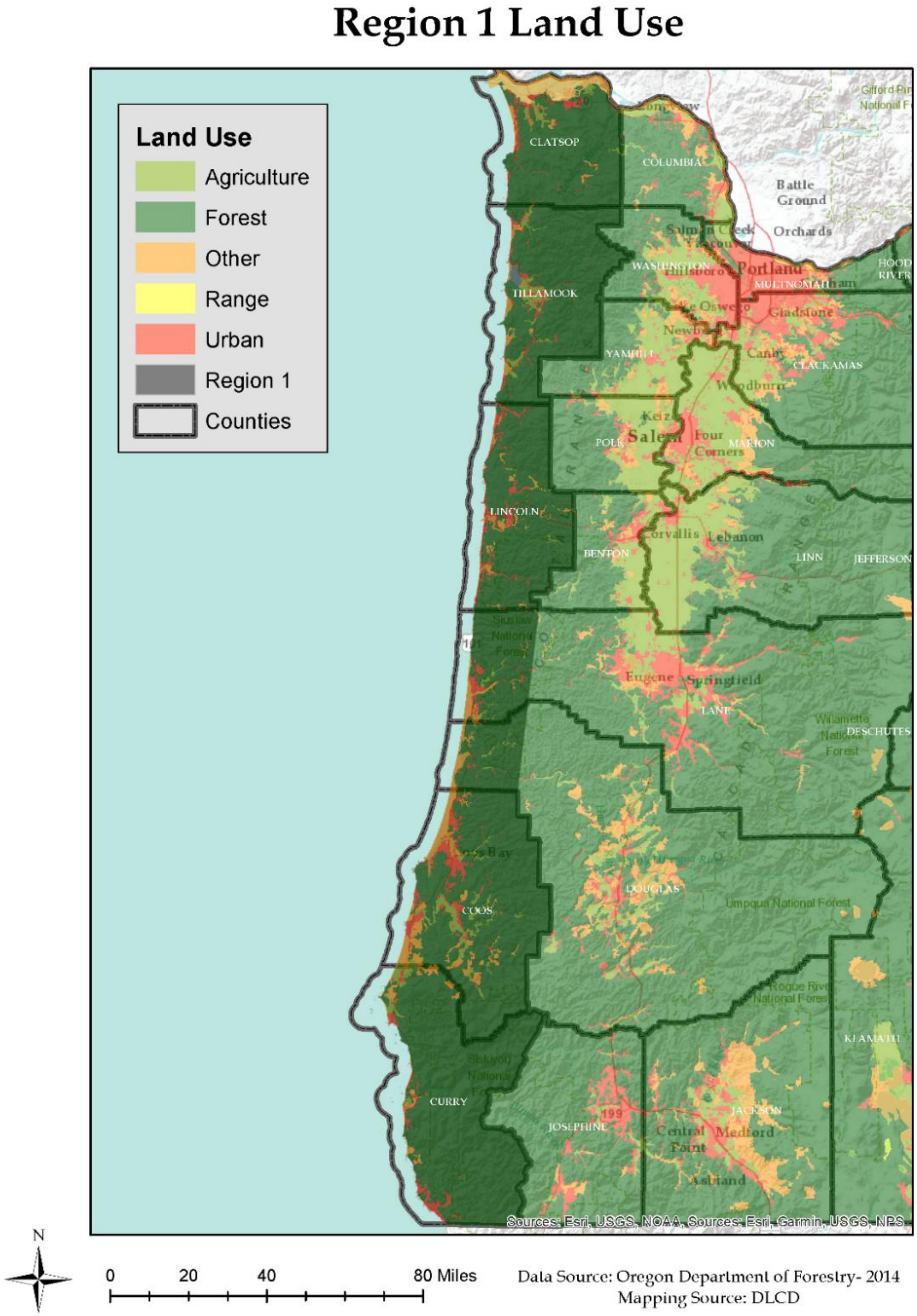
Land Use Patterns

Just over half of the land ownership of the Coast Region is privately owned, with an additional 33.8% in federal ownership, and roughly 14% in state ownership. The vast majority of this land is dedicated to forestry. From the period of 1974 to 2009 the north coast area has had the lowest conversion rate of private land from resource land uses to low-density residential and urban uses (Lettman G. J., 2011). Overall, the coastal communities have experienced little development in the past 5 years, although recently building permitting has increased, mostly for infill of existing subdivisions (DLCD, internal communication, 2014).

During 2012-2013, the Department of Geology and Mineral Industries released tsunami inundation maps displaying five scenarios of a potential impact of a Cascadia Subduction Zone tsunami, reflecting the full range of what was experienced in the past and is projected for the future. Then in January, 2014, the Department of Land Conservation and Development distributed *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* (https://www.oregon.gov/LCD/Publications/TsunamiLandUseGuide_2015.pdf). This guide is intended to help communities develop land use planning strategies to reduce tsunami hazard risk.

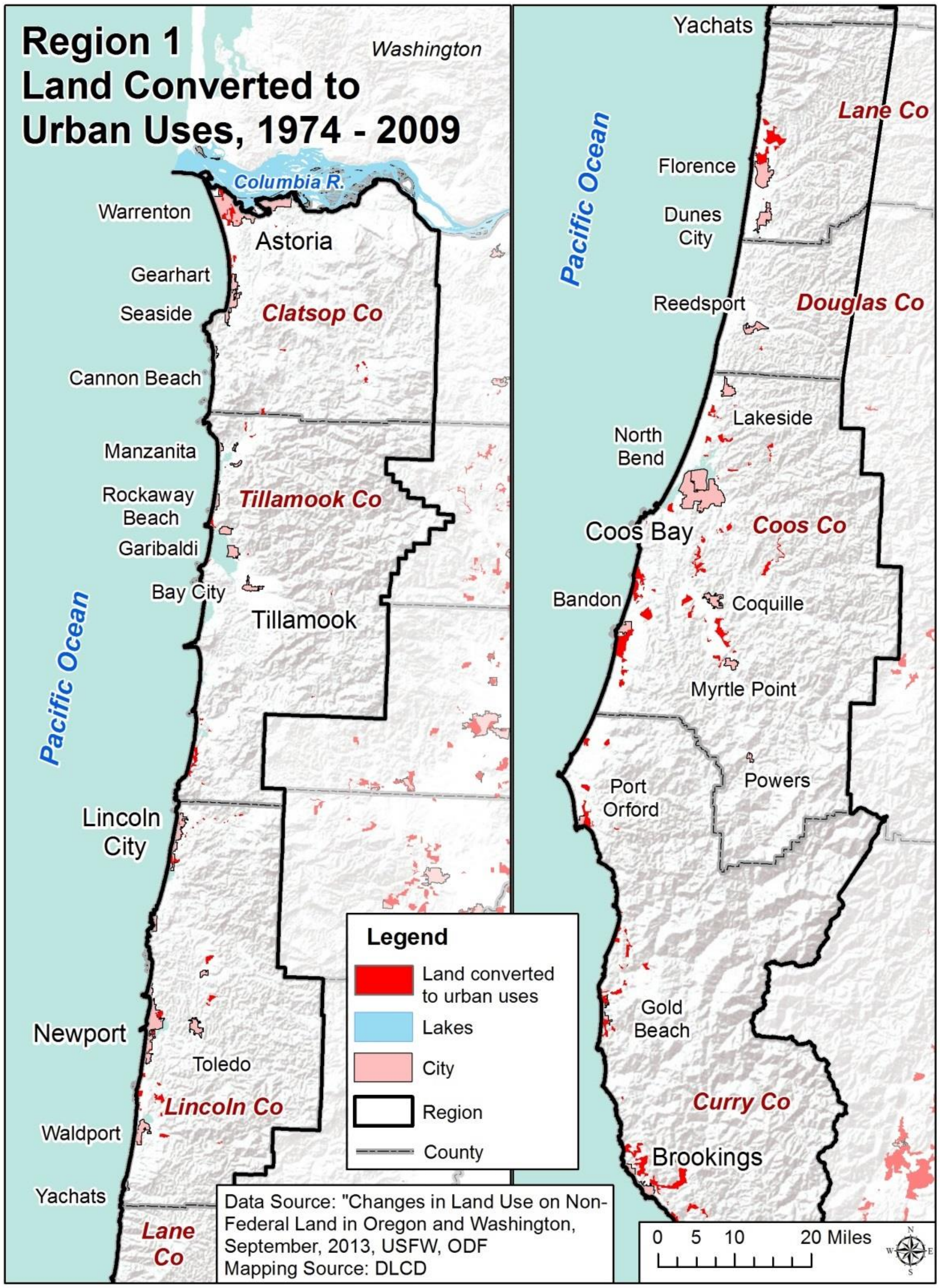
According to the Oregon Department of Forestry's most recent land-use study, "development of resource lands hit a record low between 2009 and 2014...with roughly 3,000 acres per year of Oregon's farms, forests, and rangeland shifted to low-density residential or urban uses" (Lettman G. J., Gray, Hubner, McKay, & Thompson, 2016). In Region 1, approximately 2,591 acres of resource lands were converted to more urban uses during the six-year period. Moreover, **Table 2-107** shows that during the six-year period, the percentage of resource lands converted in each county in Region 1 was less than one percent.

Figure 2-125. Region 1 Land Use



Source: Oregon Department of Forestry, 2014

Figure 2-126. Region 1 Land Converted to Urban Uses, 1974–2009



Source: Lettman (2013), http://www.oregon.gov/odf/RESOURCE_PLANNING/land_use_in_OR_WA_web_edited.pdf

Table 2-107. Region 1 Resource Lands Converted to Urban Uses, 2009–2014

	Land Use Change 2009–2014		
	Total Resource Acres (2009)	**Acres Converted to Urban Use**	**Percent Converted**
Region 1	2,722,239	1,315	0.05%
Clatsop	496,977	330	0.07%
Lincoln	399,119	241	0.06%
Tillamook	548,032	283	0.05%
Coos	733,819	227	0.03%
Curry	335,719	163	0.05%
Douglas	131,763	9	0.01%
Lane	76,810	23	0.03%

Source: Oregon Department of Forestry, 2014; Oregon Department of Land Conservation and Development, 2020

Built Environment Trends and Issues

Trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. The results of the 2020 U.S. Census will better illustrate what has happened in the region over the last decade in terms of urbanization and population dispersion. Generally, however, population growth in the region has significantly lagged behind the statewide rate of growth, a trend that is projected to continue over the next decade. Please refer to the Region 1 Risk Assessment **Demography** section for more information on population trends and forecast. All coastal counties and communities in the region have updated their FIRM in the past decade to more accurately reflect flood exposure.

Tsunami inundation maps created by DOGAMI provide coastal communities new tsunami risk information. In response, DLCD's publication *Preparing for a Cascadia Subduction Zone Tsunami: A Land Use Guide for Oregon Coastal Communities* (https://www.oregon.gov/lcd/Publications/TsunamiLandUseGuide_2015.pdf) was developed to help communities develop land use planning strategies to reduce tsunami hazard risk.

In terms of the housing stock, the region has a higher share of single-family homes vis-à-vis the state as a whole, and nearly double the state's percentage of manufactured housing. Curry County has the region's highest percentage of manufactured housing. Moreover, over 40% of all housing in Clatsop and Coos Counties was built prior to 1970 — prior to current seismic and floodplain management building standards. Manufactured housing and housing built prior to 1970 are more vulnerable to damage from earthquakes and flood hazards than other housing types.

2.3.1.3 Hazards and Vulnerability

Coastal Hazards

Characteristics

The Pacific Northwest (PNW) coast of Oregon is without doubt one of the most dynamic coastal landscapes in North America, evident by its long sandy beaches, sheer coastal cliffs, dramatic headlands and vistas, and ultimately the power of the Pacific Ocean that serves to erode and change the shape of the coast. Coastal communities in Oregon are increasingly under threat from a variety of natural hazards, including coastal erosion (both short and long term), landslides, earthquakes, and potentially catastrophic tsunamis generated by the Cascadia Subduction Zone (CSZ). Over time, these hazards are gradually being compounded, in part due to the degree of development that has evolved along the Oregon coast in recent decades. A particular concern is that the local geology and geomorphology of the region have restricted development to low-lying areas, chiefly along dunes, barrier spits, or along coastal bluffs present along the open coast that are subject to varying rates of erosion, and to low-lying areas adjacent to the numerous estuaries that make up the coast. All of these sites are highly susceptible to increased impacts as erosion processes and flood hazards intensify, driven by rising sea level and increased storminess

Historic Coastal Hazard Events

Table 2-108. Historic Coastal Erosion and Flood Hazard Events in Region 1

Date	Location	Description
Jan. 1914	Newport	damage (Nicolai Hotel)
1931	Rockaway	coastal damage from December storm
Oct–Dec. 1934	Waldport and Rockaway	flooding (Waldport) coastal damage (Rockaway Beach)
Dec. 1935	Cannon Beach and Rockaway Beach	coastal damage
Jan. 1939	coastwide	severe gale; damage coastwide severe flooding (Seaside, and Ecola Creek near Cannon Beach): • multiple spit breaches (southern portion of Netarts Spit) • storm damage (along the shore of Lincoln City and at D River) • flooding (Waldport) • extensive damage (Sunset Bay Park) • storm surge overtopped foredune (Garrison Lake plus Elk River lowland)
Dec. 1940	Waldport	flooding
1948	Newport	wave damage (Yaquina Arts Center)
Jan. 1953	Rockaway	70-ft dune retreat; one home removed
Apr. 1958	Sunset Bay State Park and Newport	flooding (Sunset Bay); wave damage (Yaquina Arts Center in Newport)
Jan–Feb. 1960	Sunset Bay State Park	flooding
1964	Cannon Beach	storm damage
Dec. 1967	Netarts Spit, Lincoln City, Newport, and Waldport	damage: coastwide State constructed wood bulkhead to protect foredune along 600 ft section (Cape Lookout State Park campground) flooding and logs (Lincoln City) wave damage (Yaquina Arts Center, Newport) flooding (Waldport) storm damage (Beachside State Park washed up driftwood (Bandon south jetty parking lot)
1971–73	Siletz Spit	high-tide line eroded landward by 300 ft February 1973, one home completely destroyed; spit almost breached logs through Sea Gypsy Motel (Nov. 1973)
1982–83	Alsea Spit	northward migration of Alsea Bay mouth; severe erosion
1997–98	Lincoln and Tillamook Counties	El Niño winter (second strongest on record); erosion: considerable
Jan–Mar. 1999	coastwide	five storms; coastal erosion extensive, including: • significant erosion (Neskowin, Netarts Spit, Oceanside, Rockaway beach) • overtopping and flooding (Cape Meares) • significant erosion along barrier beach (Garrison Lake) • overtopping 27-ft-high barrier
Dec. 2007	Tillamook and Clatsop Counties	extreme wind storm extreme coastal storm waves exceeding 40 ft on the northern Oregon coast on Dec. 7
Dec. 7-11, 2015	Tillamook and Clatsop Counties	coastal and riverine flooding in response to several days of heavy rain. Large storm waves exceeding 30 ft on Dec 11 resulted in coastal erosion issues in several communities.
Feb. 2018	Curry County	major coastal landslide at Hooskanaden, located in southern Curry County

Date	Location	Description
2019-2020	Siletz Spit	significant erosion over the 2019-20 winter resulted in several homes impacted and the need for emergency permits for coastal engineering.

Sources: Schlicker, et al. (1972), (1973); Stembridge (1975); Komar & McKinney (1977); Komar (1986), (1987), (1997), (1998); Allan, et al. (2003), (2009), and many others.

Table 2-109 lists historic landslides at the Oregon Coast. Landsliding in these areas will almost certainly continue due to the combination of steep terrain, local geology (seaward dipping tertiary sediments), and high precipitation.

Table 2-109. Historic Coastal Landslide Hazards in Region 1

Date	Location	Description
Ongoing	Clatsop County (Cannon Beach)	several large landslides exist along the Clatsop County coastline, particularly in the vicinity of Cannon Beach; these include: • large landslide block failure at Ecola State Park occurred in 1961 • Silver Point landslide in 1974 damaged several homes and affected US-101 • Slow-moving S-Curves landslide (1995) • landslide/rockfall at the south end of Falcon Cove about 2003 • landslide failure at Hug Point in 2016 • landslide failure at Ecola State Park in 2020
Ongoing	Tillamook County	several large landslides exist along the Tillamook County coastline; these include: • The Capes development on the north side of Netarts Bay and south of Oceanside • a large active landslide exists on the north side of Cape Meares and affects the southern portion of the community of Cape Meares • the Three Capes landslide, located to the south of Tierra del Mar, occurred during the 1997-98 El Niño and affected the Three Capes Scenic byway road; this landslide has been remediated • a small landslide failure developed on Aug. 21, 2011, above Happy Camp in Netarts; this landslide has been remediated
Ongoing	Lincoln County (Newport area)	Several large translational landslide blocks exist throughout Lincoln County. The majority of these are in the Newport/Beverly Beach area and include: • Cape Foulweather landslide failed in Dec. 1999 (since remediated) • Johnson Creek • Carmel Knoll • Moolack Shores • NW 73rd St landslide • Schooner Creek • landslide block failed immediately adjacent to the Jump-Off Joe headland destroying multiple homes over a period in 1942-1943 • Mark St
Jan. 2000	Lane County	Cape Cove landslide (immediately adjacent to the tunnel located between the Heceta Head lighthouse and the Sea Lion caves)
Ongoing	Curry County	Multiple large active landslide block failures exist along US-101 along the Curry County coastline; these include: • Gregory Point landslide 2.2 miles south of Port Orford occurred in Jan. 2006 • multiple landslides between Gregory Point and Humbug Mountain • Arizona landslide south of Humbug Mountain, north of Ophir • Hooskanaden Slide failure in February 2019

Sources: Schlicker, et al. (1961), (1972), (1973); Komar (1997); Allan & Hart (2009); Witter, et al. (2009); SLIDO web database (http://www.oregongeology.org/slido/index.html)

Probability

Table 2-110. Assessment of Combined Coastal Hazards Probability in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	VH	VL	L	VL	VL	H	VH

Source: DOGAMI, 2020

For the 2020 probability assessment, DOGAMI scored probability and exposure for each coastal hazard (coastal sand inundation, coastal erosion, coastal flooding, and coastal landslides) and combined them into one overall probability score. Details of the methodology are in Section 2.2.1.3, Coastal Hazards, **Probability of Coastal Hazards in Each Coastal County**.

The erosion of the Oregon coast is exceedingly complex, reflecting processes operating over both short and long time scales, and over large spatial scales. However, the most significant erosion effects are largely controlled by high-magnitude (relatively infrequent) events that occur over the winter (the months of October to March), when wave heights and ocean water levels tend to be at their highest.

Previous analyses of extreme waves for the Oregon coast estimated the "100-year" (1%) storm wave to be around 33 feet. In response to a series of large wave events that occurred during the latter half of the 1990s, the wave climate was subsequently re-examined and an updated projection of the 1% storm wave height was determined, which is now estimated to reach approximately 47 to 52 feet (**Table 2-111**), depending on which buoy is used. These estimates are of considerable importance to the design of coastal engineering structures and in terms of defining future coastal erosion hazard zones.

Table 2-111. Projection of Extreme Wave Heights for Various Recurrence Intervals: Each Wave Height Is Expected to Occur on Average Once during the Recurrence Interval

	Extreme Wave Heights (feet)	
Recurrence Interval (years)	NDBC buoy #46002*(Oregon)	NDBC buoy #46005+(Washington)
10	42.5	41.7
25	46.2	44.0
50	48.8	—
75	50.1	45.7
100	51.2	47.1

Sources: *DOGAMI analyses; +Ruggiero, et al. (2010)

In order to understand the potential extent of erosion for different communities, DOGAMI has completed coastal erosion hazard maps for Lincoln, Tillamook, and Clatsop Counties, as well in the Nesika Beach area in Curry County. Maps were undertaken for these areas mainly because they contain the largest concentration of people living along the coastal strip, and in the case of Nesika Beach in response to a specific request by the Oregon Department of Land Conservation and Development. In all cases, the maps depict erosion hazard zones that fall into four categories: Active, High, Medium, and Low. The High and Medium hazard zones reflect erosion associated with a 2% and 1% storm, respectively. The Low hazard zone includes a 1% storm coupled with a Cascadia subduction zone earthquake and has a much lower probability of occurrence. The erosion scenarios were defined using a combination of probabilistic (waves) and deterministic (water levels) approaches.

In July 2014, DOGAMI completed new updated maps for the dune-backed beaches in Tillamook County using a fully probabilistic approach of the waves and water levels to map the erosion hazard zones. The revised modeling used three total water level scenarios (10%, 2% and 1% events) produced by the combined effect of extreme wave runup (R) plus the measured tidal elevation (T), and erosion due to sea level rise (low/mean/maximum estimates) at 2030, 2050, and 2100. In total 81 scenarios of coastal erosion were modeled; an additional two scenarios were also modeled that considered the effects of a Cascadia subduction zone earthquake, and the effects of a single (1%) storm, where the storm's duration was taken into account. The completed study ultimately recommended five hazard zones for consideration. A sixth hazard zone was also proposed. This latter zone was defined using a more sophisticated dune erosion model that accounted for the effect of the duration of a storm. Table 2-112 provides the calculated erosion associated with an extreme (1%) storm for Tillamook County, after accounting for the storm's duration. The results indicate that the storm induced erosion ranges from about 47 to 73 ft. When the duration of the storm is removed from consideration the amount of beach and dune erosion increases substantially to about 70 to 260 ft. Finally, modeling coastal change by nature is fraught with large uncertainty that is a function of variations in the morphology of the beach and the beach sediment budget.

Table 2-112. Storm-Induced Erosion Defined for Selected Sites in Tillamook County after Having Accounted for the Duration of the Event

	Maximum 1% Erosion Distance	
	(meters)	(feet)
Neskowin	20.6	67.6
Nestucca Spit	14.5	47.6
Sand Lake	18.7	61.4
Netarts Spit	22.2	72.8
Bayocean Spit	17.6	57.7
Rockaway	19.9	65.3
Nehalem Spit	19.3	63.3

Modeled erosion is for a 1% storm.

Between July 2009 and 2014, DOGAMI completed new coastal erosion and flood modeling for the entire Oregon coast in order to update FEMA flood insurance rate maps derived for each coastal community. These updated maps contain probabilistic estimates of the effects of the 10-, 50- and 100-year extreme storm wave flooding (combined with high tides) and coastal erosion responses.

Although some coastal landslide failures have been remediated, the majority are considered active and hence will continue to move and fail. Without detailed knowledge of every slide, it is impossible to assign probabilities of failure. However, it is a high probability that all of these existing landslide sites would be activated following a Cascadia earthquake, and more new landslides would occur.

Climate Change

It is very likely (>90%) that the Oregon coast will experience an increase in coastal erosion and flooding hazards due to climate change induced sea level rise (high confidence) and possible changes to storminess patterns (medium confidence). Global sea levels are rising and will continue to rise at an accelerated pace under continued climate warming. In Oregon, the rates of relative sea level rise—those experienced along Oregon's coastlines—are not the same as rates of change in global mean sea levels, because of a number of factors related to ocean conditions and vertical movement of the land. Oregon's western edge is uplifting, so the rates of relative sea level rise in Oregon are not as high as rates seen in other West Coast locations. But even after factoring in local conditions, sea levels along most of Oregon's coast are rising. For locations in which sea level is not currently rising, the projected rate of future sea level rise is expected to outpace the current rate of vertical land movement in the 21st century. For more information on coastal erosion, sea level rise, and changing wave dynamics, see **2.2.1.3, Coastal Hazards, Analysis and Characterization, Climate Change and Sea Level Rise.**

The following information presents past and projected changes in local sea level for the north coast (Astoria), central coast (Newport), and south coast (Charleston) of Oregon based on the Intermediate-Low and Intermediate-High global sea level scenarios used in the 2018 U.S. National Climate Assessment (Sweet, Horton, Kopp, LeGrande, & Romanou, 2017a). This range of sea level rise scenarios is similar to the very likely range projected for the higher emissions scenario, RCP8.5, by 2100. These local sea level projections include vertical land movement trend estimates derived from GPS measurements and tide gauge platforms (Sweet, et al., 2017b). This means that the future sea level rise projections are relative to the future land position as opposed to the existing land position.

Local sea level at Astoria (NOAA water level station at Astoria–Tongue Point) has lowered by about two inches during 1947–2013 due to the land uplifting at a faster pace than sea level rise over that period. However, the pace of sea level rise is expected to accelerate such that sea level rise over the 21st century would outpace the uplifting land. Local sea level at Astoria is projected to rise by 0.8 to 4.8 feet by 2100 relative to the 1992 mean high tide line (Dalton, Future Climate Projections: Clatsop County, 2020).

Local sea level at Newport (NOAA water level station at South Beach–Yaquina River) has risen about four inches during 1967–2013 and is projected to rise by 1.7 to 5.7 feet by 2100 relative to the 1992 mean high tide line (Dalton, Future Climate Projections: Lincoln County, 2020).

Local sea level at Charleston (NOAA water level station at Charleston–Coos Bay) has risen about one inch during 1978–2013 and is projected to rise by 1.2 to 5.3 feet by 2100 relative to the 1992 mean high tide line (Climate Central, 2020).

Local sea level rise will be greatest on the central Oregon coast; however, the north and south coasts of Oregon will see local sea level rise surpass the current rate of vertical land movement.

Vulnerability

Table 2-113. Local Assessment of Vulnerability to Coastal Erosion in Region 1

	Clatsop	Coos	Curry	Douglas*	Lane*	Lincoln	Tillamook
Vulnerability	—	H	H	—	—	—	—

*Coastal portions of Douglas and Lane Counties

Source: Most recent local hazard vulnerability analyses (**Table 2-4**)

Table 2-114. State Assessment of Coastal Hazards Combined Vulnerability in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	L	M	VL	M	L	M	L

Source: DOGAMI and DLCD, 2020

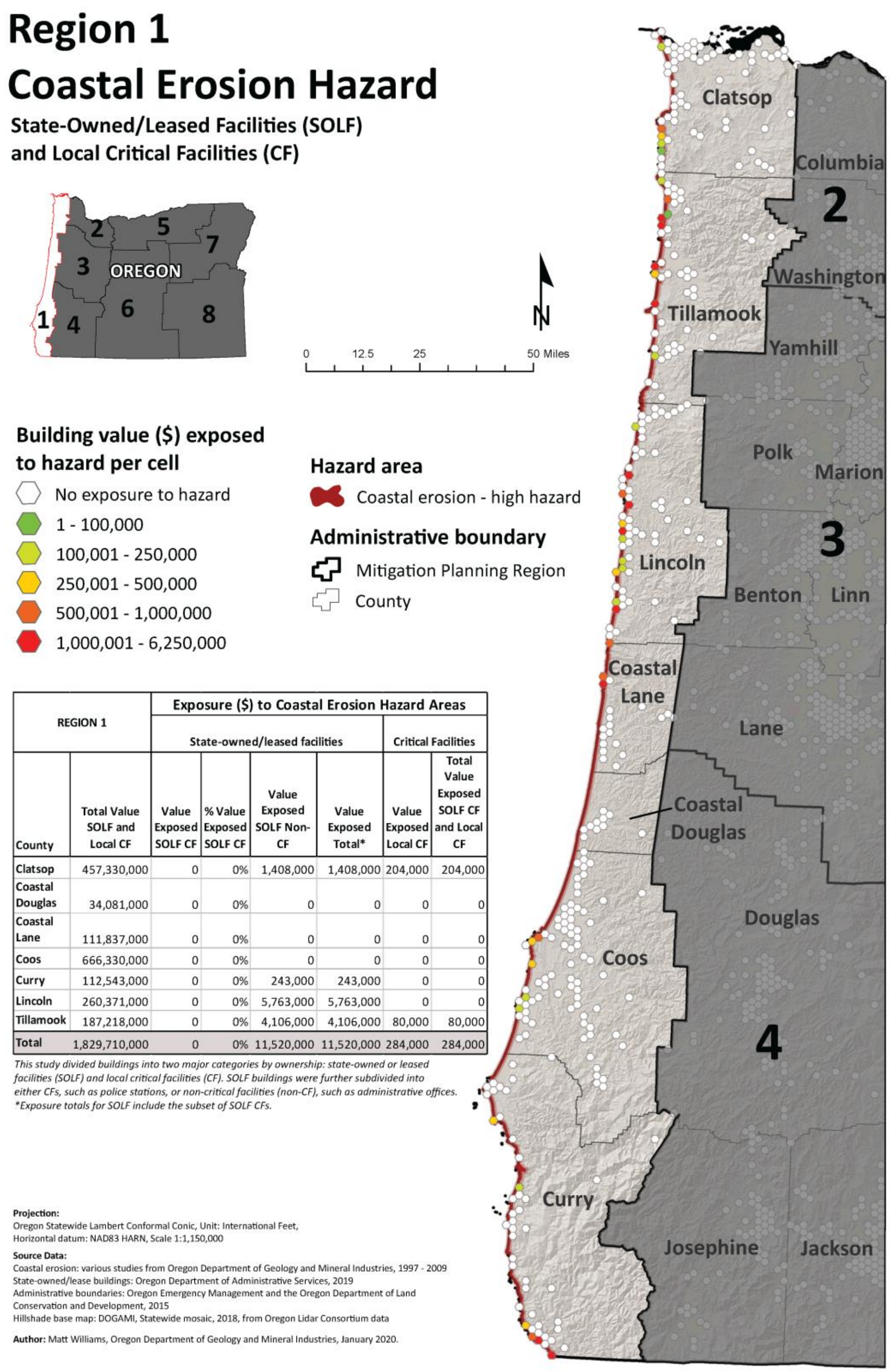
Chronic hazards are clearly evident along Oregon's shores, including beach, dune, and bluff erosion, landslides, slumps, gradual weathering of sea cliffs, and flooding of low-lying coastal lands during major storms. The damage caused by chronic hazards is usually gradual and cumulative. The regional, oceanic, and climatic environments that result in intense winter storms determine the severity of chronic hazards along the coast. These hazards threaten property and, in extreme events, human life.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

In Region 1, there is about an $11.5M potential loss in value of state buildings and state critical facilities located in coastal erosion hazard areas. The majority of that value (86%) is located in Lincoln and Tillamook Counties followed by Clatsop and Curry Counties. None is located in Coos, Coastal Douglas, or Coastal Lane Counties. Region 1 faces a potential loss of about $285K of value in local critical facilities located in coastal erosion hazard areas. Seventy-two percent of that value is located in Clatsop County and 28% in Tillamook County; none of the other coastal counties have local critical facilities located in coastal erosion hazard areas.

Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. According to Department of Administrative Services records, only one minor loss of just over $700 to a state facility was recorded in Region 1 since the beginning of 2015. It was not caused by coastal erosion.

Figure 2-127. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Coastal Erosion Zone in Region 1. High-resolution, full-size image linked from Appendix 9.1.26.



REGION 1		Exposure ($) to Coastal Erosion Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Clatsop	457,330,000	0	0%	1,408,000	1,408,000	204,000	204,000
Coastal Douglas	34,081,000	0	0%	0	0	0	0
Coastal Lane	111,837,000	0	0%	0	0	0	0
Coos	666,330,000	0	0%	0	0	0	0
Curry	112,543,000	0	0%	243,000	243,000	0	0
Lincoln	260,371,000	0	0%	5,763,000	5,763,000	0	0
Tillamook	187,218,000	0	0%	4,106,000	4,106,000	80,000	80,000
Total	1,829,710,000	0	0%	11,520,000	11,520,000	284,000	284,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet,
Horizontal datum: NAD83 HARN, Scale 1:1,150,000

Source Data:
Coastal erosion: various studies from Oregon Department of Geology and Mineral Industries, 1997 - 2009
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

Source: DOGAMI, 2020

Historic Resources

Of the 3,121 historic resources located in Oregon's coastal counties, none are located in coastal erosion high hazard areas. Only one, in Tillamook County, is located in a moderate coastal erosion hazard area, and 54 are located in low or other coastal erosion hazard areas. Of the 54 in low or other coastal erosion hazard areas, 33 are located in Clatsop county and ten in Tillamook County.

Archaeological Resources

Of the 369 archaeological resources in Oregon's coastal counties, 119 are located in an area of high coastal erosion hazards. Of those, 30 are listed on the National Register of Historic places and 2 are eligible for listing. Eighty-seven have not been evaluated as to their eligibility for listing. The 32 listed and eligible archaeological resources in high coastal erosion hazard areas are located in Clatsop, Lincoln, and Tillamook Counties. Twenty-one other listed and eligible archaeological resources are located in moderate coastal erosion hazard areas in the same three counties. Sixty-seven listed and eligible archaeological resources are located in areas of low or other coastal erosion hazard areas in throughout the coastal counties. The coastal portions of Lane and Douglas Counties were not included in this assessment.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Coos County, the coastal portion of Douglas County and Lincoln County are more vulnerable than the other counties in Region 1, but still are only moderately vulnerable.

The Department of Geology and Mineral Industries is the agency with primary oversight of coastal hazards. Based on agency staff review of the available hazard data, DOGAMI ranks Tillamook, Lincoln, Clatsop, and Curry Counties one through four respectively as the counties most vulnerable to coastal hazards in the state.

Coastal hazards in Coos, Lane, and Douglas Counties are considered to be generally negligible. This is because the bulk of these coastlines have little population base and hence are largely unmodified. In Coos County, coastal hazards can be found in a few discrete communities such as adjacent to the Coquille jetty in Bandon and along Lighthouse Beach near Cape Arago. Similarly, coastal hazards in Lane County are confined almost entirely to the Heceta Beach community and adjacent to the Siuslaw River mouth, particularly within the lower estuary mouth where development lines coastal bluffs that is gradually being eroded by riverine processes.

The counties and communities most vulnerable to coastal hazards on the Oregon Coast include:

Tillamook County (ranked #1):

- Neskowin (erosion and flooding)
- Pacific City (erosion (1970s); replaced by recent sand inundation),
- Tierra del Mar (erosion and flooding)
- Cape Meares (flooding and landsliding)
- Twin Rocks (erosion and flooding),
- Rockaway Beach (erosion and flooding)
- Nehalem (flooding during extreme high tides)

Lincoln County (ranked #2):

- Yachats to Alsea Spit (erosion)
- Waldport (erosion and flooding)
- Alsea Spit (erosion (1982/83 and 1997/98 El Niños); replaced by recent sand inundation)
- Seal Rock (erosion and landsliding)
- Ona Beach to Southbeach (erosion and landsliding)
- Newport (landsliding)
- Beverly Beach (erosion and landsliding)
- Gleneden Beach to Siletz Spit (erosion, landsliding, and flooding)
- Lincoln City (erosion and landsliding)

Clatsop County (ranked #3):

- Falcon Cove (erosion and landsliding)
- Arch Cape (erosion and flooding)
- Tolovana to Cannon Beach (erosion and flooding)
- Cannon Beach (erosion; sand inundation north of Ecola Creek),
- Ecola State Park (landsliding), and
- Seaside (Flooding);

Curry County (ranked #4):

- Multiple coastal section affecting Highway 101 (landsliding and erosion)
- Gold Beach, Hunter Creek (erosion)
- Nesika Beach (erosion and landsliding)
- Port Orford (flooding at Garrison Lake)

Coos County (ranked #5):

- North Coos Spit (erosion)
- Lighthouse Beach (bluff erosion)
- Bandon (erosion and flooding, particularly adjacent to the Coquille River south jetty)

Lane County (ranked #6):

- Heceta Beach (erosion and flooding; erosion especially significant in the north at the mouth to Sutton Creek)

Douglas County (ranked #7):

- Coastal hazards in Douglas County are considered to be negligible.

Risk

Table 2-115. Combined Risk of Coastal Hazards in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Risk	H	M	L	M	L	H	H

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the coastal hazards probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, Clatsop, Lincoln, and Tillamook Counties are at greatest risk from coastal hazards. This is consistent with DOGAMI’s independent assessment.

Droughts

Characteristics

Drought is not a common occurrence in Region 1. From 1995–2015, the Governor has declared drought only once in Region 1, in Coos and Curry Counties during 2002 when much of the state was facing drought conditions. In 2015, all Region 1 counties received a drought declaration, and in 2018 Lincoln County received a drought declaration. In the emerging drought in 2020 (as of April 30, 2020), the Governor has declared drought in Curry County. Although Region 1 is less vulnerable to drought impacts than most of Oregon, droughts can still be problematic, especially given that they often precede major wildfires. Severe drought conditions resulted in the four disastrous Tillamook fires (1933, 1939, 1945, 1951), collectively known as the Tillamook Burn.

Historic Drought Events

Table 2-116. Historic Droughts in Region 1

Date	Location	Description
1924	statewide	prolonged statewide drought that caused major problems for agriculture
1930	Regions 1, 2, 3, 5, 6, & 7	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country; moderate to severe drought affected much of the state
1939	statewide	Water Year 1939 was one of the more significant drought years in Region 1 during that period; the second of the three Tillamook Burns started in 1939
1992	statewide, especially Regions 1, 2, 3, 4, 8	1992 fell toward the end of a generally dry period, which caused problems throughout the state; the 1992 drought was most intense in eastern Oregon, with severe drought occurring in Region 1; the winter of 1991-1992 was a moderate El Niño event, which can manifest itself in warmer and drier winters in Oregon; Governor declared a drought for all 36 counties in September 1992
2001-02	affected all regions, except Regions 2 & 3	the second most intense drought in Oregon's history; 18 counties with state drought declaration (2001); 23 counties state-declared drought (2002); some of the 2001 and 2002 drought declarations were in effect through June or December 2003; Coos and Curry Counties in Region 1 were not under a drought declaration until December of 2002
2015	statewide	All 36 Oregon counties receive federal drought declarations; Coos and Curry were the only counties in Region 1 to receive a Governor's declaration.
2018	Regions 4-8, 1	Governor-declared drought in 11 counties
2020	Region 1, 6	Governor-declared drought in Klamath, Curry, and Jackson Counties as of May 1, 2020.

Sources: Taylor and Hatton (1999); NOAA's Climate at a Glance. Western Regional Climate Center's Westwide Drought Tracker, http://www.wrcc.dri.edu/wwdt; personal communication, Kathie Dello, Oregon Climate Service, Oregon State University; Governor-declared drought declarations obtained from the Oregon State Archives division

Historical drought information can also be obtained from the West Wide Drought Tracker, which provides climate data showing wet and dry conditions, using the Standard Precipitation-Evapotranspiration Index (SPEI) that dates back to 1895. **Figure 2-128** shows years where drought or dry conditions affected the coastal areas of Oregon (Climate Division 1). Based on this index, Water Years 1924 and 1977 were extreme drought years for the coastal region (**Table 2-117**). Years with at least moderate drought have occurred 17 times during 1895–2019.

U.S Climate Divisions

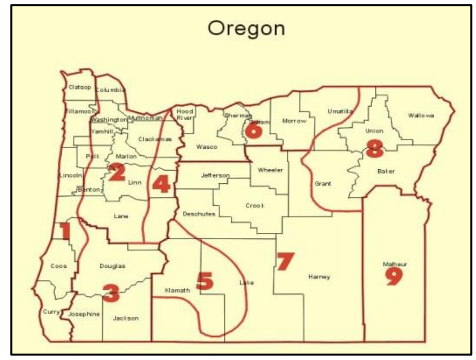
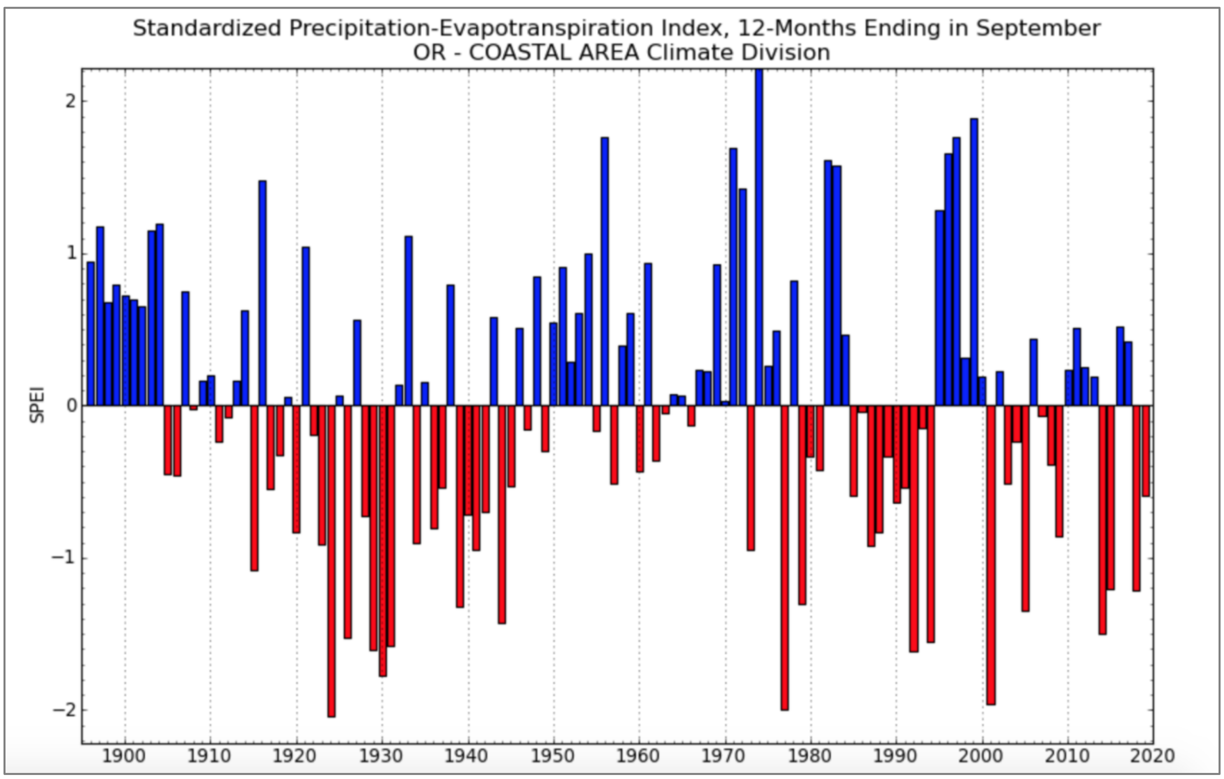


Figure 2-128. Standard Precipitation-Evapotranspiration Index for Region 1



Drought Severity Scale: -1 to -1.49 = moderate drought; -1.5 to -1.99 = severe drought; -2.0 or less = extreme drought

Source: West Wide Drought Tracker, https://wrcc.dri.edu/wwdt/time/

Table 2-117. Years with Moderate (<-1), Severe (<1.5), and Extreme (<-2) Drought in Oregon Climate Division 1 according to Standard Precipitation-Evapotranspiration Index

Moderate Drought (SPEI < -1.0)	Severe Drought (SPEI < -1.5)	Extreme Drought (SPEI < -2.0)
1944	2001	1924
2005	1930	1977
1939	1992	
1979	1929	
2018	1931	
2015	1994	
1915	1926	
	2014	

Note: Within columns, rankings are from more severe to less severe.

Source: West Wide Drought Tracker, https://wrcc.dri.edu/wwdt/time/

Probability

Table 2-118. Probability of Drought in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	VL	L	M	H	L	L	VL

Source: OWRD, DLCD

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases. A comprehensive risk analysis is needed to fully assess the probability and impact of drought to Oregon communities. Such an analysis should be completed statewide in order to analyze and compare the risk of drought across the state.

Douglas County has received drought declarations in 24% of the years since 1992 accounting for its high probability rating, and Curry County 14% accounting for its moderate rating. Whether the drought declarations pertained to the coastal portion of Douglas County is unknown.

Climate Change

Even though drought is infrequent in coastal Oregon, Region 1 is prone to summertime water scarcity, as evidenced in the 2015 statewide drought. Climate models project warmer, drier summers for Oregon, including coastal areas, leading to lower summer soil moisture and runoff. In Region 1, climate change would result in increased frequency of drought due to low summer runoff (likely, >66%) and low summer precipitation and low summer soil moisture (more likely than not, >50%). In addition, Region 1, like the rest of Oregon is projected to experience an increase in the frequency of summer drought conditions as summarized by the standard precipitation-evaporation index (SPEI) due largely to projected decreases in summer precipitation and increases in potential evapotranspiration (Dalton, Dello, Hawkins, Mote, & Rupp, 2017).

Vulnerability

Table 2-119. Local Assessment of Vulnerability to Drought in Region 1

	Clatsop	Coos	Curry	Douglas*	Lane*	Lincoln	Tillamook
Vulnerability	NA	H	—	L	—	M	—

*Coastal portions of Douglas and Lane Counties

Source: Most recent local hazard vulnerability analyses (**Table 2-4**)

Table 2-120. State Assessment of Vulnerability to Drought in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	L	H	L	H	M	M	L

Source: OWRD, DLCD

Oregon has yet to undertake a comprehensive, statewide analysis to identify which communities are most vulnerable to drought.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

Douglas and Coos Counties have high social vulnerability ratings, Lane and Lincoln Counties moderate. This indicates the extent of impact that any natural hazard, including drought, is likely to have on their populations. The high and moderate social vulnerability ratings for Douglas and Lane Counties, respectively, are for each county as a whole and may not accurately reflect the social vulnerability situation in their coastal areas. Without finer-grained data, we must give less weight to these ratings.

Even short term droughts can be problematic. Potential impacts to community water supplies are the greatest threat. Long-term drought periods of more than a year can impact forest conditions and set the stage for potentially devastating wildfires.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

In Region 1, there is about an $11.5M potential loss in value of state buildings and state critical facilities located in coastal erosion hazard areas. The majority of that value (86%) is located in Lincoln and Tillamook Counties followed by Clatsop and Curry Counties. None is located in Coos, Coastal Douglas, or Coastal Lane Counties. Region 1 faces a potential loss of about $285K of value in local critical facilities located in coastal erosion hazard areas. Seventy-two percent of that value is located in Clatsop County and 28% in Tillamook County; none of the other coastal counties have local critical facilities located in coastal erosion hazard areas.

The value of state-owned and leased buildings and critical facilities in Region 1 is approximately $535,054,000 representing the total potential for loss of state assets due to coastal hazards. The value of locally owned critical facilities is $1,294,655,000. Because drought, while uncommon in Region 1, could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to drought. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. According to Department of Administrative Services records, only one minor loss of just over $700 to a state facility was recorded in Region 1 since the beginning of 2015. It was not caused by drought.

Risk

Table 2-121. Risk of Drought in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Risk	L	M	M	H	M	M	L

Source: OWRD, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. Based on social vulnerability (considering the limitations of the data for Douglas and Lane Counties) and a review of Governor-declared drought declarations since 1992, Region 1 is considered to be generally at low to moderate risk from drought.

Earthquakes

Characteristics

The geographic position of Region 1 makes it susceptible to earthquakes from three sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, and (c) shallow crustal events within the North America Plate. All have some tie to the subducting or diving of the dense, oceanic Juan de Fuca Plate under the lighter, continental North America Plate. Stresses occur because of this movement.

There is no historic record of major damaging crustal earthquakes centered in Region 1 in the past 156 years, although the region has experienced small crustal earthquakes and crustal earthquakes that originated outside the region. The geologic record shows that movement has occurred along numerous offshore faults as well as a few onshore faults in Coos and Tillamook Counties. The faulting has occurred over the last 20,000 years. Intraplate earthquakes are very rare in Oregon, although such earthquakes originating outside of the state have been felt in Region 1. It is believed that the M7.3 near Brookings in 1873 was an intraplate quake.

In Region 1, geologic earthquake hazards include severe ground shaking, liquefaction of fine-grained soils, landslides, and flooding from local and distant tsunamis. The severity of these effects depends on several factors, including the distance from earthquake source, the ability of soil and rock to conduct seismic energy composition of materials, and ground and ground water conditions.

Historic Earthquake Events

Table 2-122. Significant Earthquakes Affecting Region 1

Date	Location	Magnitude (M)	Comments
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	Probably 8-9	these are the mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 1873	Brookings area, Oregon	7.3	intraplate event; origin probably Gorda block of the Juan de Fuca plate; chimneys fell (Port Orford, Grants Pass, and Jacksonville); no aftershocks
Nov. 1962	Portland, Oregon	5.2 to 5.5	crustal event; damage to many homes (chimneys, windows, etc.)
Mar. 1993	Scotts Mills, Oregon	5.6	crustal event; FEMA-985-DR-OR; damage: $28 million (homes, schools, businesses, state buildings [Salem])
Sep. 1993	Klamath Falls, Oregon	5.9 to 6.0	crustal event; FEMA-1004-DR-OR; two earthquakes; fatalities: two; damage $7.5 million (homes, commercial, and government buildings)
May 8, 2015	Pacific Ocean, west of Coos Bay, OR	4.4	
Nov. 29, 2019	Port Orford, OR	4.5	
Feb. 8, 2020	Pacific Ocean west of Coos Bay, Oregon	4.7	

*BCE: Before Common Era.

Sources Wong & Bott (1995); Pacific Northwest Seismic Network, https://pnsn.org/

Probability

Table 2-123. Assessment of Earthquake Probability in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	VH	VH	VH	H	H	H	H

Source: DOGAMI, 2020

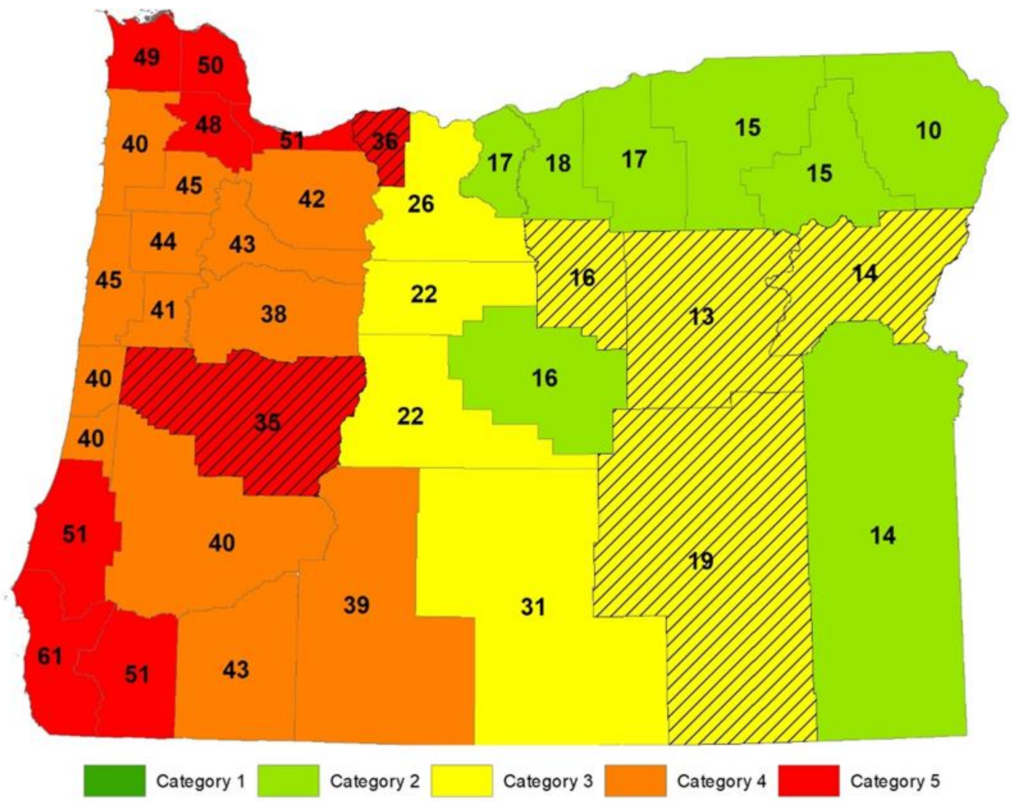
The probability of damaging earthquakes varies widely across the state. In Region 1, the hazard is dominated by Cascadia Subduction Zone (CSZ) earthquakes originating from a single fault with a well-understood recurrence history.

DOGAMI has developed a new probability ranking for Oregon counties that is based on the average probability of experiencing damaging shaking during the next 100 years, modified in some cases by the presence of newly discovered faults. If a county had newly discovered faults that were within 10-12 miles of a community, the category defined by the average probability of damaging shaking was increased one step.

- Category 1 100-year probability < 10%
- Category 2 100 year probability 10-20%
- Category 3 100 year probability 21-31%
- Category 4 100 year probability 32-45%
- Category 5 100 year probability > 45%

The probability levels for Baker, Grant, Harney, Hood River, and Wheeler Counties, and the non-coastal portion of Lane County were all increased in this way. The results of this ranking are shown in **Figure 2-129**.

Figure 2-129. 2020 Oregon Earthquake Probability Ranking Based on Mean County Value of the Probability of Damaging Shaking and Presence of Newly Discovered Faults



Note: Counties with hatching had their probability category increased one step due to newly discovered faults.

Source: DOGAMI 2020

For Oregon west of the crest of the Cascades, the CSZ is responsible for most of the hazard shown in **Figure 2-129**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10 to 20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37–43%.

Vulnerability

Table 2-124. Local Assessment of Vulnerability to Earthquakes in Region 1

	Clatsop	Coos	Curry	Douglas*	Lane*	Lincoln	Tillamook
Vulnerability	H	M	H	H	—	H	H

*Coastal portions of Douglas and Lane Counties

Source: Most recent local hazard vulnerability analyses (**Table 2-4**)

Table 2-125. State Assessment of Vulnerability to Earthquakes in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	VH	H	VH	VH	VH	M

Source: DOGAMI and DLCD, 2020

Region 1 is especially vulnerable to earthquake hazards. This is because of the built environment's proximity to the CSZ, regional seismicity, topography, bedrock geology, and local soil profiles. For example, a large number of buildings are constructed of unreinforced masonry (URM) or are constructed on soils that are subject to liquefaction during severe ground shaking. Also, some principal roads and highways are susceptible to earthquake-induced landslides. Bridges and tunnels need to be retrofitted to withstand ground shaking and the dams should be able to withstand earthquake forces to prevent uncontrolled releases. This is especially important as 12 dams in Region 1 have been designated as "high hazard." Problem areas within the region are readily identifiable online at Oregon's hazard viewer at http://www.oregongeology.org/sub/hazvu/index.htm and on earthquake hazard maps prepared by DOGAMI (available at website: http://www.oregongeology.org/pubs/ofr/p-O-13-06.htm).

Table 2-126 shows the number of school and emergency response buildings surveyed in each county with their respective rankings.

Table 2-126. Region 1 School and Emergency Response Building Collapse

County	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Clatsop	24	19	20	1
Tillamook	19	9	23	5
Lincoln	30	18	12	3
Lane*	8	4	5	—
Douglas**	3	2	10	—
Coos	41	11	48	7
Curry	15	10	10	2

*Includes only the Lane County coastal communities of Deadwood, Florence, Mapleton, and Swisshome.

**Includes only the Douglas County coastal communities of Gardiner, Reedsport, and Winchester Bay.

Source: Lewis (2007), available at http://www.oregongeology.org/sub/projects/rvs/default.htm

Other useful resources for planning for earthquakes include the following:

- Maps of earthquake hazard areas: DOGAMI has mapped all of the Region 1 counties and has statewide GIS earthquake hazard layers available through Open-File Report O-13-06 (Madin & Burns, 2013).
- Map of coastal critical facilities vulnerable to hazards: DOGAMI has developed these maps for all Region 1 counties. For more information about critical facilities in Region 1 see **State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities**.
- Environmental geology maps: DOGAMI has developed these maps for all Region 1 counties (DOGAMI Bulletins 74, 79, 81, 84, 85, and 87).
- Nuclear energy and hazardous waste sites inventories: No Region 1 counties have nuclear facilities.

DOGAMI developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). Both models use Hazus, a software program developed by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The CSZ event is based on a potential M8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from such an event. The 500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults. Neither model takes unreinforced masonry buildings into consideration.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning and policy making purposes. Despite their limitations, the models do provide some approximate estimates of damage and are useful to understand the relative relationships between the counties.

Table 2-127 shows the projected dollar losses based on both models. Please note that the losses are in 1999 dollars. Since that time, additional growth and inflation has occurred, thus the values are too low. However, the relative rankings are between the counties likely remains the same. For example, the economic base (column 2) for Clatsop County remains lower than Coos County, and the expected losses from a magnitude 8.5 Cascadia earthquake (column 3) in Clatsop County remain lower than Coos County.

Table 2-127. Projected Dollar Losses in Region 1, Based on an M8.5 Subduction Event and a 500-Year Model

Region 1 Counties	Economic Base in Thousands (1999)	Greatest Absolute Loss in Thousands (1999) from an M8.5 CSZ Event[1]	Greatest Absolute Loss in Thousands (1999) from a 500-Year Model[2]
Clatsop	$2,198,000	$549,000	$760,000
Coos	$3,263,000	$1,339,000	$1,429,000
Curry	$1,093,000	$371,000	$388,000
Douglas[3]	$4,631,000	$275,000	$546,000
Lane[3]	$15,418,000	$1,614,000	$3,044,000
Lincoln	$2,668,000	$624,000	$793,000
Tillamook	$1,539,000	$226,000	$364,000

Notes:

[1] "…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

[2]Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (Wang & Clark, 1999).

[3]Entire county.

Source: Wang & Clark (1999)

Table 2-128 shows the projected dollar losses associated with the magnitude 8.5 Cascadia model.

Table 2-128. Estimated Losses in Region 1 Associated with a M8.5 Subduction Zone Event

	Region 1 Counties						
	Clatsop	Coos	Curry	Douglas[1]	Lane[1]	Lincoln	Tillamook
Injuries	298	854	221	151	1,036	358	132
Deaths	6	16	3	2	19	7	3
Displaced Households	788	2,069	430	255	2,345	592	158
Operational the "day after" the event[2]:							
Fire stations	16%	10%	9%	66%	49%	26%	31%
Police stations	15%	6%	5%	57%	42%	22%	44%
Schools	16%	8%	6%	44%	46%	19%	32%
Bridges	58%	44%	34%	74%	76%	51%	58%
Economic losses to[2]:							
Highways	$18 mil	$44 mil	$48 mil	$43 mil	$39 mil	$16 mil	$25 mil
Airports	$5 mil	$20 mil	$11 mil	$5 mil	$11 mil	$9 mil	$7 mil
Communications	$6 mil	$25 mil	$18 mil	$7 mil	$11 mil	$9 mil	$5 mil
Debris Generated (thousands of tons)	383	853	267	222	1,341	446	158

Notes:

The Cascadia Subduction Zone (CSZ) is the most dangerous fault in Oregon. The entire coastline is essentially the epicenter. The earthquake could be M8.5 (or M9.0). The event might last as long as 4 minutes. Within a few minutes a tsunami would follow. (Tsunami damages are not included in the estimates for this earthquake but would dramatically increase losses for coastal counties.) A CSZ earthquake could affect a very large area. If the entire fault ruptures, destruction could occur from northern California to Canada. The number of deaths and injuries depends on the time of day, building type, occupancy class, and traffic pattern. (DOGAMI Special Paper 29 (Wang & Clark, 1999, p. 4).

[1] Entire county.

[2] "…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

Source: Wang & Clark (1999)

Table 2-129 shows the estimated losses associated with the 500-year model.

Table 2-129. Estimated Losses in Region 1 Associated with a 500-Year Model

	Clatsop	Coos	Curry	Douglas[1]	Lane[1]	Lincoln	Tillamook
Injuries	397	845	212	294	2,254	436	181
Deaths	8	16	3	4	45	9	4
Displaced households	1,182	2,521	486	534	4,543	847	275
Economic losses for buildings[2]	$760 mil	$1.4 bil	$328 mil	$546 mil	$3 bil	$792 mil	$364 mil
Operational the "day after" the event[3]:							
Fire stations	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Police Stations	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Schools	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bridges	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Economic losses to[2]:							
Highways	$33 mil	$49 mil	$44 mil	$69 mil	$74 mil	$22 mil	$39 mil
Airports	$7 mil	$20 mil	$12 mil	$9 mil	$20 mil	$12 mil	$8 mil
Communications	$8 mil	$2 mil	$15 mil	$12 mil	$20 mil	$10 mil	$6 mil
Debris generated (thousands of tons)	474	864	261	411	2,424	525	224

Note: Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[1]Entire county.

[2]"…there are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5).

[3]Because the 500-year model includes several earthquakes, the number of facilities operational the "day after" cannot be calculated.

Source: Wang & Clark (1999)

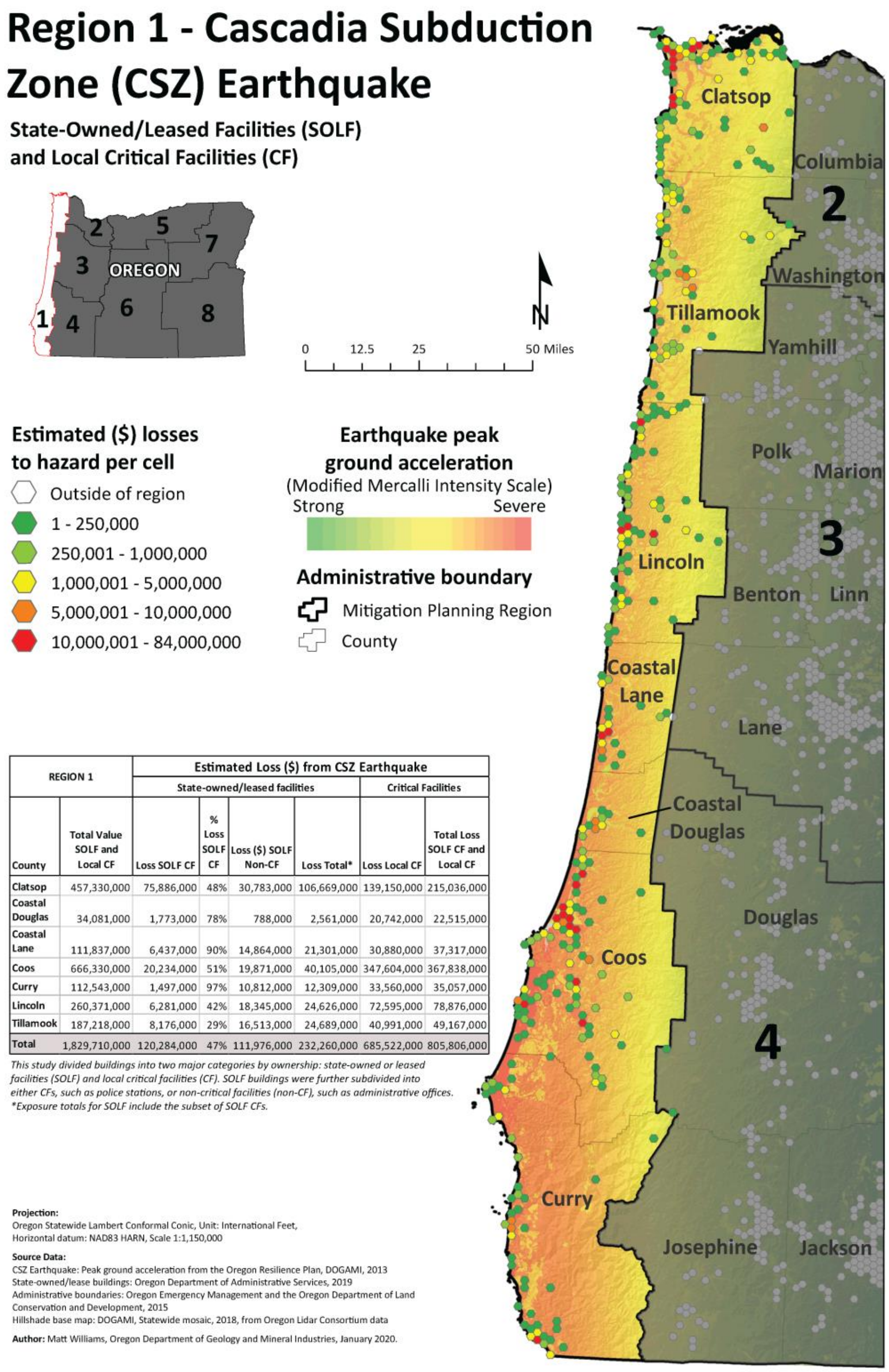
State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

For the 2020 vulnerability assessment, DOGAMI used Hazus-MH to estimate potential loss from a Magnitude 9 Cascadia Subduction Zone (CSZ) event in Region 1. The analysis incorporated information about the earthquake scenario (such as coseismic liquefaction and landslide potential), as well as building characteristics (including the seismic building code and building material). The results of the analyses are provided as a loss estimation (the building damage in dollars) and as a loss ratio (the loss estimation divided by the total value of the building) reported as a percentage at the county level.

DOGAMI used the loss ratio to formulate a separate relative vulnerability score for the state buildings, state critical facilities, and local critical facilities data sets. The percentage of loss for each county was statistically distributed into 5 categories (Very Low, Low, Moderate, High, or Very High).

In Region 1, there is a potential loss of over $232M in state building and critical facility assets to a CSZ event. Almost half of that is in Clatsop County alone. There is a far greater potential loss in local critical facilities: over $685M. Coos County stands to lose the most, about 51% of that total, followed by Clatsop County with about 20%. **Figure 2-130** illustrates the potential loss to state buildings and critical facilities and local critical facilities from a CSZ event.

Figure 2-130. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Cascadia Subduction Zone Earthquake Hazard Zone in Region 1. High-resolution, full-size image linked from Appendix 9.1.26.



REGION 1		Estimated Loss ($) from CSZ Earthquake					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Loss SOLF CF	% Loss SOLF CF	Loss ($) SOLF Non-CF	Loss Total*	Loss Local CF	Total Loss SOLF CF and Local CF
Clatsop	457,330,000	75,886,000	48%	30,783,000	106,669,000	139,150,000	215,036,000
Coastal Douglas	34,081,000	1,773,000	78%	788,000	2,561,000	20,742,000	22,515,000
Coastal Lane	111,837,000	6,437,000	90%	14,864,000	21,301,000	30,880,000	37,317,000
Coos	666,330,000	20,234,000	51%	19,871,000	40,105,000	347,604,000	367,838,000
Curry	112,543,000	1,497,000	97%	10,812,000	12,309,000	33,560,000	35,057,000
Lincoln	260,371,000	6,281,000	42%	18,345,000	24,626,000	72,595,000	78,876,000
Tillamook	187,218,000	8,176,000	29%	16,513,000	24,689,000	40,991,000	49,167,000
Total	1,829,710,000	120,284,000	47%	111,976,000	232,260,000	685,522,000	805,806,000

Source: DOGAMI, 2020

Historic Resources

Of the 3,121 historic resources in Region 1, one hundred sixty-five are in an area of high or very high liquefaction potential. One hundred thirty-eight or 84% are located in Coos County. One thousand, one hundred seventy-two historic resources (38%) in Region 1 are located in areas with high or very high potential for ground shaking amplification.

Archaeological Resources

Of the 1,198 archaeological resources located in earthquake hazard areas in Region 1, two hundred forty are in areas of high earthquake hazards. Of those, 22 are listed on the National Register of Historic Places and 41 are eligible for listing. Nine have been determined not eligible, and 189 have not been evaluated. Thirteen of the 22 listed resources are in Tillamook County and 18 of the 20 eligible resources are in Coos County.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Coos, the coastal portions of Douglas and Lane, and Lincoln Counties are the most vulnerable to earthquake hazards in Region 1.

Seismic Lifelines

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in Section **2.1.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at Appendix **9.1.16**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification*. According to that report, seismic lifelines in Region 1 have the following vulnerabilities.

Region 1 has the most seismically vulnerable highway system of all the geographic zones and is the most difficult to access due to multiple geographic constraints. While it could be argued that the region's critical post-earthquake needs should dictate that all coastal area routes be Tier 1 (first priority roadways), the reality is that — to make the entire lifeline system resilient — the vulnerabilities in Region 1 are so extensive that the majority of the cost would be incurred for repairs done within this region. Furthermore, because of the high vulnerability of the region, it is paramount that emergency services and recovery resources are able to reach this region from other regions. Consequently, all needs are best served with a conservative Tier 1 backbone system, selected according to the criteria described earlier in this Plan.

The Tier 1 (first roadway priority) system in Region 1 consists of three access corridors:

- OR-30 from Portland to Astoria,
- OR-18 from the Willamette Valley to US-101 and north and south on US-101 between Tillamook and Newport, and
- OR-38 from I-5 to US-101 and north and south on US-101 from Florence to Coos Bay.

The Tier 2 (second roadway priority) system in Region 1 consists of three access corridors:

- US-26 from OR-217 in Portland to US-101 and north and south on US-101 from Seaside to Nehalem,
- OR-126 from the Valley to US-101 at Florence, and
- US-101 from Coos Bay to the California border.

The Tier 3 (third roadway priority) system in Region 1 would complete an integrated coastal lifeline system and consists of the following corridors:

- US-101 from Astoria to Seaside,
- US-101 from Nehalem to Tillamook,
- OR-22 from its junction with OR-18 to the Valley,
- OR-20 from Corvallis to Newport,
- OR-42 from I-5 to US-101, and
- US-199 from I-5 to the California border.

Regional Impact. Coastal highways, most importantly US-101, will be fragmented in many areas. In some areas there are possible detours inland from US-101, but many of those routes are also vulnerable to ground shaking, landslides, and other hazards.

- Ground shaking: In Region 1 ground shaking will be intense and prolonged. Most unreinforced structures and many unreinforced roadbeds and bridges will be damaged to varying extents, and it is likely that many damaged areas will become impassable without major repairs.
- Landslides and Rockfall: Many areas along the coast highway, US-101, are cut into or along landslide prone features. Removal of slide and rockfall material is an ongoing responsibility of ODOT Maintenance crews on long stretches of the highway. A major seismic event will increase landslide and rockfall activities and may reactivate ancient slides that are currently inactive.
- Tsunami: Some reaches of US-101 and connecting and parallel routes will be inundated by tsunami. Tsunami debris may block large areas of the street and highway network.
- Liquefaction: Structures in wetland, estuarine, alluvial and other saturated areas will be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event.

Regional Loss Estimates. Highway-related losses include disconnection from supplies and replacement inventory, and the loss of tourists and other customers who must travel to do business with affected businesses.

Most Vulnerable Jurisdictions. The vulnerabilities studied in the OSLR project are geographic rather than jurisdictional. Other research suggests that the risks of a subduction zone seismic event are somewhat higher along the Southern Oregon Coast, but the risks assessed in this study pertain to the vulnerability of highway facilities in the case of a CSZ event and the higher vulnerabilities are generally low lying areas, active and ancient landslide and rockfall areas, and where critical bridges may not be easily repaired or detoured around. Vulnerability also relates to a current conditions context — high groundwater and saturated soils, high tides, and time of day as it relates to where people are relative to the highway system and other vulnerable facilities. Coos, Curry, Douglas, Lane, Lincoln, Tillamook, and Clatsop Counties are all highly vulnerable to a CSZ event.

Risk

Table 2-130. Risk of Earthquake Hazards in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Risk	VH	VH	VH	VH	VH	VH	H

Source: DOGAMI, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the earthquake probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, all the counties in Region 1 except Tillamook County are at very high risk from earthquake hazards; Tillamook County is at high risk.

Extreme Heat

Characteristics

Extreme temperatures are rare on the coast. Most years do not have temperatures above 90°F and years that do, generally only have one or two days. In fact, the relatively cooler temperatures make the coast a destination for relief when the Willamette Valley experiences extreme heat.

Historic Extreme Heat Events

Table 2-131. Historic Extreme Heat Events in Region 1

Date	Location	Notes
June 24–26, 2006	Region 1–3, 5	A broad upper ridge of unusually high height coupled with a thermally induced surface trough of low pressure lingered over the Pacific Northwest for several days. This pattern resulted in persistent offshore flow, and therefore many days of record-smashing high temperatures. Astoria had 85 degrees on June 24 breaking the old record at 81 degrees in 2000.
July 20-24, 2006	Region 1–3, 5, 7	An unusually strong ridge of high pressure brought several days of record breaking hot and humid weather to NW Oregon. Many cities in Oregon saw record-breaking daily high temperatures for multiple days in a row. On July 21, Astoria reported 81°F.
August 25-26, 2016	Region 1, 2	Ridge of high pressure and offshore winds brought temperatures along the North Oregon Coast up into the mid 80s to mid 90s on August 25. News reported 8 runners were taken to the hospital with heat-related injuries during the Hood-to-Coast relay through Portland.

Source: https://www.ncdc.noaa.gov/stormevents

Probability

The relative probability of extreme heat was determined by dividing the counties by quintiles based on historic and projected future frequency of days with heat index above 90°F (as shown in **Figure 2-62**). Counties in the bottom quintile had the lowest frequency of days with heat index above 90°F relative to the rest of the state and were given a score of 1 meaning “very low.” Region 1’s relative probability rankings are shown in **Table 2-132**.

All coastal counties in Region 1 were in the bottom quintile indicating extreme heat is and will continue to be rare on the coast and lowest in frequency of extreme heat days relative to the rest of the state. It is important to note that in counties with “very low” probability like those in Region 1, extreme heat is rare, yet frequency is expected to increase due to climate change.

Table 2-132. Probability of Extreme Heat in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	VL	VL	VL	—	—	VL	VL

Note: Coastal portions of Douglas and Lane counties were not included in Region 1, but in Region 4 and 3, respectively, for this assessment.

Source: Oregon Climate Change Research Institute, https://climatetoolbox.org/

Climate Change

It is *extremely likely* (>95%) that the frequency and severity of extreme heat events will increase over the next several decades across Oregon due to human-induced climate warming (*very high confidence*). Extreme temperatures are rare on the coast (Region 1) and will continue to be rare under future climate change. However, climate model projections indicate that Region 1 counties that are accustomed to no and one days per year may begin to experience extreme heat days with heat index over 90°F by the 2050s under the higher emissions scenario (RCP 8.5) in place. **Table 2-133** lists the number of days exceeding the heat index of 90°F in the historical baseline and future mid-21st century period under RCP 8.5 for counties in Region 1.

Table 2-133. Annual Number of Days Exceeding Heat Index ≥ 90°F for Region 1 Counties

County	Historic Baseline	2050s Future
Clatsop	1	5
Coos	1	7
Curry	3	15
Lincoln	1	6
Tillamook	0	4

Note: Numbers represent the multi-model mean from 18 CMIP5 climate models

Source: Oregon Climate Change Research Institute using data from the Northwest Climate Toolbox, https://climatetoolbox.org/.

Vulnerability

Vulnerability of Oregon counties to extreme heat is discussed in Section 2.2.1.3, **Extreme Heat**. Vulnerability is defined as the combination of sensitivity to extreme heat and level of adaptive capacity in response to extreme heat.

For this assessment, sensitivity to extreme heat events was defined using the Center for Disease Control and Prevention (CDC) 2016 Social Vulnerability Index, https://svi.cdc.gov/data-and-tools-download.html.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

Adaptive capacity to extreme heat is defined here as percent of homes with air conditioning; however, the authors note that this measure has its flaws. First, it assumes that people who have access to cooling systems are able to afford to use them. Second, the data only includes single-family homes, which omits populations living in multi-family housing or who are houseless.

Because extreme heat is rare in Region 1 ("very low" probability), many people may not be accustomed or prepared when an extreme heat event occurs ("moderate" adaptive capacity). In Cooling Zone 1, which includes coastal areas in Region 1, 58% of single-family homes have air-conditioning (https://neea.org/img/uploads/Residential-Building-Stock-Assessment-II-Single-Family-Homes-Report-2016-2017.pdf).

The relative vulnerability of Oregon counties to extreme heat was determined by adding the rankings for sensitivity (social vulnerability) and adaptive capacity (air conditioning). The sum of the two components ranged from 1 to 10. Rankings were determined as follows: total vulnerability scores of 1-2 earned a ranking of 1 (very low); scores of 3-4 earned a ranking of 2 (low); scores of 5-6 earned a ranking of 3 (moderate); scores of 7-8 earned a ranking of 4 (high); and scores of 9-10 earned a ranking of 5 (very high). Rankings for NHMP regions are averages of the counties within a region rounded to the nearest whole number.

Table 2-134 displays the vulnerability rankings as well as rankings for sensitivity and adaptive capacity for each county in NHMP Region 1. Table 2-135 provides the summary descriptors of Region 1's vulnerability.

Combining sensitivity and adaptive capacity, Region 1's total relative vulnerability to extreme heat is "Moderate." Only Coos County's vulnerability is high. Coos County is the most vulnerable to extreme heat in Region 1.

Table 2-134. Relative Vulnerability Rankings for Region 1 Counties

County	Sensitivity	Adaptive Capacity	Vulnerability
Region 1	**3**	**3**	**3**
Clatsop	2	3	3
Coos	4	3	4
Curry	2	3	3
Lincoln	3	3	3
Tillamook	2	3	3

Source: Oregon Climate Change Research Institute

Table 2-135. Vulnerability to Extreme Heat in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	M	H	M	–	–	M	M

Source: Oregon Climate Change Research Institute

Region 1 counties did not rank vulnerability to extreme heat.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

The value of state-owned and leased buildings and critical facilities in Region 1 is approximately $535,054,000 representing the total potential for loss of state assets due to coastal hazards. The value of locally owned critical facilities is $1,294,655,000. Because extreme heat, while uncommon in Region 1, could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to extreme heat. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. According to Department of Administrative Services records, only one minor loss of just over $700 to a state facility was recorded in Region 1 since the beginning of 2015. It was not caused by extreme heat.

Risk

With respect to extreme heat, risk is defined as the combination of the probability of extreme heat events and vulnerability to them, in this assessment sensitivity to extreme heat and level of adaptive capacity in response to extreme heat.

The total relative risk of Oregon counties to extreme heat was determined by adding the rankings for probability and vulnerability (sensitivity and adaptive capacity). The sum of the two components ranged from 1 to 10. Rankings were determined as follows: total risk scores of 1–2 earned a ranking of 1 (“very low”); scores of 3–4 earned a ranking of 2 (“low”); scores of 5–6 earned a ranking of 3 (“moderate”); scores of 7–8 earned a ranking of 4 (“high”); and scores of 9–10 earned a ranking of 5 (“very high”). Rankings for NHMP regions are averages of the counties within a region and rounded to the nearest whole number.

Table 2-136 displays the relative risk ranking as well as rankings for probability and vulnerability for each county in NHMP Region 1. Table 2-137 provides the summary descriptors of Region 1’s risk to extreme heat.

Combining probability and vulnerability, Region 1’s total relative risk to extreme heat is “Low.”

Table 2-136. Risk Rankings for Region 1 Counties

County	Probability	Vulnerability	Risk
Region 1	**1**	**3**	**2**
Clatsop	1	3	2
Coos	1	4	3
Curry	1	3	2
Lincoln	1	3	2
Tillamook	1	3	2

Source: Oregon Climate Change Research Institute

Table 2-137. Risk of Extreme Heat in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Risk	L	M	L	–	–	L	L

Source: Oregon Climate Change Research Institute

Floods

Characteristics

In general, three types of flooding occur in Region 1. These are riverine, ocean flooding from high tides and wind-driven waves, and flooding associated with a tsunami event. Tsunami flooding is not addressed in this section.

Riverine

There are two distinct periods of riverine flooding in Region 1 — winter and late spring — with the most serious occurring December through February. The lower Siletz and Siuslaw rivers in Lincoln and Lane Counties respectively and the rivers that feed Tillamook Bay in Tillamook County have all experienced significant flooding resulting in losses. The situation is especially severe when riverine flooding, caused by prolonged rain and melting snow, coincides with high tides and coastal storm surges. In short, the rivers back up and flood the lowlands. This type of flooding is especially troublesome in the Tillamook Bay area where homes and livestock can be isolated for several days. Several northern coastal rivers carry heavy silt loads that originated in areas burned during the “Tillamook Burn” fires (1933 to 1951) or from areas covered with volcanic ash during the Mount St. Helens eruption (1980). Consequently, some rivers actually may be elevated above local floodplains, which increases flood hazards. The costs and long-term benefits of dredging these rivers have not been determined.

In general, the northern half of Region 1 is more vulnerable to riverine flood damage than the southern half because it is more densely populated and consequently contains much of the region’s infrastructure.

Table 2-138 lists the principal riverine flood sources in Region 1.

Ocean Flooding and Wave Action

Low-lying coastal areas in Region 1 are particularly vulnerable to flood hazards that can be exacerbated by high tides. Flooding from wind-driven waves is common during the winter, during El Niño events, and when spring and perigean tides occur. The Federal Emergency Management Agency has identified and mapped coastal areas subject to direct wave action (V zones) and sand dune over-topping (AH and AO zones). Direct wave action was especially severe during the winter storm events of 1972 (Siletz Spit), 1978 (Nestucca Spit), and the El Niño events of 1982-83 and 1997-98. Significant beach and cliff erosion occurred during these periods and a number of homes were destroyed.

Oregon coastal processes are complex and dynamic, sometimes eroding, sometimes aggrading stream banks. Erosion rates vary and are dependent on several factors including storm duration and intensity, composition of sea cliff, time of year, and impact of human activities (e.g., altering the base of sea cliffs, interfering with the natural movement of beach sand).

While the exact number of buildings, parks, infrastructure, and critical facilities in Region 1 vulnerable to ocean storms is unknown, the low-lying areas adjacent to bays or the ocean are known to be at risk. Bayocean, Salishan Spit, Jumpoff Joe, Rogue Shores, and The Capes are examples of development in such areas whose buildings and infrastructure have been destroyed by wave attack. A number of local governments in Region 1 have initiated and accomplished building elevation and/or buy-out programs. Also, dairy farmers and other businesses have made considerable progress in protecting their investments.

Flood Insurance Rate Maps (FIRM) show flood conditions. The following is a list of Region 1 counties and the dates of their most recent FIRMs:

- Clatsop, September 17, 2010 and June 20, 2018;
- Coos, March 17, 2014 and December 7, 2018;
- Curry, November 16, 2018;
- Douglas, February 17, 2010, revised mapping in preliminary stage;
- Lane, June 2, 1999, revised mapping in preliminary stage;
- Lincoln, October 18, 2019; and
- Tillamook, September 28, 2018.

Historic Flood Events

Table 2-138. Historic Floods in Region 1

Date	Location	Description	Type of Flood
1813	NW Oregon	said to exceed “Great Flood” of 1861 (source: Native Americans)	unknown
Dec. 1861	coastal rivers	the “Great Flood”; largest flood of known magnitude on the Rogue	rain on snow
Feb. 1890	coastal rivers	widespread flooding; Siuslaw River dammed by a large debris flow	rain on snow
Jan. 1923	Lower Columbia	mild temperatures; large amount of rain; flooded roads and railroads	rain on snow
Mar. 1931	western Oregon	extremely wet and mild; saturated ground	rain on snow
Dec. 1933	northern Oregon	intense warm rains; Clatskanie River set record	rain on snow
Dec. 1937	western Oregon	heavy coastal rain; large number of debris flows	rain on snow
Oct. 1950	SW Oregon coast	heavy October rain	rain on snow
Dec. 1953	western Oregon	heavy rain accompanied major windstorm; serious log hazards on Columbia	rain on snow
Dec. 1955	Columbia and coastal streams	series of storms; heavy, wet snow; many homes and roads damaged	rain on snow
Dec. 1962	SW Oregon	severe flooding, especially the Rogue River	rain on snow
Mar. 1964	coast and Columbia River estuary	Ocean flooding	tsunami
Dec. 1964	entire state	two storms; intense rain on frozen ground	rain on snow
Jan. 1972	northern coast	severe flooding and mudslides; 104 evacuated from Tillamook	rain on snow
Jan. 1974	western Oregon	series of storms with mild temperatures; large snowmelt; rapid runoff	rain on snow
Dec. 1978	coastal streams	Intense warm rain; two fatalities on Yaquina River; widespread flooding	rain on snow
Feb. 1986	entire state	warm rain and melting snow; numerous homes evacuated	rain on snow

Date	Location	Description	Type of Flood
Feb. 1987	western Oregon	heavy rain; mudslides; flooded highways; damaged homes	rain on snow
Dec. 1989	Clatsop, Tillamook and Lincoln	warm Pacific storm system; high winds; fatalities; mudslides	rain on snow
Jan. 1990	W. Oregon	significant damage in Tillamook County; many streams had all-time records	rain on snow
Apr. 1991	Tillamook County	48-hour rainstorm. Wilson River 5 ft. above flood stage; businesses closed	rain on snow
Feb. 1996	NW Oregon	deep snowpack; warm temperatures; record-breaking rains	rain on snow
Nov. 1996	W. Oregon	record-breaking precipitation; flooding; landslides (FEMA-1149-DR-Oregon)	rain on snow
Dec. 1998	Lincoln and Tillamook Counties		
Nov. 1999	Coastal rivers in Lincoln and Tillamook Counties	heavy rainfall and high tides	riverine and ocean flooding
Jan. 2000	Curry, Douglas and Josephine Counties	A Flood Warning was issued for the South fork of the Coquille River from Myrtle Point to Coquille City, North and South forks of the Coquille River. Brookings recorded 4.72 inches of rain, a record for the date. Two Small Stream Flood Advisories were issued, the first, for Elk Creek, the second for Deer Creek. A Flood Warning was issued for the lower Rogue River from Agness to Gold Beach.	riverine
Dec. 2005	Coos, Curry, and Douglas Counties	$2,840,000.00 in property damage (includes Jackson and Josephine Counties)	riverine
Nov. 2006	Tillamook County	heavy rains caused major flooding in Nehalem and Tillamook, causing $1 million in damage in Nehalem and $15 million in Tillamook (DR-1672)	riverine
Nov. 2006	Lincoln County	Siletz River crested at 7 feet above flood stage	riverine
Dec. 2006	Coos County	two floods in Coos County on the Coquille River inundated several roads, including OR-42 and OR-42S	riverine
Dec. 2007	Clatsop County	storm total of 7.3 inches of rain, causing many rivers to overflow their banks. $9.15 million in damages	riverine
Dec. 2007	Columbia County	Nehalem (Vernonia)	riverine
Dec. 2007	Tillamook County	heavy rains led to flooding in Tillamook along the Wilson River damaging businesses, homes, the railroad to the Port; county-wide damages total 26 million	riverine
Dec. 2007	Lincoln County	Siletz River had moderate flooding, causing flood damage near Siletz and Lincoln City; total county-wide damages include $124,000 in damages inland and $31,000 damages for coastal property	riverine
Dec. 2007	Lane County	flooding along coast, $31,000 in property damage	riverine
Dec. 2007	Curry County	Rogue river exceeds flood stage, but no known damages	riverine
Dec. 2008	Tillamook County	Flooding caused by convergence of heavy precipitation and high tides; heavy rainfall caused flooding in downtown Tillamook; estimate of $3.8 million in damages throughout Tillamook County	riverine/ocean flooding

Date	Location	Description	Type of Flood
Jan. 2011	Clackamas, Clatsop, Douglas, Lincoln, and Tillamook Counties	severe winter storm, flooding, mudslides, landslides, and debris flows (DR-1956)	riverine
Jan. 2012	Coos, Curry, Lincoln, and Tillamook Counties	a severe winter storm including flooding, landslides, and mudslides affected mostly the southern Oregon coastal counties	riverine
Nov. 2012	Curry and Josephine Counties	heavy precipitation caused over $4 million in damages to public infrastructure	riverine, sheet flow
Sep. 2013	Tillamook County	heavy rain caused flooding at the Wilson River	riverine
Feb. 2014	Lane, Coos, Marion and Tillamook and Counties	A series of fronts resulted in a prolonged period of rain for Northwest Oregon, and minor flooding of several of the area's rivers from February 12th through February 17th. Heavy rains caused the Coquille River at Coquille to flood. The flood was categorized as a moderate flood. The Nehalem River near Foss in Tillamook County exceeded flood stage on February 18th, 2014.	riverine
Mar. 2014	Tillamook County	Heavy rain resulted in the Nehalem River to flood near Foss. The river reached flood stage around 2 pm March 6, and crested at 14.8 feet at 8 pm	riverine
Dec. 2014	Tillamook, Lincoln, Lane, Coos, and Douglas Counties	A slow moving front produced heavy rain over Northwest Oregon which resulted in the flooding of eight rivers. Another impact from the rain were a couple of land/rock slides that both blocked two highways. Heavy rain brought flooding to several rivers in southwest Oregon.	riverine
Feb. 2015	Curry, Coos, and Douglas Counties	Heavy rains caused flooding on the Rogue River at Agness and along the Coquille River at Coquille.	riverine
Nov. 2015	Tillamook County	A very moist frontal system produced heavy rain across the region resulting in flooding. Rain rates of 0.3 to 0.5 inch per hour was observed for several hours at many locations. The 5 day rainfall total ending in the morning on November 17th for Lees Camp, OR was 14.60 inches.	riverine
Dec. 2015	Tillamook, Lincoln, Washington, Lane, Coos, Douglas and Curry Counties	A moist pacific front produced heavy rainfall across Northwest Oregon which resulted in river flooding, urban flooding, small stream flooding, landslides, and a few sink holes. After a wet week (December 5 through Dec 11), several rivers were near bank full ahead of another front on December 12th. Flooding from the Nehalem River and Rock Creek in Vernonia resulted in evacuation of homes and the implementation of the Vernonia Emergency Command Center. Heavy rain resulted in a land slide that closed OR47 at mile marker 8. More than $15 million dollars in property damage reported in these counties combined.	riverine
Jan. 2016	Curry and Coos Counties	Heavy rain brought flooding to some areas of southwest Oregon. Minor flooding on the Rogue at Agness and moderate flooding on the Coquille River at Coquille.	riverine
Oct. 2016	Tillamook County, Northern Oregon Coast	The combination of heavy rain, large swell, and high tides brought minor tidal overflow flooding during high tides to the North Oregon Coast.	riverine/ocean flooding

Date	Location	Description	Type of Flood
Nov. 2016	Columbia, Tillamook, Lincoln, and Washington Counties	A moist Pacific front moving slowly across the area produced heavy rainfall, resulting in flooding of several rivers across Northwest Oregon and at least two landslides.	riverine
Dec. 2016	Douglas, Coos and Curry Counties	Heavy rain brought some areal flooding to parts of southwest Oregon.	riverine
Jan. 2017	Coos and Curry Counties	An extended period of heavy rain combined with snowmelt to cause flooding of the Coquille River the South Fork of the Coquille River and, the Rogue River flooded at Agness flooded twice that month.	riverine/rain on snow
Feb. 2017	Washington, Columbia, Tillamook, Lane, Coos, and Curry Counties	High river flows combined with high tide to flood some areas near the southern Oregon coast. Heavy rain combined with snow melt caused flooding along the Coquille River and the Rogue River twice this month in southwest Oregon. Heavy rain combined with snow melt caused flooding along the Sprague River in south central Oregon. Flows on the John Day river reached flood levels downstream of Monument due to the breaking up of an ice jam.	riverine/ocean flooding/rain on snow
Oct. 2017	Tillamook County	A very potent atmospheric river brought strong winds to the north Oregon Coast and Coast Range on October 21st. What followed was a tremendous amount of rain for some locations along the north Oregon Coast and in the Coast Range, with Lees Camp receiving upwards of 9 inches of rain. All this heavy rain brought the earliest significant Wilson River Flood on record, as well as flooding on several other rivers around the area.	riverine
June 2018	Lane County	In Lane County an upper-level trough moved across the area from the southwest, generating strong thunderstorms which produced locally heavy rainfall, lightning, hail, and gusty winds.	riverine
Dec. 2018	Tillamook County	A strong low pressure system over the Gulf of Alaska brought a strong cold front through. This generated strong winds across northwest Oregon, and also brought heavy rain which caused flooding on the Tillamook river. Large seas also caused damage in spots along beaches.	riverine/ocean flooding
Jan. 2019	Coos and Curry Counties	A weekend of very heavy rain led to river rises across southern Oregon. The Rogue River at Agness exceeded flood stage and the Coquille River at Coquille flooded as well.	riverine
Feb. 2019	Douglas, Coos and Curry Counties	Very heavy rain along with the melting of recent snowfall caused flooding at several locations in southern Oregon in late February. Deer Creek at Roseburg, South Fork of the Coquille at Myrtle Point, North Fork of the Coquille at Myrtle Point, the Coquille River at Coquille and the Rogue River at Agness all exceeded flood stage.	riverine/rain on snow
April 2019	Douglas, Coos and Curry Counties	Two days of very heavy rainfall (compared to April normals) combined with snowmelt led to areal flooding in southwest and south central Oregon.	riverine/rain on snow

Source: Taylor and Hannan (1999), Source: Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://hvri.geog.sc.edu/SHELDUS/index.cfm?page=faq. National Climatic Data Center, Storm Events, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms; NOAA Storm Event Database, (http://www.ncdc.noaa.gov/stormevents/), January 2020; Planning for Natural Hazards: Flood TRG (Technical Resource Guide), July 2000, DLCD, Community Planning Workshop.

Table 2-139. Principal Riverine Flood Sources by County in Region 1

Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Lewis and Clark R	Coquille R	Chetco R	Umpqua R	Siuslaw R	Alsea R	Kilchis R
Little Walluski R	Willicoma R	Elk R	Smith R	Munsel Cr	Salmon R	Miami R
Necanicum R	Ten Mile Cr	Pistol R	Scholfield Cr		Siletz R	Nehalem R
Nehalem R	Palouse Cr	Rogue R			Yachats R	Nestucca R
Bear Cr	Larson Cr	Sixes R			Yaquina R	Three Rivers
Beerman Cr	Kentuck Sl	Winchuck R			Drift Cr	Tillamook R
Big Cr	Willanch Sl	Hunter Cr			Depot Cr	Trask R
Cow Cr	Pony Cr				Ollala Cr	Wilson R
Fishhawk Cr					Schooner Cr	Dogherty Sl
Humbug Cr						Hoquarten Sl
Little Cr						
Neacoxi Cr						
Neawanna Cr						
Northrup Cr						
Plymton Cr						

Note: R = river, Cr = creek, Sl = slough.

Sources: Federal Emergency Management Agency (FEMA), Clatsop County Flood Insurance Study (FIS), July 17, 2001, FEMA, Coos County FIS, May 15, 1984, FEMA, Curry County FIS, Feb. 04, 1998, FEMA, Douglas County FIS, Apr. 21, 1999, FEMA, Lane County FIS, June 02, 1999, FEMA, Lincoln County FIS, Mar. 1, 1980, FEMA, Tillamook County FIS, Aug. 20, 2002.

Probability, Vulnerability, and Risk

Different methods are used to assess probability and vulnerability at local and state levels. These methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. A description of the "OEM Hazard Analysis Methodology" used by local governments is provided in Section 2.1, **Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in Appendix **9.1.19**.

The purpose of the probability and vulnerability scores is to identify high-priority areas to which local and state governments can target mitigation actions.

Probability

Local Assessment

Participants in each county's Natural Hazard Mitigation Plan update process used the OEM Hazard Analysis Methodology to analyze the probability that Region 1 will experience flooding. The resulting estimates of probability are shown in **Table 2-140**.

Table 2-140. Local Assessment of Flood Probability in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	H	H	H	H	H

Source: Clatsop County NHMP (2020 draft), Coos County NHMP (2016), Curry County NHMP (2016), Douglas County NHMP (2016), Lane County NHMP (2018), (Lincoln County NHMP (2015, rev. 2017), Tillamook County NHMP (2017).

State Assessment

Using the methodology described in Section **2.2.5.2**, Floods > Probability, the state assessed the probability of flooding in the counties that comprise Region 1. The results are shown in **Table 2-141**.

Table 2-141. State Assessment of Flood Probability in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	VH	VH	VH	VH*	VH*	VH	VH

*The coastal portions of Douglas and Lane Counties could not be split out from the probability analysis of the whole county. For the purposes of the 2020 Risk Assessment calculations, the coastal portions of Douglas and Lane Counties were assigned a probability value consistent with the other coastal counties

Source: DOGAMI

Climate Change

It is very likely (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (high confidence). The likelihood of increase in extreme precipitation events is greater east of Cascades than west. Extreme river flow, while affected by extreme precipitation, is also driven by antecedent conditions (soil moisture, water table height), snowmelt, river network morphology, and spatial variability in precipitation and snowmelt. Most projections of extreme river flows show increases in flow magnitude at most locations across Oregon. However, large increases in extreme flows are least likely along the Lower Columbia Basin (northern border of Region 1).

Overall, it is more likely than not (>50%) that increases in extreme river flows will lead to an increase in the incidence and magnitude of damaging floods (low confidence), although this depends on local conditions (site-dependent river channel and floodplain hydraulics). Increases in extreme river flows leading to damaging floods will be less likely where storm water management (urban) and/or reservoir operations (river) have capacity to offset increases in flood peak.

Vulnerability

Table 2-142. Local Assessment of Vulnerability to Flood in Region 1

	Clatsop	Coos	Curry	Douglas (coastal)	Lane	Lincoln	Tillamook
Vulnerability	H	M	H	M	H	M	H

Source: Clatsop County NHMP (2020 draft), Coos County NHMP (2016), Curry County NHMP (2016), Douglas County NHMP (2016), Lane County NHMP (2018), (Lincoln County NHMP (2015, rev. 2017), Tillamook County NHMP (2017)

Table 2-143. State Assessment of Vulnerability to Flood in Region 1

	Clatsop	Coos	Curry	Douglas (coastal)	Lane	Lincoln	Tillamook
Vulnerability	L	H	VL	H	M	L	L

Source: DOGAMI, DLCD

As part of Multi-Hazard Hazard Risk Reports, DOGAMI performed flood loss estimate analyses in Clatsop, Coos, and Curry Counties by overlaying building locations on the 100-year flood extent. By comparing the number of non-damaged buildings from Hazus-MH with exposed buildings in the flood zone, DOGAMI estimated the number of buildings that could be elevated above the level of flooding. In Clatsop County of the 3,011 buildings that are exposed to flooding, DOGAMI estimate that 482 are above the height of the 100-year flood. In Coos County, of the 2,055 buildings that are exposed to flooding, 185 are above the height of the 100-year flood. In Curry County, of the 464 buildings that are exposed to flooding, 55 are estimated to be above the height of the 100-year flood. This evaluation can also shed some light on the number of residents that might have mobility or access issues due to surrounding water. In Clatsop County, 4,498 residents might have mobility or access issues due to surrounding water. In Coos County, 2,116 residents might have mobility or access issues and in Curry County 411 residents might have mobility or access issues due to flooding of surrounding land.

The DOGAMI Risk Assessment and exposure analysis found that 14 of Clatsop County's critical facilities are at risk to flood hazard. Of these the majority are located in Warrenton including the Port of Astoria, Providence Medical Clinic – Warrenton, US Coast Guard Air Station, Warrenton Grade School and High School, the Warrenton Police Department, Fire Department and Public Works Department. The exposure analysis for Coos County found that 13 of the county's critical facilities could be damaged by flooding. The majority of these are located in Coos Bay including Blossom Gulch Elementary School, the Coos Bay Police Department, the Wastewater Department, the International Port of Coos Bay Port Office, the US Coast Guard Station – Cutter Orcas, the Coos Bay Coast Guard Station, and the offices of Pacific Power, as well as Coquille High School, Lakeside Water Treatment plant and Myrtle Point and Bandon's Water Plants. In Curry County only one critical facility was found to be exposed to flooding that being the Port of Port Orford.

For Douglas, Lane, Lincoln and Tillamook Counties the most recent NHMPs do not include analyses of vulnerabilities of specific critical infrastructure. They do include general observations about population, economic, infrastructure, critical facilities, built environment and cultural and historic resources at risk of damage from flooding.

Repetitive Losses

FEMA has identified 138 Repetitive Loss (RL) properties in Region 1, three of which are Severe Repetitive Loss (SRL) properties. This region has the most repetitive flood losses of any of the Oregon NHMP Natural Hazard Regions, reflecting the high rainfall amounts characteristic of the coastal region and the high density of watercourses. The coast is also subject to flooding from the Pacific Ocean.

Table 2-144. Flood Severe/Repetitive Loss Buildings and Community Rating System Communities by County in Region 1

County	RL/SRL	# of CRS Communities per County
Clatsop	5	0
Coos	16	0
Curry	3	0
*Douglas	—	0
*Lane	—	0
Lincoln	47	0
Tillamook	62	2
Total	**133**	**2**

* Not currently possible to include only coastal sections of Douglas and Lane Counties.

Source: FEMA NFIP Community Information System, https://portal.fema.gov/famsVuWeb/home, accessed February 2020

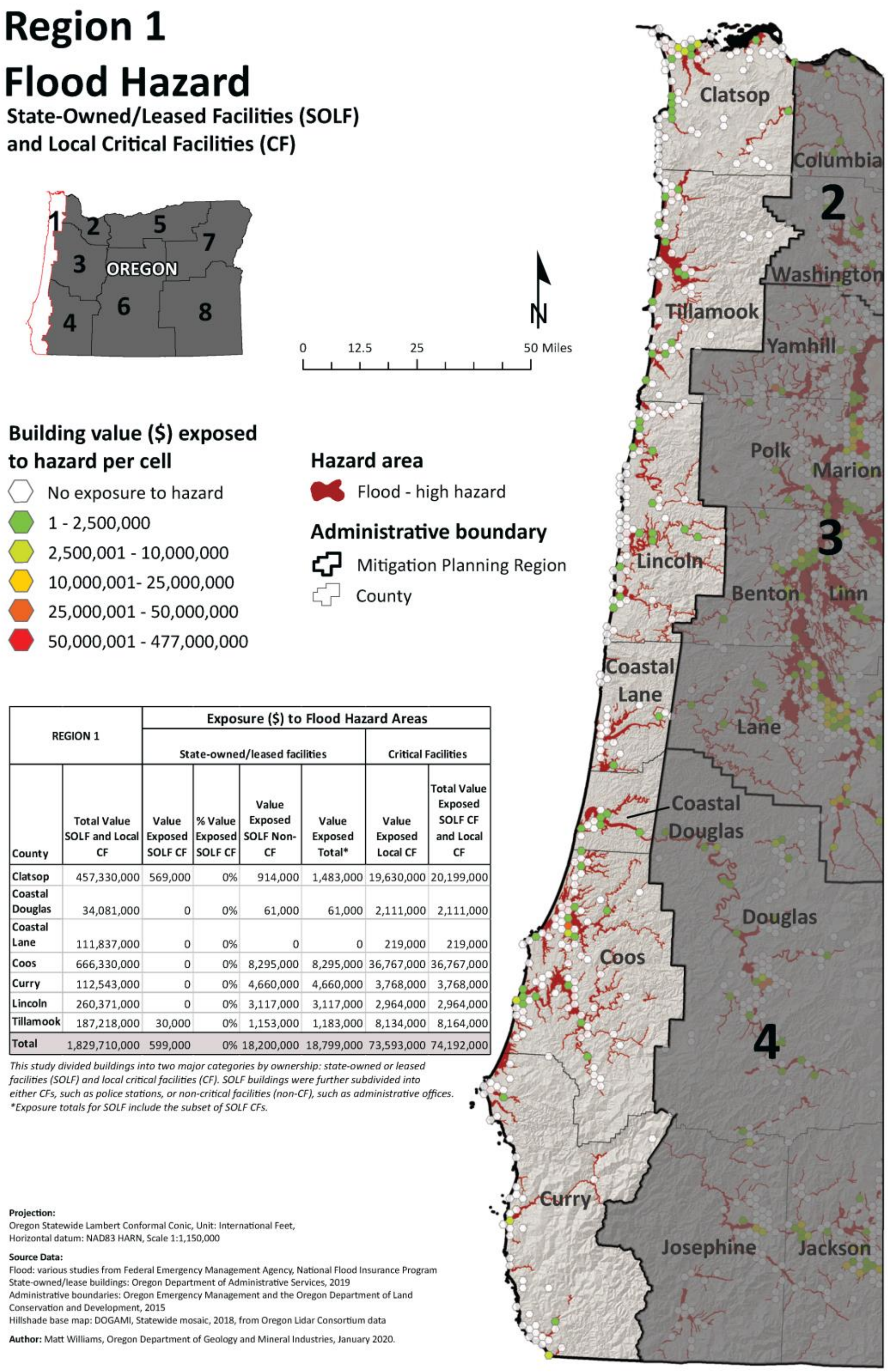
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs. Lane Counties participates in CRS, as do the cities of Nehalem and Tillamook.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

For the 2020 Risk Assessment, DOGAMI used a combination of FEMA effective and preliminary flood zone data (FEMA National Flood Hazard Layer, 2019) and FEMA Q3 data (an unpublished digital dataset of paper flood insurance rate maps). All FEMA data that DOGAMI used was current as of 2019. The flood hazard was not divided in to High, Moderate, or Low categories due to the wide variety of flood data, its variable absolute and relative accuracy, and its variable geographic coverage and completeness. Rather, when a building was located within a floodway, 100-year floodplain, or 500-year floodplain, a "High" flood hazard was designated. When there was insufficient information to determine whether a flood hazard exists for a given site, the flood hazard was designated "Other." Sites with "Other" designations could conceivably face relatively high flood hazards or no flood hazard at all.

In Region 1, there is a potential loss from flooding of close to $19M in state building and critical facility assets, 44% of it in Coos County, about 25% in Curry County, and about 17% in. Lincoln County. Clatsop, Tillamook, and the coastal portion of Douglas County each have less than 10% and the coastal portion of Lane County has none. There is a far greater potential loss due to flood in local critical facilities: over $73M, almost four times as much. Fifty percent of that value is located in Coos County; 27% in Clatsop County. The other counties have 11% or less. **Figure 2-131** illustrates the potential loss to state buildings and critical facilities and local critical facilities from flooding.

Figure 2-131. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Flood Hazard Zone in Region 1. High-resolution, full-size image linked from Appendix 9.1.26.



REGION 1		Exposure ($) to Flood Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Clatsop	457,330,000	569,000	0%	914,000	1,483,000	19,630,000	20,199,000
Coastal Douglas	34,081,000	0	0%	61,000	61,000	2,111,000	2,111,000
Coastal Lane	111,837,000	0	0%	0	0	219,000	219,000
Coos	666,330,000	0	0%	8,295,000	8,295,000	36,767,000	36,767,000
Curry	112,543,000	0	0%	4,660,000	4,660,000	3,768,000	3,768,000
Lincoln	260,371,000	0	0%	3,117,000	3,117,000	2,964,000	2,964,000
Tillamook	187,218,000	30,000	0%	1,153,000	1,183,000	8,134,000	8,164,000
Total	1,829,710,000	599,000	0%	18,200,000	18,799,000	73,593,000	74,192,000

Source: DOGAMI, 2020

Historic Resources

Of the 3,121 historic resources in Region 1, two hundred fifty-three (8%) are located in an area of high flood hazard, 40% of those in Curry County alone. Clatsop County, the coastal portion of Douglas County, and Tillamook County follow with 19%, 16%, and 13%, respectively.

Archaeological Resources

Of the 536 archaeological resources located in high flood hazard areas in Region 1, almost half (45%) are located in Coos County. Close to 20% are located in Lincoln County. Seventy-five (14%) are listed on the National Register of Historic Places and 41 (8%) are eligible for listing. Twenty-seven have been determined not eligible and 393 have not been evaluated as to their eligibility. Together, Coos and Curry Counties are the location of almost 60% of the listed and eligible archaeological resources in Region 1. At 49%, Coos County has significantly more of the unevaluated resources than any other county in Region 1.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Coos County and the coastal portion of Douglas County are most vulnerable to flooding with high scores. Lane County follows with a moderate score, and the other counties all have low or very low vulnerability. The two high scores are driven by high social vulnerability. Region 1 has very low to moderate scores for potential loss to state buildings and critical facilities and local critical facilities.

Most Vulnerable Jurisdictions

While all the counties in Region 1 are vulnerable to flooding, Coos County is the most vulnerable with its high social vulnerability, significant trove of archaeological resources, significant number of repetitive or severe repetitive loss properties, high percentages of state building, state critical facility, and local critical facility value in a high flood hazard area, and low percentage of buildings exposed to flood hazards that are above flood level.

Risk

Table 2-145. Risk of Flood Hazards in Region 1

	Clatsop	Coos	Curry	Douglas (coastal)	Lane	Lincoln	Tillamook
Risk	VH	VH	H	VH	VH	VH	VH

Source: DOGAMI, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, all the counties in Region 1 are at high or very high risk from flooding. Given its significant vulnerabilities, Coos County is at greatest risk.

Dam Safety

The Oregon Water Resources Department (OWRD) is the state authority for dam safety with specific authorizing laws and implementing regulations. Oregon's dam safety laws were re-written by HB 2085 which passed through the legislature and was signed by Governor Brown in 2019. This law becomes operative on July 1, 2020, with rules and guidance have been drafted and are currently in the public review and comment period.

OWRD coordinates on but does not directly regulate the safety of dams owned by the United States or most dams used to generate hydropower. OWRD is the Oregon Emergency Response System contact in the event of a major emergency involving a state-regulated dam, or any dam in the State if the regulating agency is unknown. The Program also coordinates with the National Weather Service and the Oregon Office of Emergency Management on severe flood potential that could affect dams and other infrastructure.

Analysis and Characterization

Oregon's statutory size threshold for dams to be regulated by OWRD is at least 10 feet high and storing at least 3 million gallons. Many dams that fall below this threshold have water right permits for storage from OWRD.

Under normal loading conditions dams are generally at very low risk of failure. Specific events are associated with most dam failures. Events that might cause dams to fail include:

- An extreme flood that exceeds spillway capacity and causes an earthen dam to fail;
- Extended high water levels in a dam that has no protection against internal erosion;
- Movement of the dam in an earthquake; and
- A large rapidly moving landslide impacting the dam or reservoir.

Landslides are a significant hazard in many parts of Oregon, and some dams are constructed on landslide deposits. Though not common, a large and rapidly moving landslide or debris flow may generate a wave that can overtop a dam, causing significant flooding, especially if it causes a dam to fail.

Wildfires may increase the risk of debris flows (though wildfire generated debris flows are typically on the smaller size scale). Wildfires and windstorms can also result in large woody debris that can block spillways, also a risk to dam integrity. Oregon will be evaluating both landslide and wildfire risks during its HHPD grant funded risk assessments of dams currently eligible for the program.

Most of the largest dams, especially those owned or regulated by the Federal Government are designed to safely withstand these events and have been analyzed to show that they will. However, there are a number of dams where observations, and sometimes analysis indicates a deficiency that may make those dams susceptible to one or more of the events. The large majority of state regulated dams do not have a current risk assessment or analysis, and safe performance in these events is uncertain.

Failures of some dams can result in loss of life, damage to property, infrastructure, and the natural environment. The impacts of dam failures range from local impacts to the owner's property and waters below the dam to community destruction with mass fatalities. The 1889 Johnston Flood in Pennsylvania was caused by a dam failure and resulted in over 2000 lives lost.

Oregon's first dam safety laws were developed in response to the St. Francis dam failure in California in 1928. That failure was attributed to unsafe design practice, and because of this about 500 persons perished. In modern times (2006) a dam owner filled in the spillway of a dam on the island of Kauai causing dam failure that killed 7 people. This dam had no recent dam safety inspections because the hazard rating was incorrect.

Where a dam's failure is expected to result in loss of life downstream of the dam, an Emergency Action Plan (EAP) must be developed. The EAP contains a map showing the area that would potentially be inundated by floodwaters from the failed dam. These dams are often monitored so that conditions that pose a potential for dam failure are identified to allow for emergency evacuations.

Table 2-146. Historic Significant Dam Failures in Region 1

Year	Location	Description
1996	Powers Log Pond in Powers in south Coos Co.	Damaged road and limited damage to dwellings

Source: Oregon Water Resources Department Dam Safety Program records

Dam Hazard Ratings

Oregon follows national guidance for assigning hazard ratings to dams and for the contents of Emergency Action Plans, which are now required for all dams rated as "high hazard." Each dam is rated according to the anticipated impacts of its potential failure. The state has adopted these definitions (ORS 540.443–491) for state-regulated dams:

- "High Hazard" means loss of life is expected if the dam fails.
- "Significant Hazard" means loss of life is not expected if the dam fails, but extensive damage to property or public infrastructure is.
- "Low Hazard" is assigned to all other state-regulated dams.
- "Emergency Action Plan" means a plan that assists a dam owner or operator, and local emergency management personnel, to perform actions to ensure human safety in the event of a potential or actual dam failure.

Hazard ratings may change for a number of reasons. For example, a dam's original rating may not have been based on current inundation analysis methodologies, or new development may have changed potential downstream impacts.

There are 12 High Hazard dams and 5 Significant Hazard dams in Region 1.

Table 2-147. Summary: High Hazard and Significant Hazard Dams in Region 1

	Hazard Rating		
	State		Federal
	High	Significant	High
Region 1	**12**	**5**	**0**
Clatsop	4	1	0
Coos	2	4	0
Curry	1	0	0
Lincoln	5	0	0
Tillamook	0	0	0

Source: Oregon Water Resources Department, 2019

Table 2-148. High Hazard and Significant Hazard Dams in Region 1

County	Name	Rating	Regulator
Clatsop	Bear Creek	High	State
Clatsop	Middle	High	State
Clatsop	Seaside City	High	State
Clatsop	Wickiup Lake (Astoria)	High	State
Clatsop	Fishhawk Lake	Significant	State
Coos	Pony Creek - Lower	High	State
Coos	Pony Creek - Upper	High	State
Coos	Jackson Farms Dam	Significant	State
Coos	Powers Log Pond	Significant	State
Coos	Rink Creek Reservoir	Significant	State
Coos	Windhurst	Significant	State
Curry	Ferry Creek	High	State
Lincoln	Big Creek #1 (Lower)	High	State
Lincoln	Big Creek #2 (Upper)	High	State
Lincoln	Mill Creek	High	State
Lincoln	Olalla	High	State
Lincoln	Spring Lake	High	State

Source: Oregon Water Resources Department, 2019

Probability

Engineering risk assessment and analysis of a dam is the best indicator of the probability of failure. Without that, the condition of a dam as determined by OWRD engineering staff is a helpful indicator OWRD has for of the failure potential of a dam.

Dam safety regulators determine the condition of high hazard rated dams, both state- and regulated. A dam’s condition is considered public information for state-regulated dams, but the conditions of federally regulated dams are generally not subject to disclosure. State-regulated significant hazard dams do not yet have condition ratings.

Oregon uses FEMA’s condition classifications. These classifications are subject to change and revisions are being considered at the national level. Currently, FEMA’s condition classifications are:

- “Satisfactory” means no existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.
- “Fair” means no existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.
- “Poor” means a dam safety deficiency is recognized for loading conditions that may realistically occur. Remedial action is necessary. A poor rating may also be used when

uncertainties exist as to critical analysis parameters that identify a potential dam safety deficiency. Further investigations and studies are necessary.

- "Unsatisfactory" means a dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.
- "Not Rated" means the dam has not been inspected, is not under State jurisdiction, or has been inspected but, for whatever reason, has not been rated.

Only two of the twelve state-regulated high hazard dams are in satisfactory condition. Five are in poor or unsatisfactory condition.

Table 2-149. Summary: Condition of High Hazard State-Regulated Dams in Region 1

	Condition of State-Regulated High Hazard Dams				
	Satisfactory	**Fair**	**Poor**	**Unsatisfactory**	**Not Rated**
Region 1	2	5	2	3	0
Clatsop	0	3	1	0	0
Coos	1	0	1	0	0
Curry	0	0	0	1	0
Lincoln	1	2	0	2	0
Tillamook	0	0	0	0	0

Source: Oregon Water Resources Department, 2019

Table 2-150. Condition of High Hazard State-Regulated Dams in Region 1

County	Dam Name	Condition
Clatsop	Middle	Fair
Clatsop	Seaside City	Fair
Clatsop	Wickiup Lake (Astoria)	Fair
Clatsop	Bear Creek	Poor
Coos	Pony Creek - Lower	Poor
Coos	Pony Creek - Upper	Satisfactory
Curry	Ferry Creek	Unsatisfactory
Lincoln	Mill Creek	Fair
Lincoln	Olalla	Fair
Lincoln	Spring Lake	Satisfactory
Lincoln	Big Creek #1 (Lower)	Unsatisfactory
Lincoln	Big Creek #2 (Upper)	Unsatisfactory

Source: Oregon Water Resources Department, 2019

State-Regulated High Hazard Dams not Meeting Safety Standards

There are five state-regulated high hazard dams in Region 1 that are currently assessed to be below accepted safety standards (in Poor or Unsatisfactory Condition). These dams and the population at risk, based on a screen using the screening tool DSS-WISE, are shown in Table 2-151. As the dam safety program conducts analysis over time, the number of dams in less than satisfactory condition may change. Currently dams that are in poor or unsatisfactory condition are in need of rehabilitation or other action to bring them into a fully safe condition. As of

December 2019, these are the dams in Region 1 that are not yet demonstrably unsafe, but that do pose unacceptable risk. When Oregon's new dam safety laws take effect July 1, 2020, the condition of some of these dams may be reclassified as unsafe or potentially unsafe.

It is important to note that many state regulated dams have not received a deep level of risk analysis and review, so the number of dams not meeting minimum standards may increase as additional analyses are performed.

Table 2-151. State-Regulated High Hazard Dams Not Meeting Safety Standards in Region 1

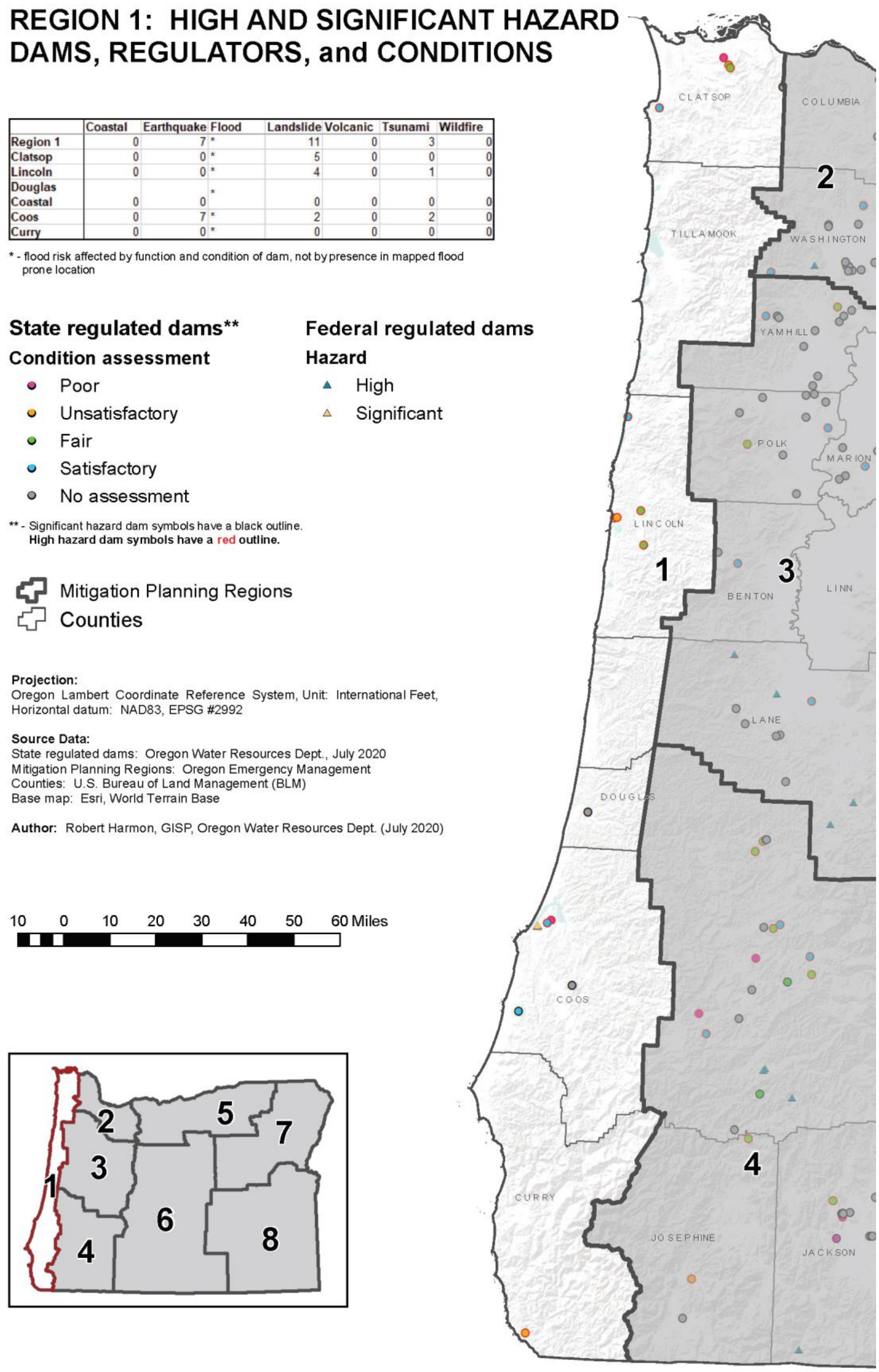
Dam	NID#	Condition Rating	Daytime PAR (number of people)	Nighttime PAR (number of people)	County
Bear Creek (Astoria)	OR00449	POOR	20	57	Clatsop
Pony Creek Lower	OR00070	POOR	687	408	Coos
Ferry Creek	OR00437	UNSAT	84	25	Curry
Big Creek Reservoir #1 (Lower)	OR00225	UNSAT	16	35	Lincoln
Big Creek Reservoir #2 (Upper)	OR00473	UNSAT	26	52	Lincoln

Note: "PAR" is number of "Persons At Risk" in the dam failure inundation zone based on a conservative estimate using DSS-Wise dam breach estimator. It includes all persons that normally could be in the inundation area. Actual impacts depend on the velocity and depth of water and will be determined as part of Oregon's HHPD grant tasks.

Source: DSS-Wise output

Figure 2-132 shows state- and federally regulated high and significant hazard dams as well as the condition of state-regulated dams in Region 1. The table on the map shows the total number of these dams in each of the seven mapped hazard areas.

Figure 2-132. High- and Significant-Hazard Dams, Regulators, and Conditions in Region 1



	Coastal	Earthquake	Flood	Landslide	Volcanic	Tsunami	Wildfire
Region 1	0	7	*	11	0	3	0
Clatsop	0	0	*	5	0	0	0
Lincoln	0	0	*	4	0	1	0
Douglas Coastal	0	0	*	0	0	0	0
Coos	0	7	*	2	0	2	0
Curry	0	0	*	0	0	0	0

Climate Change

Most climate change models indicate there may be more extreme precipitation due to the increased energy in the oceanic and atmospheric systems. Of main concerns for dams is the potential for larger floods than experienced in the past. Almost half of the historical dam failures around the world have been due the floods that exceed the flow capacity of the spillway and overtop the dam. Another issue for the Pacific coast is the shorter record of precipitation and flood events in the data records. Even without climate change there is uncertainty in the extreme storms that could occur in an extreme atmospheric river event (about which there is much to learn). If the actual flood is larger than the design flood, spillway capacity may be exceeded and the dam may overtop, or the spillway may erode so that it can rapidly empty the reservoir. These scenarios can present real risks to some dams in Oregon, risks that depending on the location may be greater than earthquake related risks.

Vulnerability

Table 2-151, State-Regulated High Hazard Dams Not Meeting Safety Standards in Region 1, indicates the number of people currently anticipated to be impacted by potential failure of the state-regulated high hazard dams in poor or unsatisfactory condition. OWRD plans to do more analysis to determine the number and value of structures that may be impacted as well.

Dams in Region 1 often have a higher vulnerability from earthquakes and landslides than dams in other regions. Most dams in this region were constructed prior to an understanding that the Cascadia subduction Zone can and will produce extreme earthquakes. And because of dense forest cover, very large landslides above some dams were not identified. As a result, some dams in this region were built below areas prone to large, rapidly moving landslides. One dam in this region was recently removed due to risk from a very large landslide area above the dam and reservoir. Also because of the often dense forest cover, this region is prone to debris loading after wildfires or windstorms. This debris can reduce spillway capacity and the ability of a dam to safely pass a large flood without overtopping. Other coastal and tsunami hazards do not generally add much to the risk to dams, and there is negligible volcanic hazard to dams in this region.

Five dams in Region 1 meet FEMA HHPD eligibility criteria. Critical infrastructure, including water intake and water supply treatment plants for three cities, and one major highway (lifeline to coastal communities) lies below four of them.

Most Vulnerable Jurisdictions

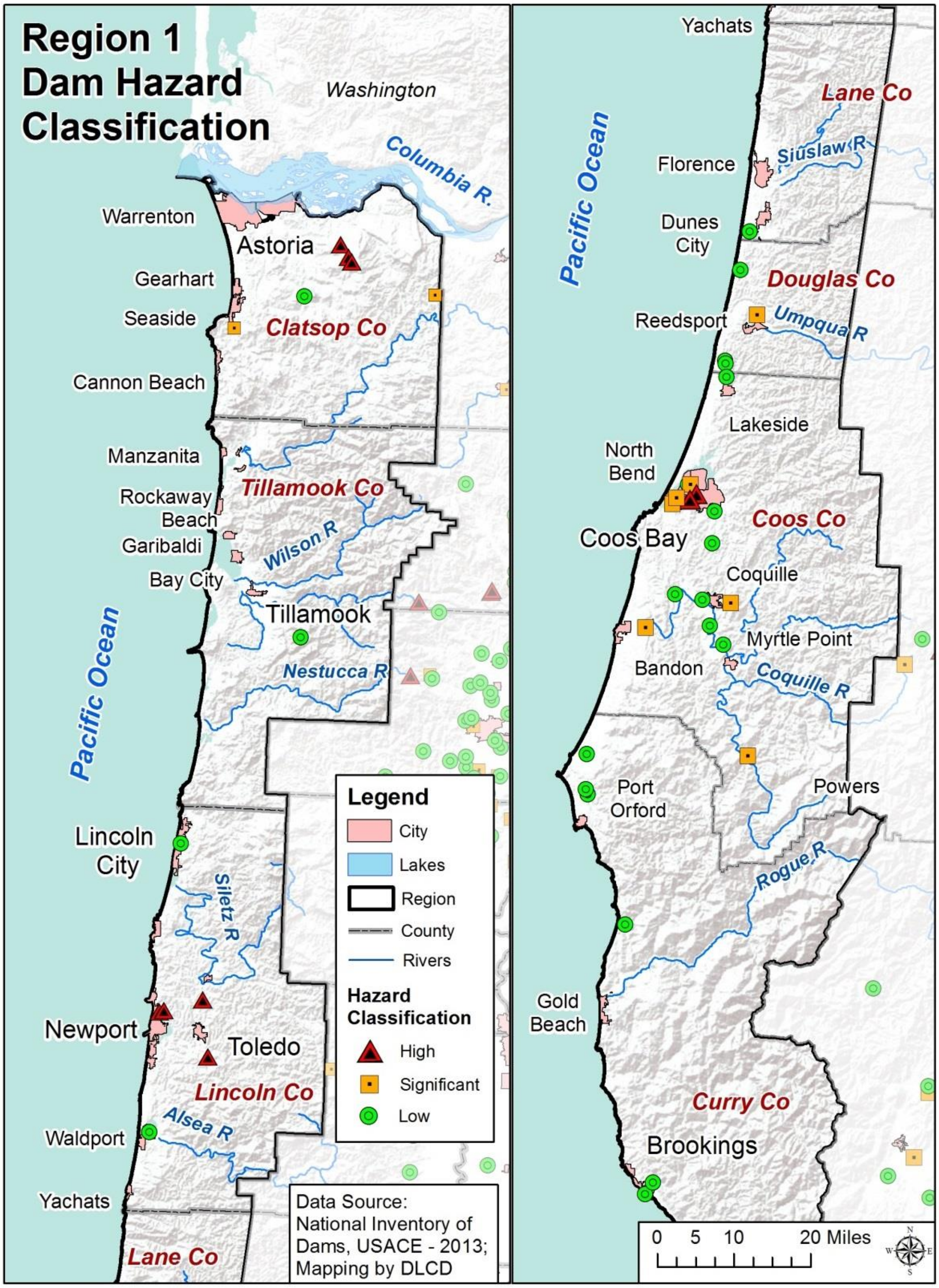
Given the information presented about state-regulated high hazard dams (county and condition; failure expected to result in loss of life) and significant hazard dams (county; failure expected to result in extensive property or infrastructure damage), the counties in Region 1 with high hazard dams in poor or unsatisfactory condition are considered most vulnerable: Clatsop, Coos, Curry, Lincoln. Of those, by far the greatest number of people in potentially dangerous locations if a dam were to fail are in Coos County.

As with high hazard dams, whether counties with significant hazard dams are actually “most vulnerable jurisdictions” depends on the conditions of those dams. Since the dams’ conditions have not yet been rated, we cannot determine the counties’ vulnerability with respect to significant hazard dams. The county with the most state-regulated significant hazard dams is Coos County (4).

Risk

With FEMA and State funding, OWRD will be completing risk assessments for Region 1's state-regulated high hazard dams in poor or unsatisfactory condition over the next several years. For now, the potential for damage to the dam from extreme floods, lack of protection against internal erosion, earthquakes, or landslides and debris indicates greater potential for failure. Coupled with the potential for loss of life and extensive damage to property and public infrastructure, risk is qualitatively determined.

Figure 2-133. Region 1 Dam Hazard Classification



Source: National Inventory of Dams, 2013

Note: Federally regulated significant hazard dams are not shown.

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the coast and Coast Range Mountains have a very high incidence of landslides. On occasion, major landslides occur on U.S. or state highways and sever these major transportation routes (including rail lines), causing temporary but significant economic damage to the state. Less commonly, landslides and debris flows in this area cause loss of life.

Historic Landslide Events

Table 2-152. Historic Landslides in Region 1

Date	Location	Description
Feb. 1926	between Coos Bay and Coquille, Oregon	damages: $25,000; closed Roosevelt Highway
Feb. 1961		large section of Ecola State Park slid into the Pacific Ocean
Feb. 1996		FEMA-1099-DR-Oregon; heavy rains and rapidly melting snow contributed to hundreds of landslides and debris flows across the state, many on clear cuts that damaged logging roads
Nov. 1996	Lane and Douglas Counties	FEMA-1149-DR-Oregon; heavy rain triggered mudslides (Lane and Douglas Counties); five fatalities; several injuries (Douglas County)
Feb. 1999	south of Florence, Oregon	two timber workers killed in a mud and rockslide (south of Florence)
Jan. 2000	north of Florence, Oregon	a landslide (north of Florence) closed US-101 for 3 months, resulting in major social and economic disruption to nearby communities
Dec. 2004	Lane, Polk, and Lincoln Counties	property damage: $12,500
Dec. 2007	Clatsop and Tillamook	property damage: $300,000
Dec. 2008	Clatsop and Tillamook Counties	DR-1824; landslide closed Wilson River highway
Jan. 2011	Clatsop, Tillamook, Lincoln, and Douglas Counties	DR-1956; landslide closed OR 22; landslides along OR 6, US 20, and US 26
Mar. 2011	Lincoln, Coos, and Curry Counties	DR-1964
Jan. 2012	Tillamook, Lincoln, Lane, Douglas, Coos, Curry	DR-4055
Feb. 2014	Lincoln, Lane	DR-4169; portions of US 101 closed
Dec. 2015	Clatsop, Tillamook, Lincoln, Lane, Douglas, Coos, and Curry Counties	DR-4258; several homes destroyed in north Newport; OR 42 closed from landslide; fatality in Florence from landslide; many other roads closed
Dec. 2016	Lane	DR-4296
Feb. 2019	Lane, Douglas, Coos, and Curry Counties	DR-4432; Hooskanaden landslide closed US 101
Apr. 2019	Douglas and Curry Counties	DR-4452; several roads closed

Sources: Taylor and Hatton (1999); and FEMA After-Action Report, 1996 events; and interviews, Oregon Department of Transportation representatives; https://www.fema.gov/disasters

Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from: http://www.sheldus.org

Probability

Table 2-153. Assessment of Landslide Probability in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	VH	VH	VH	VH	VH	VH	VH

Source: DOGAMI 2020

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in Oregon in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Climate Change

Landslides are often triggered by heavy rainfall events when the soil becomes saturated. It is *very likely* (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events (*high confidence*). Because landslide risk depends on a variety of site-specific factors, it is *more likely than not* (>50%) that climate change, through increasing frequency of extreme precipitation events, will result in increased frequency of landslides.

Vulnerability

Table 2-154. Local Assessment of Vulnerability to Landslides in Region 1

	Clatsop	Coos	Curry	Douglas*	Lane*	Lincoln	Tillamook
Vulnerability	M	H	L	M	—	H	M

*Coastal portions of Douglas and Lane Counties

Source: Most recent local hazard vulnerability analyses (Table 2-4)

Table 2-155. State Assessment of Vulnerability to Landslides in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	L	H	L	H	H	VH	H

Source: DOGAMI and DLCD, 2020

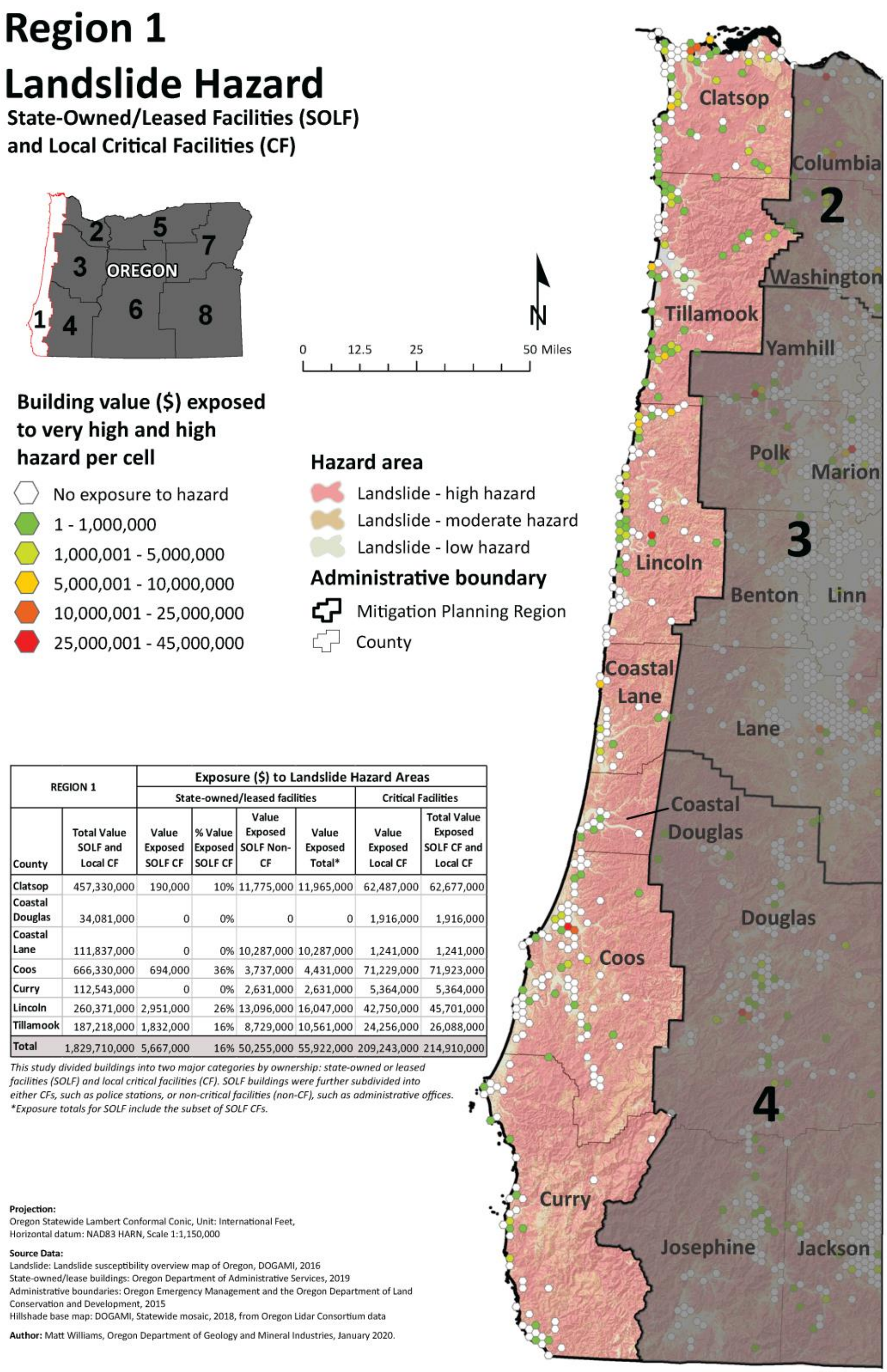
Rain-induced landslides and debris flows can potentially occur during any winter in this region. This area is also subject to future very large earthquakes, which will trigger landslides. Many of the communities in Region 1 have a high exposure to the landslide hazard, for example Astoria. A study of the landslide hazard and risk of Astoria found 121 landslides within the city limits and losses in a major earthquake are likely to be 50% greater than somewhere with low or no landslide hazards (Burns & Mickelson, 2013).

Some of the greatest exposure in Region 1 is the east-west roadways that carry traffic to and from the coast, with the potential for injuries and loss of life from rapidly moving landslide events.

State-Owned/Leased Facilities and Critical/Essential Facilities

DOGAMI analyzed the potential dollar loss from landslide hazards to state buildings and critical facilities as well as to local critical facilities in Region 1. Almost $56M in value of state facilities is exposed to landslide hazards in Region 1, close to 30% of it in Lincoln County followed by Clatsop, Tillamook, and the coastal portion of Lane County. The coastal portion of Douglas County has no state facilities at potential loss from landslides. In contrast, the region has critical facilities representing over $209M in value in landslide hazard areas. Together, Coos and Clatsop Counties have almost two-thirds of the value of local critical facilities followed by Lincoln and Tillamook Counties. **Figure 2-134** illustrates the potential loss to state buildings and critical facilities and local critical facilities from a CSZ event.

Figure 2-134. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Landslide Hazard Zone in Region 1. High-resolution, full-size image linked from Appendix 9.1.26.



REGION 1		Exposure ($) to Landslide Hazard Areas						
		State-owned/leased facilities					Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*		Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Clatsop	457,330,000	190,000	10%	11,775,000	11,965,000		62,487,000	62,677,000
Coastal Douglas	34,081,000	0	0%	0	0		1,916,000	1,916,000
Coastal Lane	111,837,000	0	0%	10,287,000	10,287,000		1,241,000	1,241,000
Coos	666,330,000	694,000	36%	3,737,000	4,431,000		71,229,000	71,923,000
Curry	112,543,000	0	0%	2,631,000	2,631,000		5,364,000	5,364,000
Lincoln	260,371,000	2,951,000	26%	13,096,000	16,047,000		42,750,000	45,701,000
Tillamook	187,218,000	1,832,000	16%	8,729,000	10,561,000		24,256,000	26,088,000
Total	1,829,710,000	5,667,000	16%	50,255,000	55,922,000		209,243,000	214,910,000

Source: DOGAMI, 2020

Historic Resources

Of the 3,121 historic resources in Region 1, all but 14 are exposed to landslide hazards: 1,439 are in an area of very high or high landslide hazard susceptibility; 729 in moderate; and 939 in low. The greatest numbers of historic resources exposed to landslide hazards are in Clatsop, Coos, and Tillamook Counties.

Archaeological Resources

Of the 547 archaeological resources located in landslide hazard areas in Region 1, eighty-six percent (557) are in high landslide hazard areas. Of those, 72 are listed on the National Register of Historic Places and 33 are eligible for listing. Twenty have been determined not eligible, and 432 have not been evaluated as to their eligibility. About one-third of the archaeological resources in a high landslide hazard area are located in Curry County and another 30% in Coos County. Curry County is home to the most archaeological resources listed and eligible for listing on the National Register. Together, Coos and Curry Counties contain 64% of the archaeological resources in landslide hazard areas in Region 1.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Lincoln County is the most vulnerable to landslide hazards in Region 1 followed by Coos, Douglas, Lane, and Tillamook Counties. Lincoln County's overall vulnerability is driven primarily by the presence of state buildings and state and local critical facilities, somewhat by social vulnerability. Coos and Douglas Counties' vulnerability score is driven by the presence of local critical facilities and its high social vulnerability. Lane County's vulnerability is driven by the presence of state buildings and local critical facilities together with social vulnerability. Tillamook County's vulnerability is driven by the presence of state and local critical facilities.

Risk

Table 2-156. Assessment of Risk to Landslides in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Risk	H	VH	H	VH	VH	VH	VH

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment methodology combined the probability of landslide hazards occurring with the potential cost of damage to exposed state buildings and state and local critical facilities and with an assessment of the social vulnerability of the local population.

According to the 2020 risk scores and DOGAMI expertise, all of the coastal counties are “most vulnerable jurisdictions” with either very high or high risk ratings. All communities should be prioritized for mitigation actions.

Tsunamis

Characteristics

Tsunami waves are infrequent events, but tsunamis can be extremely destructive. They may be generated by earthquakes, submarine volcanoes, or landslides, and travel hundreds of miles before striking land. Hardly discernible at sea, tsunami waves travel as fast as 500 mph across open water until, at landfall, they slow down significantly and rapidly increase in height that range from 20 to about 100 feet. Seward, Alaska, experienced tsunami waves as high as 25 feet during the 1964 earthquake-tsunami event.

Most tsunami waves have been described as an onrushing, rapidly rising tide, which can be seen in the few motion pictures that have captured the tsunami phenomenon. The size and behavior of tsunamis depend on a number of factors, including distance traveled, submarine topography and the shape and orientation of the coastline. Much of the damage results from water-borne debris, which can act as battering rams against on-shore development. Wave-borne fuel drums are especially hazardous because of their propensity to cause or exacerbate fires.

All Region 1 counties are susceptible to tsunami hazards. Oregon's coastal communities have experienced, to various degrees, tsunamis that have originated in the oceanic regions near Russia's Kamchatka Peninsula, Japan, Chile, Hawaii, the Gulf of Alaska, and northern California. Additionally, the geologic record indicates that over the last 10,200 years approximately 45 tsunamis have been generated locally off the Oregon Coast along the Cascadia Subduction Zone (CSZ). Nineteen of these tsunamis were from full-margin ruptures of the CSZ and arrived in all parts of the coast about 10–20 minutes after the earthquake; the remaining 25 events occurred on the southern (south of the vicinity of Cape Blanco) Oregon coast. Any locally generated tsunamis would cause significant damage to coastal ports and pose a threat to those near waterfront areas. This is the region's greatest concern.

Historic Tsunami Events

Table 2-157 describes the effects of distant tsunami events that have impacted the Oregon Coast (Region 1).

Table 2-157. Historic Tsunamis Affecting the Oregon Coast

Date	Origin of Event	Affected Community	Damage	Remarks
04/1868	Hawaii	Astoria, Oregon		observed
08/1868	N. Chile	Astoria, Oregon		observed
08/1872	Aleutian Is	Astoria, Oregon		observed
11/1873	N. California	Port Orford, Oregon		debris at high tide line
04/1946	Aleutian Is	Bandon, Oregon		barely perceptible
04/1946		Clatsop Spit, Oregon		water 3.7 m above MLLW
04/1946		Depoe Bay, Oregon		bay drained; water returned as a wall
04/1946		Seaside, Oregon		wall of water swept up Necanicum River
11/1952	Kamchatka	Astoria, Oregon		observed
11/1952		Bandon, Oregon	log decks broke loose	
05/1960	S. Cent. Chile	Astoria, Oregon		observed
05/1960		Seaside, Oregon	bore on Necanicum River damaged boat docks	
05/1960		Gold Beach, Oregon		observed
05/1960		Newport, Oregon		observed for about four hours
05/1960		Netarts, Oregon	some damage observed	
Mar. 1964	Gulf of Alaska	Cannon Beach, Oregon	bridge and motel unit moved inland; $230,000 damage	
Mar. 1964		Coos Bay, Oregon	$20,000 damage	
Mar. 1964		Depoe Bay, Oregon	$5,000 damage; four children drowned at Beverly Beach	
Mar. 1964		Florence, Oregon	$50,000 damage	
Mar. 1964		Gold Beach, Oregon	$30,000 damage	
Mar. 1964		Seaside, Oregon	one fatality (heart attack); damage to city: $41,000; private: $235,000; four trailers, 10-12 houses, two bridges damaged	
05/1968	Japan	Newport, Oregon		observed
04/1992	N. California	Port Orford, Oregon		observed
10/1994	Japan	Oregon Coast		tsunami warning issued, but no tsunami observed
3/2011	Japan	Oregon Coast	$6.7 million; extensive damage to the Port of Brookings	tsunami warning issued, observed ocean waves

Date	Origin of Event	Affected Community	Damage	Remarks
Oct. 2012	Haida Gwaii, BC	coast		M 7.7 caused a tsunami with local runup of more than 7 meters and amplitudes up to 0.8 meter on tide gauges 4,000 kilometers away in Hawaii. Source: NOAA
Jan. 2018	Kodiak Is., AK	coast		minor tsunami impacts in AK, HI and US west coast; the largest tsunami amplitude was recorded at 25cm in Crescent City CA 4-5 hrs after the magnitude 7.9 earthquake

Sources: NOAA, 1993, Tsunamis Affecting the West Coast of the United States: 1806-1992; FEMA, 2011, Federal Disaster Declaration; NOAA, https://www.ngdc.noaa.gov/hazel/view/hazards/tsunami/event-more-info/5673, downloaded on 4/15/20; NOAA https://www.ngdc.noaa.gov/hazel/view/hazards/tsunami/event-more-info/5673 downloaded on 4/15/20

Probability

Table 2-158. Local Probability Assessment of Tsunami in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	VH	VH	H	H	H	H

Source: DOGAMI, 2020

With respect to distant sources, Oregon has experienced 25 tsunamis in the last 145 years with only 3 causing measurable damage. Thus, the average recurrence interval for tsunamis on the Oregon coast from distant sources would be about 6 years. However, the time interval between events has been as little as one year and as much as 73 years. The two most destructive tsunamis occurred only 4 years apart (1960 and 1964) and originated from two different source areas: south central Chile and the Gulf of Alaska. Because only a few tsunamis caused measurable damage, a recurrence interval for distant tsunamis does not have much meaning for this region with respect to losses. However, every time NOAA issues a distant tsunami warning for the coast, evacuation plans are triggered at significant cost to local government and business.

Geologists estimate a 16-22% chance that a CSZ tsunami will be triggered by a shallow, undersea earthquake offshore Oregon in the next 50 years, causing a tsunami that will strike all parts of the Oregon coast about 10–20 minutes after the earthquake. This forecast comes from the 10,000-year geologic record of 19 CSZ fault ruptures extending the entire length of the Oregon coast (i.e., recurrence of approximately 500 years) (Wang & Clark, 1999). As previously mentioned, the southern Oregon coast has a higher chance of experiencing a local tsunami and earthquake, estimated to be approximately 43% in the next 50 years. At the time of this update, the last CSZ event occurred 320 years ago (Satake K., Shimazaki K., Tsuji Y., & Ueda K., 1996).

Owing to their much faster wave arrival and generally larger size, tsunamis originating from the CSZ will cause much larger life and property losses. Inundation from the largest distant tsunamis approximates inundation from the “Small” Cascadia tsunami on Oregon Tsunami Inundation Maps (TIMs).

Vulnerability

Table 2-159. Local Assessment of Vulnerability to Tsunamis in Region 1

	Clatsop	Coos	Curry	Douglas*	Lane*	Lincoln	Tillamook
Vulnerability	—	M	M	H	--	H	M

*Coastal portions of Douglas and Lane Counties

Source: Most recent local hazard vulnerability analyses (Table 2-4)

Table 2-160. State Assessment of Vulnerability to Tsunamis in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	VH	VH	L	H	VH	M	L

Source: DOGAMI, 2020

The entire coastal zone is highly vulnerable to tsunami impact. Distant tsunamis caused by earthquakes on Pacific Rim strike the Oregon coast frequently but only a few of them have caused significant damage or loss of life. Local tsunamis caused by earthquakes on the Cascadia Subduction Zone (CSZ) happen much less frequently but will cause catastrophic damage and, without effective mitigation actions, great loss of life.

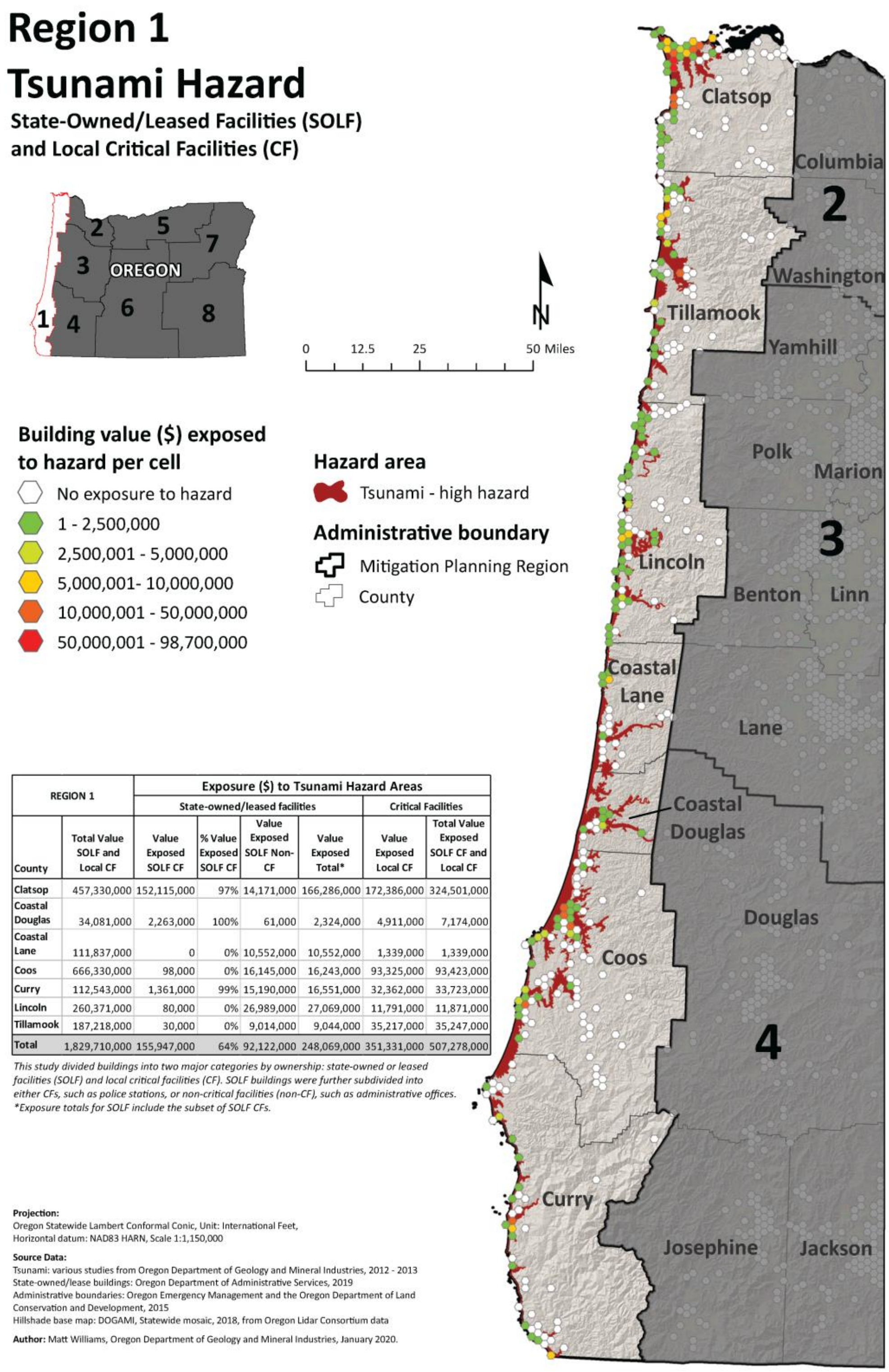
Most Vulnerable Jurisdictions

For the 2020 vulnerability assessment, DOGAMI considered all Cascadia Subduction Zone (CSZ) tsunami hazard zones as high hazard areas.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

DOGAMI analyzed the potential dollar loss from tsunami hazards to state buildings and critical facilities as well as to local critical facilities statewide. Over $248M in value of state buildings and state critical facilities is located in tsunami hazard areas, and 67% of that value is located in Clatsop County. Eleven percent is located in Lincoln County; about 7% is located in each of Coos and Curry Counties; about 4% in each of the coastal portion of Lane County and Tillamook only 1% in the coastal portion of Douglas County. More than $351K of value in local critical facilities is located in tsunami hazard areas. Again, most of that value, 49%, is located in Clatsop County. Twenty-seven percent is located in Coos County; about 10% in each of Tillamook and Curry Counties; and 3% or less in Lincoln County and the coastal portions of Lane and Douglas Counties.

Figure 2-135. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Tsunami Hazard Zone in Region 1. High-resolution, full-size image linked from Appendix 9.1.26.



REGION 1		Exposure ($) to Tsunami Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Clatsop	457,330,000	152,115,000	97%	14,171,000	166,286,000	172,386,000	324,501,000
Coastal Douglas	34,081,000	2,263,000	100%	61,000	2,324,000	4,911,000	7,174,000
Coastal Lane	111,837,000	0	0%	10,552,000	10,552,000	1,339,000	1,339,000
Coos	666,330,000	98,000	0%	16,145,000	16,243,000	93,325,000	93,423,000
Curry	112,543,000	1,361,000	99%	15,190,000	16,551,000	32,362,000	33,723,000
Lincoln	260,371,000	80,000	0%	26,989,000	27,069,000	11,791,000	11,871,000
Tillamook	187,218,000	30,000	0%	9,014,000	9,044,000	35,217,000	35,247,000
Total	1,829,710,000	155,947,000	64%	92,122,000	248,069,000	351,331,000	507,278,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

Source: DOGAMI

Historic Resources

Of the 3,121 historic resources located in Oregon's coastal counties, 794 (25%) are located in tsunami hazard areas. Of those located in tsunami hazard areas, 73% (582) are located in Clatsop County; 21% (170) in Coos County; and 4% or less in Lincoln, Curry, and Tillamook Counties, respectively. None are located in the coastal portions of Douglas or Lane Counties.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard. The counties with the greatest social vulnerability statewide are Marion, Morrow, Umatilla, Wasco, Jefferson, Klamath, and Malheur.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

For the 2020 vulnerability assessment, DLCD combined this index with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Clatsop County, Coos County, and the coastal portion of Lane County are the most vulnerable to the CSZ tsunami hazard followed by the coastal portion of Douglas County.

All communities in Region 1 are especially vulnerable to local tsunamis because of their coastal settings and locations in low-lying areas. Seaside is the most vulnerable city due to its low elevation and high resident and tourist populations, and its county, Clatsop, is the most vulnerable county, having the largest exposed population (**Figure 2-136**) (Wood N. , 2007). Although many communities have evacuation maps and evacuation plans, many casualties are expected. The built environment in the inundation zone will be especially hard hit.

The United States Geological Survey (USGS) completed a comprehensive study (Wood N. , 2007) of coastal cities' exposure and sensitivity to a CSZ tsunami similar to the most likely "Medium" scenario depicted in the 2010–2013 DOGAMI Tsunami Inundation Map series. The tsunami zone of the USGS study is the 1995 regulatory inundation zone that was previously used by the Oregon Building Code to limit new construction of critical/essential, hazardous, and high-occupancy facilities; this restriction was recently rescinded by the Oregon legislature. Results from the (Wood N. , 2007) study indicated that the regulatory inundation zone contained approximately 22,201 residents (4% of the total population in the seven coastal counties), 14,857 employees (6% of the total labor force), and 53,714 day-use visitors on average every day to coastal Oregon State Parks within the tsunami-inundation zone. The zone also contained 1,829 businesses that generate approximately $1.9 billion in annual sales volume (7% and 5% of study-area totals, respectively) and tax parcels with a combined total value of $8.2 billion (12% of the study-area total). Although occupancy values are not known for each facility, the tsunami-inundation zone also contains numerous dependent-population facilities (for example, adult-residential-care facilities, child-day-care facilities, and schools), public venues (for example, religious organizations and libraries), and critical facilities (for example, police stations).

Additionally, results indicate that vulnerability, described in the study by exposure (the amount of assets in tsunami-prone areas) and sensitivity (the relative percentage of assets in tsunami-prone areas) varies considerably among 26 incorporated cities in Region 1 (Wood N. , 2007). City exposure and sensitivity to tsunami hazards is highest in the northern portion of the coast. The City of Seaside in Clatsop County has the highest exposure, the highest sensitivity, and the highest combined relative exposure and sensitivity to tsunamis. Results also indicate that the amount of city assets in tsunami-prone areas is weakly related to the amount of a community's land in this zone; the percentage of a city's assets, however, is strongly related to the percentage of its land that is in the tsunami-prone areas.

Using U.S. 2010 census data, Wood and others (2015) performed similar analyses as Wood (2007) for the Oregon coast using the L1 tsunami inundation line. This latter tsunami zone is akin to an approximate 3,333 year event and covers 95% of the expected inundation defined from the full geologic record. Analyses of these data indicate that 33,244 people live in the tsunami zone. However, the number of employees and businesses identified had decreased to 10,237 and 624 respectively; further analysis of the data indicated 109 dependent care located in the tsunami zone. As with Wood (2007), the largest population exposures to the tsunami hazard occur on the northern Oregon coast in Clatsop and Tillamook Counties (**Figure 2-137**). Localized hotspots are also apparent in communities such as Gold Beach, Port Orford and Reedsport.

Figure 2-136. Number (A) and Percentage (B) of Residents in the Oregon Regulatory Tsunami Inundation Zone (Wood N. , 2007)

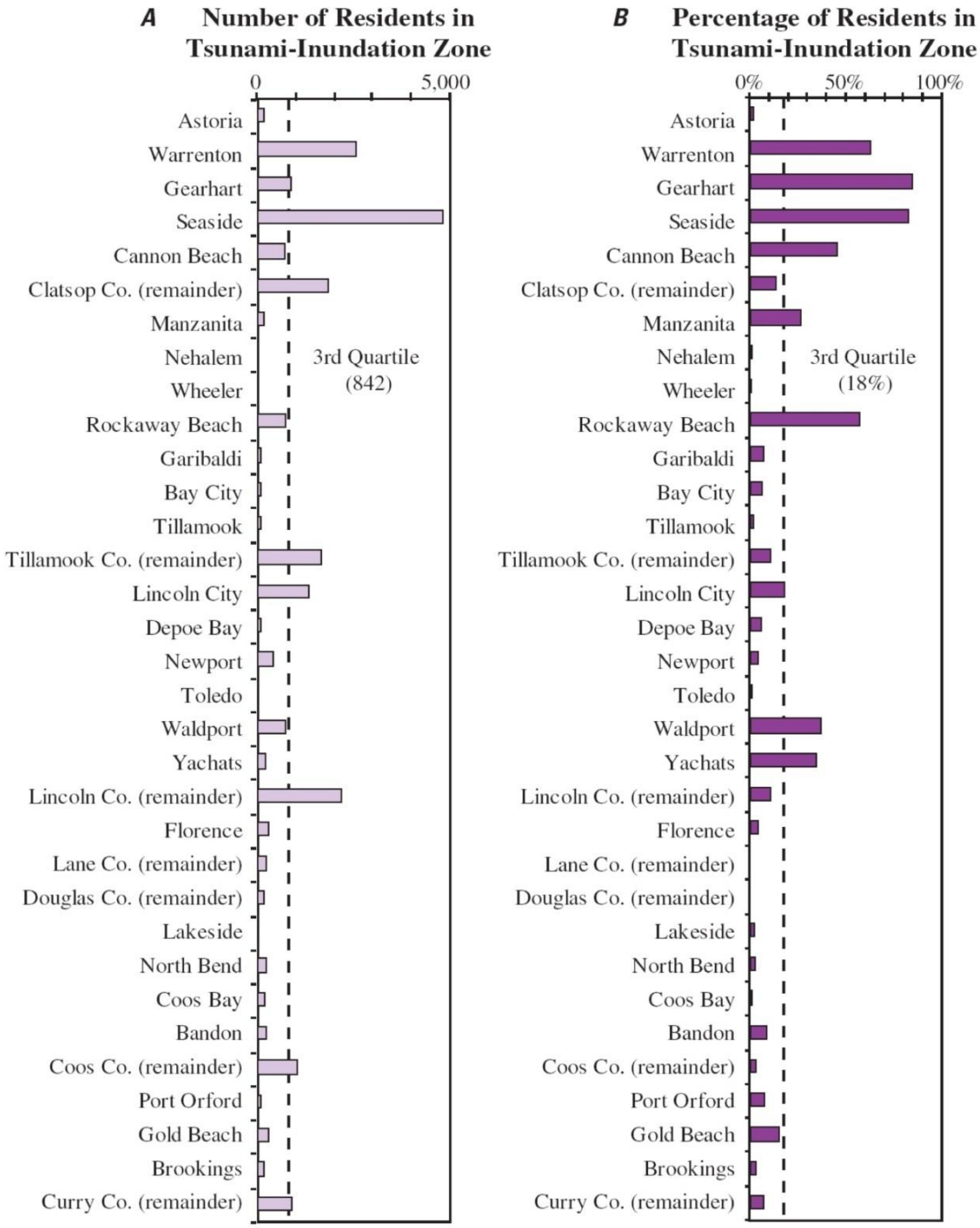
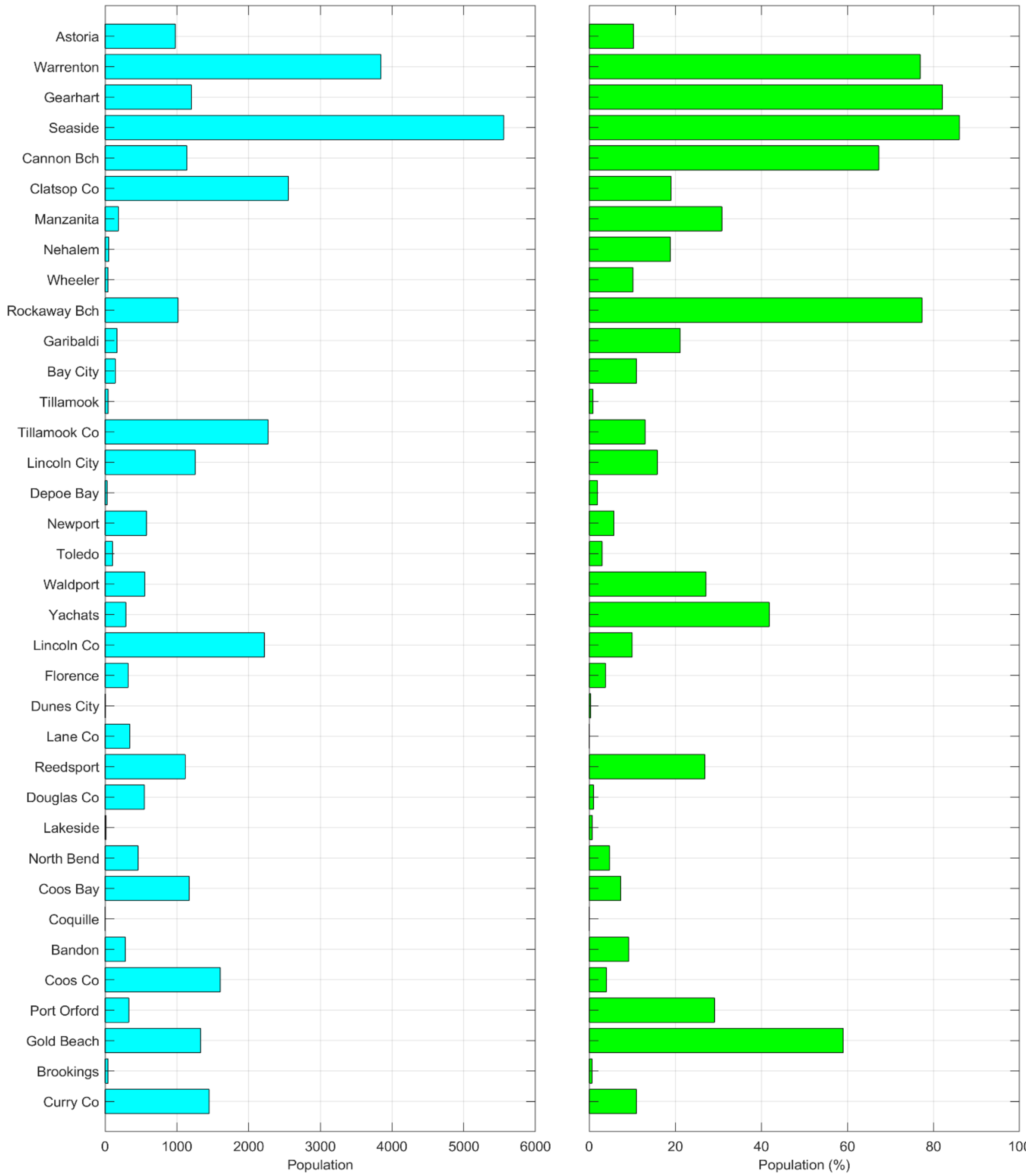


Figure 2-137. Number (A) and Percentage (B) of Residents in the Oregon Regulatory Tsunami Inundation Zone (data from Wood and others, 2015)



Risk

Table 2-161. Risk from Tsunami Hazard in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Risk	VH	VH	M	VH	VH	H	M

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the coastal hazards probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, Clatsop, Coos, and the coastal portions of Douglas and Lane Counties are at greatest risk from coastal hazards, followed by Lincoln County. By all measures discussed in this chapter, Clatsop County is at greatest risk from the tsunami hazard.

Volcanoes

Characteristics

The volcanic Cascade Mountain Range is not within Region 1 counties; consequently, the risk from local volcano-associated hazards (e.g., lahars, pyroclastic flows, lava flows, etc.) is not a priority consideration for Coastal Oregon. However, there is some risk from volcanic ashfall. This fine-grained material, blown aloft during a volcanic eruption, can travel many miles from its source. For example, the cities of Yakima (80 miles) and Spokane (150 miles), Washington, were inundated with ash during the May 1980, Mount St. Helens eruption. Ashfall can reduce visibility to zero, and bring street, highway, and air traffic to an abrupt halt. The material is noted for its abrasive properties and is especially damaging to machinery. It would be prudent for communities that may be exposed to ashfall to identify disposal areas for large quantities of ash. Part of Clatsop County borders the Columbia River, which in theory makes it vulnerable to lahars or mudflows carried by the river. Although unlikely, such an event cannot be dismissed out of hand. A lahar or mudflow that traveled down Washington's Cowlitz River following the eruption of Mount St. Helens, filled the Columbia River channel overnight from its previous 40-foot depth to a mere 14 feet. This delayed ship movements in the vicinity of the Cowlitz for months (Wolfe & Pierson, 1995).

Historic Volcanic Events

There are no significant volcanoes within Region 1 and no historic volcano-related events.

Probability

Table 2-162. Assessment of Volcanic Hazards Probability in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	VL	VL	VL	VL	VL	VL	VL

Source: DOGAMI, 2020

Mount St. Helens is a probable source of ashfall and lahars that can reach the Columbia River. The probability of coastal counties receiving ashfall is about 1 in 10,000 — with a large portion of Curry County having even less probability (Sherrod, Mastin, Scott, & Schilling, 1997). A lahar mudflow that traveled down Washington's Cowlitz River following the 1980 eruption of Mount St. Helens filled the Columbia River channel overnight from its previous 40-foot depth to a mere 14 feet. This delayed ship movements for months.

Vulnerability

Table 2-163. Local Assessment of Vulnerability to Volcanic Hazards in Region 1

	Clatsop	Coos	Curry	Douglas*	Lane*	Lincoln	Tillamook
Vulnerability	M	—	H	—	—	L	L

*Coastal portions of Douglas and Lane Counties

Source: Most recent local hazard vulnerability analyses (Table 2-4)

Table 2-164. State Assessment of Vulnerability to Volcanic Hazards in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	VL	M	VL	M	L	L	VL

Source: DOGAMI and DLCD, 2020

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

DOGAMI analyzed the potential dollar loss from volcanic hazards to state-owned and –leased buildings and critical facilities as well as to local critical facilities in Region 1. There is over $1.8B of value in state buildings, state critical facilities, and local critical facilities in Region 1; none of it exposed to volcanic hazards. Similarly, none of the 3,121 historic buildings in Region 1 are exposed to volcanic hazards. See Appendix **9.1.12** for details.

Historic Resources

None of the 3,121 historic buildings in Region 1 are exposed to volcanic hazards. See Appendix **9.1.12** for details.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

According to the 2020 vulnerability scores, none of the communities identified by DOGAMI as being most vulnerable to volcano hazards are located in Region 1. Coos County and the coastal portion of Douglas County scored moderately vulnerable due to high social vulnerability.

Risk

Table 2-165. Assessment of Risk to Volcanic Hazards in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Risk	VL	VL	VL	VL	VL	VL	VL

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment methodology combined the probability of volcanic hazards occurring with the potential cost of damage to exposed state buildings and state and local critical facilities and with an assessment of the social vulnerability of the local population.

All communities in Region 1 all have very low (VL) risk ratings. However, as noted earlier, there is some risk of ashfall that can be especially damaging to machinery. Although remote, the threat of lahars or volcanic related mudflows could impact the shipping industry on the Columbia River in Region 1 (Ewart, Diefenbach, & Ramsey, 2018).

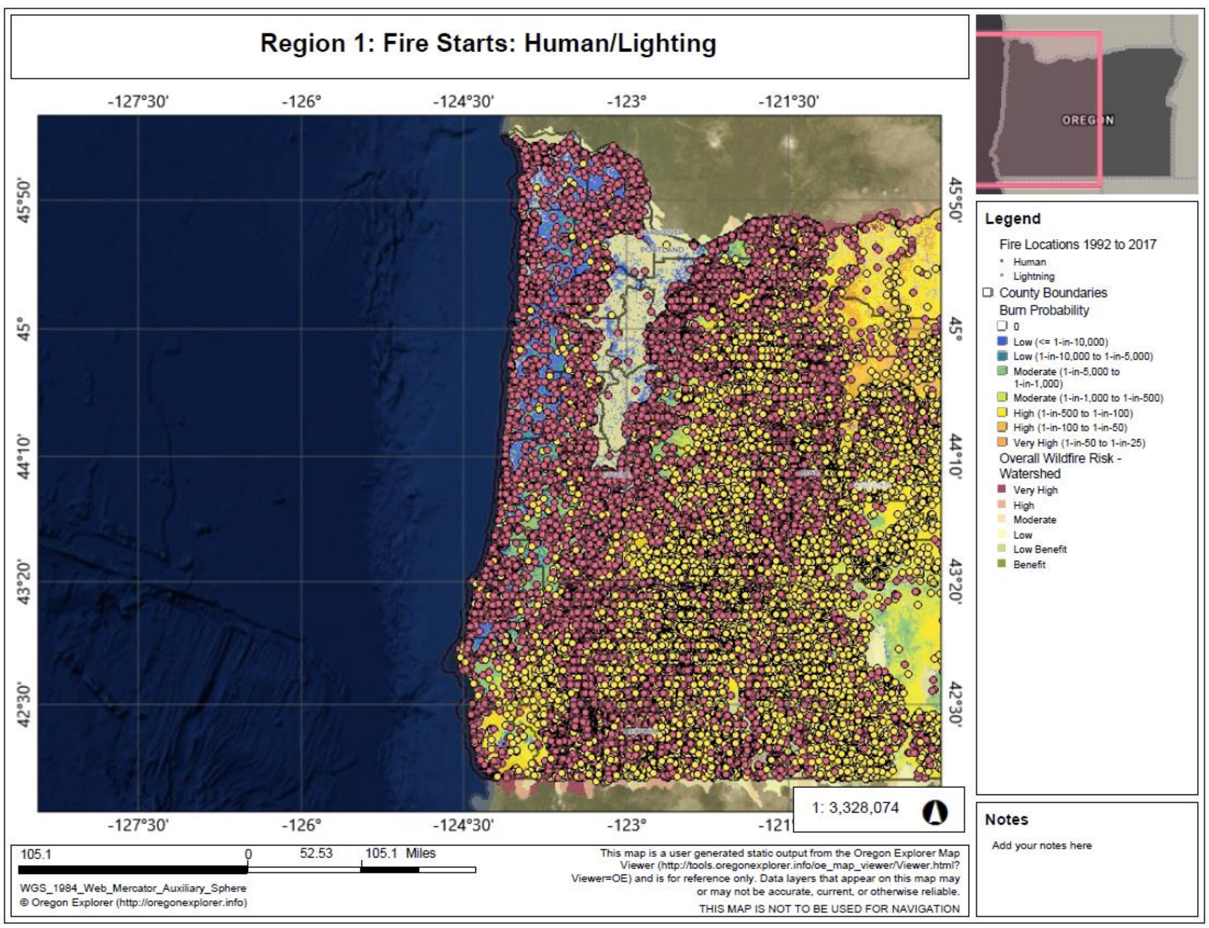
Wildfires

Characteristics

Existing development near wildland areas combined with the spread of gorse and other flammable plant species throughout the region is increasing the level of wildfire risk. Wildfires in the wildland-urban interface (WUI) pose serious threats to life and endanger property, critical infrastructure, water resources, and valued commercial and ecological forest resources. While the region is characterized as moist and regarded as lower than normal fire danger, historically some the largest fire events have occurred in this area. The Tillamook Burn, comprising devastating wildfires every 6 years between 1933 and 1951, burned a total of 355,000 acres. Much of the burn was attributed to powerful east wind events and heavy fuels.

Historically, lighting has been the primary ignition source of wildfires in the region. Weather patterns from May through October are characterized by periods of drought separated by storms that produce dry forest fuels followed by frequent lightning strikes, a common source of ignitions. During the past two decades, though, fires caused by human activities in this area were more frequent than those ignited by natural processes.

Figure 2-138. Fires Caused by Humans and Lightning



Source: Oregon Wildfire Risk Explorer, 2020

Long periods of drought are common during the summer and electrical storms are a common cause of wildfire. These types of storms are most frequent from May through October. Long periods of drought during the summer months also create challenges for wildfire responders. Many small rural communities lack the type of water systems that make water accessible for fire suppression. Instead fire fighters in these areas are often dependent on water from ponds, creeks, and rivers. Often in the mid- to late summer months, these sources are low or completely dry.

Wind direction changes to an easterly flow in early fall when landscapes are at their driest. These “east wind events” resemble the well-known Santa Anna winds of southern California that produce large, destructive wildfires.

Wildfires have played a significant role in shaping the species composition and forest structure in the region. Intensive fire suppression has resulted in forest fuel buildup and changes in species composition and structure in the past 65 years.

Coastal and Lower Columbia River counties are heavily timbered and have a long history of devastating forest fires. Some of the history is derived from Native Americans who recall extensive forest fires before the arrival of Euro-Americans. Fires involving the wildland interface occur in portions of the state where urbanization and natural vegetation fuels allow a fire to spread rapidly from natural fuels to structures and vice versa. Especially in the early stage of such fires, structural fire suppression resources can be quickly overwhelmed increasing the number of structures destroyed. Such fires are known for the large number of structures that are simultaneously exposed to fire, increasing the total losses per structure ignited. Nationally, wildland interface fires commonly produce widespread, extreme losses. Thus far, Oregon has escaped the level of property losses experienced by neighboring states.

Gorse, a spiny evergreen shrub, was introduced in south coastal Oregon from Europe. It has become an established invasive weed that displaces native vegetation, significantly altering the native vegetation patterns. Because Gorse is highly flammable, it increases wildfire risk wherever it spreads. Infestations of Gorse are particularly common along the coastal area; these areas are a major concern for wildfire managers. Currently there is a group of federal and state agencies, non-profit organizations, private industry, and landowners who have formed the Gorse Action Group (GAG). This group has made it their mission to control and reduce the spread of gorse and minimize the impact on economy and natural resources.

Wildfire managers in the southern part of the region are also concerned with the spread of Port-Orford-Cedar root disease and Sudden Oak Death. Trees infected by these pathogens are at increased risk to wildfire and vegetation management activities need to be conducted in a way that minimizes the spread of disease pathogens. The Rogue River-Siskiyou National Forest, Bureau of Land Management, Oregon Department of Forestry, and Oregon State Parks have implemented actions to manage the spread of these pathogens.

Historic Wildfire Events

Table 2-166. Historic Wildfires in Region 1

Date	Name of Fire	Location	Characteristics	Remarks
1846	Yaquina	Lincoln and Lane Counties	> 450,000 acres	event related by Native American hunters
1853	Nestucca		> 320,000 acres	
1868	Coos Bay	Coos	296,000 acres	
1922	Astoria	downtown City of Astoria	many buildings (32 city blocks burned!)	early December structural fire most likely not related to wildfire
1933	Tillamook		240,000 acres	the Tillamook Forest burned every 6 years between 1933 and 1951; total acreage burned was over 350,000 acres; together, the four events are called the Tillamook Burn; dry forest conditions seems to have been a major factor (Taylor)
1936	Bandon	Coos	143,000 acres	destroyed 100s of homes and killed 10 people.
1939	Saddle Mountain	Clatsop County	207,000 acres	
1945	Wilson River / Salmonberry	Tillamook County	173,000 acres	
1951	North Fork / Elkhorn	Tillamook County	33,000 acres	
2002	Florence / Biscuit	Curry County	almost 500,000 acres (perimeter)	largest forest fire in Oregon since arrival of Euro-Americans; the perimeter contained many unburned islands within the overall acreage
	Holloway Fire	Tillamook	more than 245,000 acres	Holloway Fire burned more than 245,000 acres in Oregon from a lightning strike and also burned more than 215,000 acres in Nevada. One firefighter was killed.
	Chetco Bar	Curry	burned 191,125 acres	started by lightning strike

Source: Brian Ballou, 2002, A Short History of Oregon Wildfires, Oregon Department of Forestry, unpublished; unknown sources from previous versions of the Oregon NHMP; Oregon Department of Forestry, 2020

Probability

Table 2-167. Assessment of Wildfire Probability in Region 1

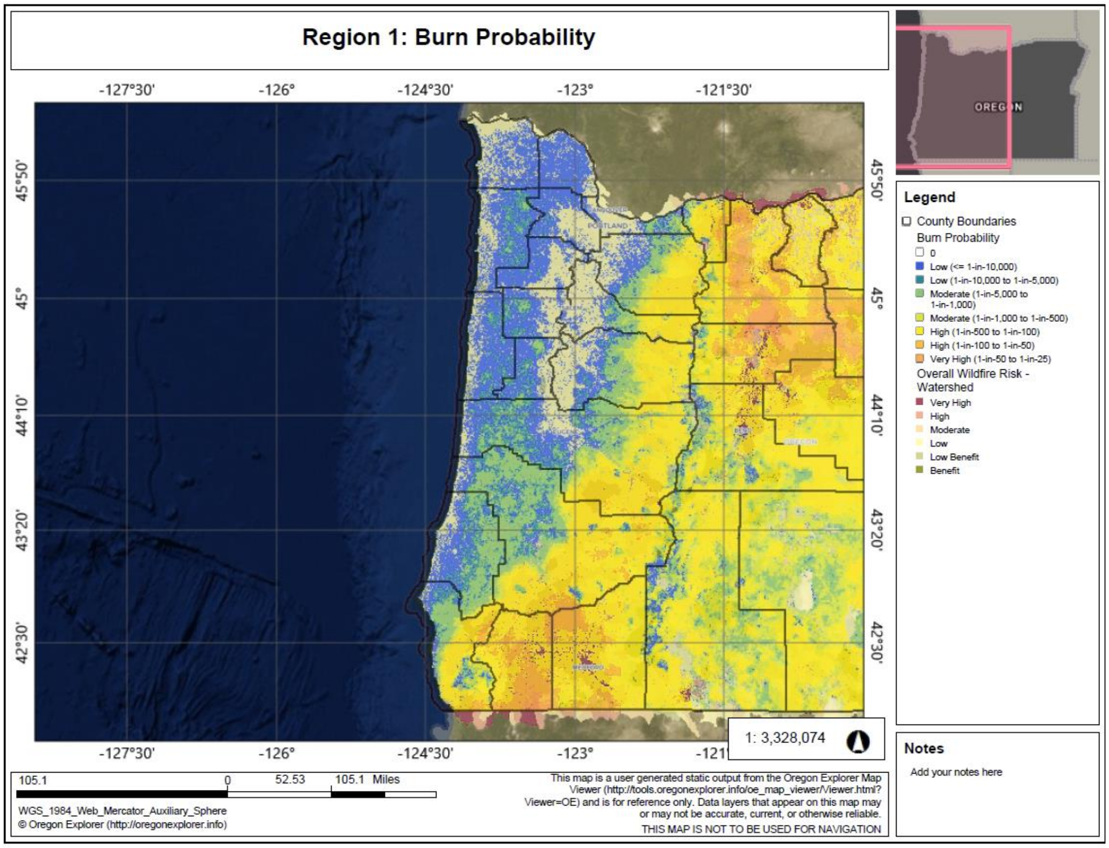
	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	L	L	H	M	L	L	L

Source: Oregon Wildfire Risk Explorer, March 2020; PNW Quantitative Wildfire Risk Assessment: Burn Probability, March 2020

The PNW Quantitative Wildfire Risk Assessment utilizes fire history, topography, weather, infrastructure, and fuels data to determine probability and vulnerability scores for each county. These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with statewide assessments and methodologies is that scale and values of the data have to be applicable to the entire state, so local level information may show some inaccuracy. Interpretation of the data is not necessarily the same at local levels. Community Wildfire Protection Plans (CWPPs) still play a crucial role in addressing additional vulnerability and probability of wildfire due to "on the ground" information such as ingress/egress, building materials, landscaping, and location of fire response, etc. The state recognizes these inconsistencies and has partnerships that will be working on more of a parcel level assessment in the future. A description of how the Very High (VH), High (H), Moderate (M), Low (L), and Very Low (VL) scores in the local probability and vulnerability tables in this section were determined is provided in the Probability section of the state risk assessment for wildfires.

Figure 2-139 shows the likelihood of a wildfire >250 acres burning a given location, based on wildfire simulation modeling. This is an annual burn probability, adjusted to be consistent with the historical annual area burned. Be aware that conditions vary widely with local topography, fuels, and weather, especially local winds. In all areas, under warm, dry, windy, and drought conditions, expect higher likelihood of fire starts, higher fire intensities, more ember activity, a wildfire more difficult to control, and more severe fire effects and impacts.

Figure 2-139. Burn Probability

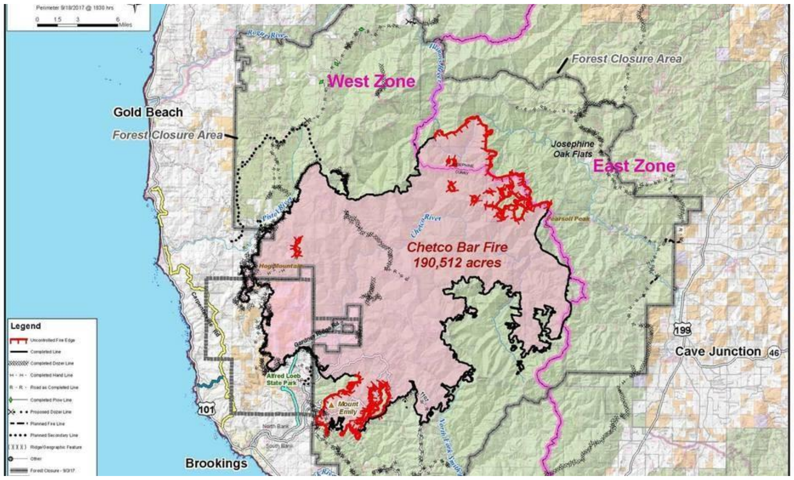


Source: Oregon Wildfire Risk Explorer, March 2020

The potential that wildland fires, both small and large, will threaten life, property and natural resources is a reality. Fire statistics show that fire incident rates, and therefore risks, are prevalent in the WUI areas. Population growth and development continue to encroach into and fragment forests. The natural ignition of forest fires is largely a function of weather and fuel; human-caused fires add another dimension to the probability. Dry and diseased forests can be mapped accurately and some statement can be made about the probability of lightning strikes. Each forest is different and consequently has different probability/recurrence estimates.

The probability of significant fire activity occurring in Region 1 is most likely during the late summer and early fall months when temperatures remain high, vegetation has had the entire summer to dry out and east winds are more prevalent coming out of the Columbia Gorge in the north and Chetco drainages in the south portions of the region. The Chetco Bar Fire was a classic example of this, starting July 12, 2017 and burning 191,125 acres until November 4, 2017 when it was finally 100% contained. The Chetco Effect (warm, dry winds in this area) and high pressure over the Great Basin both had significant impact on this fire.

Figure 2-140. Chetco Bar Fire



Source: Chetco Bar Fire Map, September 20, 2017. (InciWeb.org)

Climate Change

Over the last several decades, warmer and drier conditions during the summer months have contributed to an increase in fuel aridity and enabled more frequent large fires, an increase in the total area burned, and a longer fire season across the western United States. Human-cause climate change is partially responsible for these trends, which are expected to continue increasing under continued climate warming (Dalton, Dello, Hawkins, Mote, & Rupp, 2017).

In moisture-limited forest systems, such as those in the Coast Range, warming winters will lead to more fine fuels from greater cold season growth. Hotter and drier conditions will lead to large fuel quantities, which lead to large and severe fires. It is very likely (>90%) that the Coast Range in Region 1 will experience increasing wildfire frequency and intensity under future climate change. Modeled projections of future fire frequency indicate more frequent fires for the Pacific Northwest, particularly west of the Cascade Mountains where fires have been infrequent historically. In coastal areas, fire frequency is projected to change from approximately every 100 years to every 60 years.

One proxy for future change in wildfire risk is a fire danger index called 100-hour fuel moisture (FM100), which is a measure of the amount of moisture in dead vegetation in the 1–3 inch diameter class available to a fire. A majority of climate models project that FM100 would decline across Oregon under future climate scenarios. This drying of vegetation would lead to greater wildfire risk, especially when coupled with projected decreases in summer soil moisture. The number of “very high” fire danger days—in which fuel moisture is below the 10th percentile—is projected to increase across the state and in Region 1 counties (**Table 2-168**).

Table 2-168. Projected Increase in Annual Very High Fire Danger Days in Region 1 Counties by 2050 under RCP 8.5

County	# Additional Days	Percent Change
Clatsop	10	27%
Coos	11	31%
Curry	11	30%
Lincoln	14	37%
Tillamook	11	30%

Note: Very High fire danger days are defined as days in which the fuel moisture is below the 10th percentile. By definition, the historical baseline has a 36.5 Very High fire danger days. These numbers represent the multi-model mean change.

Source: Oregon Climate Change Research Institute (OCCRI)

Vulnerability

Table 2-169. Local Assessment of Vulnerability to Wildfire in Region 1

	Clatsop	Coos	Curry	Douglas*	Lane*	Lincoln	Tillamook
Vulnerability	M	M	H	M	—	L	M

*Coastal portions of Douglas and Lane Counties

Source: Most recent local hazard vulnerability analyses (Table 2-4)

Table 2-170. Assessment of Vulnerability to Wildfire in Region 1 – Communities at Risk

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	L	L	VL	M	L	VL	L

Source: Trentadue & Alcock, ODF Communities at Risk Report (2020)

Table 2-171. Assessment of Vulnerability to Wildfire in Region 1 – 2020 Vulnerability Assessment

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	VL	M	VL	M	M	L	VL

Source: DOGAMI, DLCD

According to ODF’s assessment of Communities at Risk, counties within Region 1 have very low to moderate risk from wildfire based primarily on cool, moist weather conditions. However, this region has had some of the largest wildfires that posed threats to communities when they occurred. The 1936 Bandon Fire is a prime example of a fire that, when combined with heavy fuels (gorse) and powerful dry east winds, an entire city was destroyed killing 13 people.

Gorse, brush, and timber still make up much of the landscape in Region 1. Given the right conditions, this region’s vulnerability to wildfire exists. However, due to infrequent fire activity, the level of vulnerability can be categorized as moderate. A large wildfire in this region would affect local economies that rely on tourism and recreation dollars.

The economic stability of the region is dependent on a major state highway (US-101) that runs along the Oregon Coast. Should a major wildfire or other natural event (such as a tsunami) threaten or impact this major thoroughfare, coastal tourism and recreational economies would come to a halt.

Each year a significant number of people build homes within or on the edge of the forest (urban-wildland interface), thereby increasing wildfire hazards. These communities have been designated "Wildland-Urban Interface Communities" and are listed in **Table 2-172**.

Table 2-172. Wildland-Urban Interface Communities in Region 1

Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Arch Cape	Bandon	Agness	Azalea	Bohemia City	Depoe Bay	Bay City
Astoria	Bridge	Brookings	Camas Valley	Coburg	Elk City	Beach
Beach	Bunker Hill	Cape Ferrelo	Canyonville	Cottage Florence	Lincoln City	Beaver
Brownsmead	Charleston	Gold Beach	Cavitt Creek	Crestwell	Newport	Blaine
Brownsville	Coos Bay	Harbor	Cow Creek	Deadwood	Otter Rock	Camp Cloverdale
Cannon Costal Strip	Coquille	Illahe	Curtin	Dexter	Rose Lodge	Cape Meares
Elsie-Vinemaple	Dora	Langlois	Days Creek	Dorena	Salishan	Foley Creek
Fern Hill	Fairview	Nesika Beach	Diamond Lake	Dunes City	Seal Rock	Garibaldi
Fort Clatsop	Greenacres	Ophir	Dillard	Eugene	Siletz	Hebo
Gearhart	Hauser	Pistol River	Dixonville	Glenwood	Spring Valley St. Park	Hemlock
Hamlet	Lakeside	Port Orford	Drain	Goshen	Tidewater	Jordan Creek
Hewell	Libby	Sixes	Drew	Grove	Toledo	Kilchis
Knappa	Millington	Upper Chetco	Dry Creek	Hazeldell	Waldport	Lees Camp
Lewis and Clark	Myrtle Point		Elkton	Junction City	Yachats	Magruder
Necanicum	North Bay		Fair Oaks	London Springs		Manhattan
Seaside	North Bend		Fortune Branch	Lorane		Wheeler
Svensen	Powers		Cow Creek	Lowell		Manzanita
Warrenton	Saunders Lake		Freezeout Creek	Lower Mckenzie		Nedonna Beach
Westport	Sitkum		Gardiner	Lower Willamette		Nehalem
	Sumner		Glenbrook	Mapleton		Neskowin
			Glendale	McKenzie		Netarts
			Glide	Mohawk		Oceanside
			Green Acres	Morcola		Oretown
			Kellogg	Oakridge		Pacific City
			Lemolo	Pleasant Hill		Pleasant Valley
			Lemolo Lake	Rainbow		Rockaway Beach
			Little River	Santa Clara		Sandlake
			Lookingglass	Siuslaw		Siskeyville
			Loon Lake	Springfield		Tierra del Mar
			Milo	Swisshome		Tillamook
			Myrtle Creek	Triangle Lake		Winema Beach
			N. Umpqua	Upper McKenzie		Woods
			North Umpqua Village	Upper Willamette		
			Oakland			
			Reedsport			
			Rice Hill			

Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
			Riddle	Veneta		
			Roseburg	Waldon		
			Scottsburg	Walker		
			South Umpqua	West Valley		
			Steamboat	Westfir		
			Susan Creek	Willakenzie		
			Sutherlin			
			Tenmile			
			Tiller			
			Tokette			
			Tri City			
			Umpqua			
			Union Gap			
			Upper Ollala			
			Camas Tenmile			
			Wiber			
			Winchester Bay			
			Winston			
			Wolf Creek			
			Yoncalla			

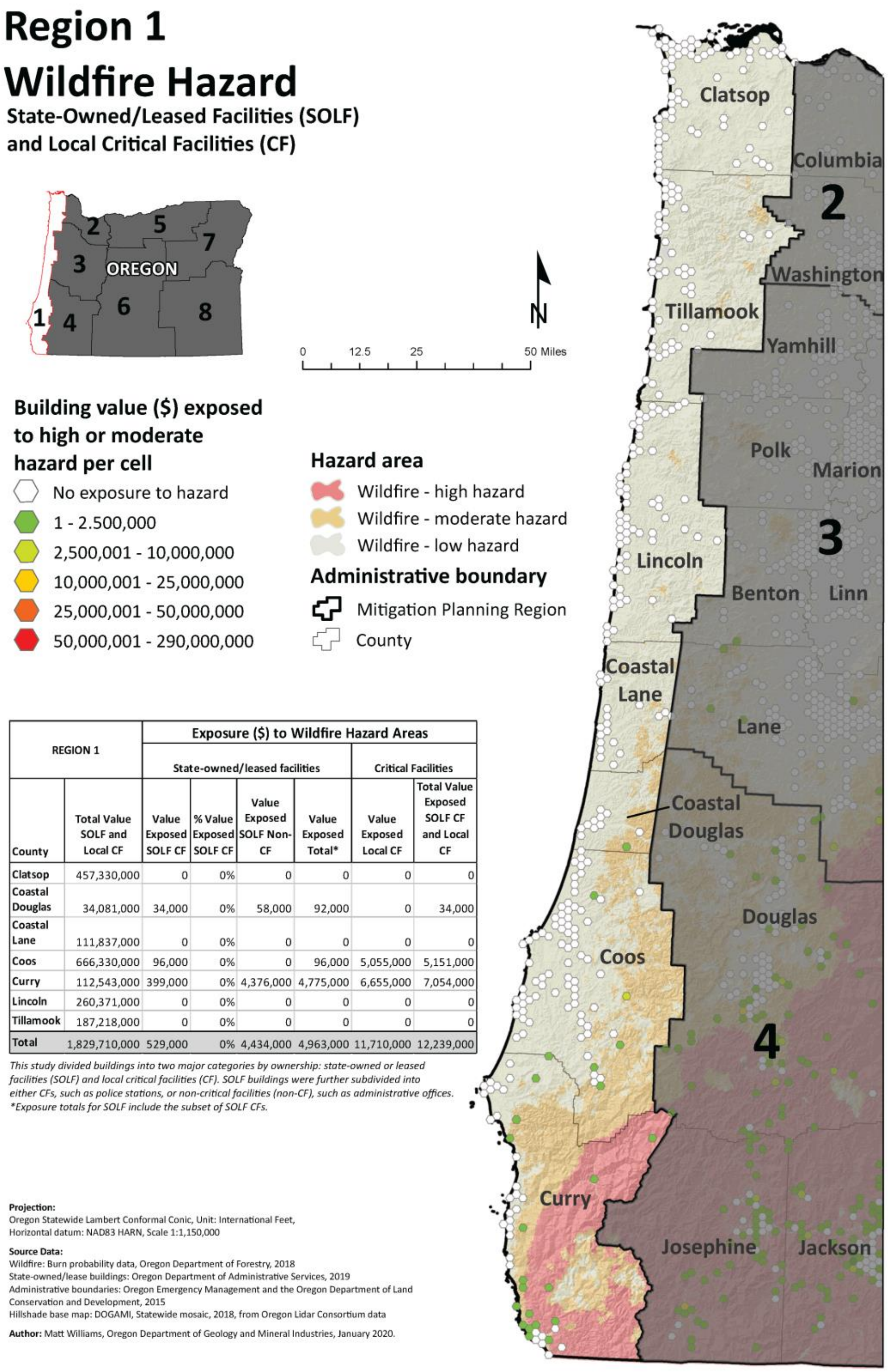
Source: Oregon Dept. of Forestry Statewide Forest Assessment September, 2006

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

For the 2020 vulnerability assessment, DOGAMI followed ODF guidance and evaluated building exposure to wildfire using the Burn Probability dataset which was classified by ODF in “High,” “Moderate,” and “Low” categories. Urban areas, lake surfaces, and areas bare of vegetation do not have fire risk classifications in the data and are represented here as “Low.”

In Region 1, there is a potential loss of almost $5M in state building and critical facility assets, 96% of it in Curry County. The other 4% is divided almost equally between the coastal portion of Douglas County and Coos County. There is a far greater potential loss in local critical facilities: over $11M, over twice as much. A little less than half that value is located in Coos County; a little more than half in Curry County. There are no state buildings or critical facilities exposed to wildfire hazards in Clatsop County, the coastal portion of Lane County, Lincoln or Tillamook Counties. The same is true for local critical facilities with the addition of the coastal portion of Douglas County. **Figure 2-141** illustrates the potential loss to state buildings and critical facilities and local critical facilities from a wildfire event.

Figure 2-141. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Wildfire Hazard Zone in Region 1. High-resolution, full-size image linked from Appendix 9.1.26.



REGION 1		Exposure ($) to Wildfire Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Clatsop	457,330,000	0	0%	0	0	0	0
Coastal Douglas	34,081,000	34,000	0%	58,000	92,000	0	34,000
Coastal Lane	111,837,000	0	0%	0	0	0	0
Coos	666,330,000	96,000	0%	0	96,000	5,055,000	5,151,000
Curry	112,543,000	399,000	0%	4,376,000	4,775,000	6,655,000	7,054,000
Lincoln	260,371,000	0	0%	0	0	0	0
Tillamook	187,218,000	0	0%	0	0	0	0
Total	1,829,710,000	529,000	0%	4,434,000	4,963,000	11,710,000	12,239,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet,
Horizontal datum: NAD83 HARN, Scale 1:1,150,000

Source Data:
Wildfire: Burn probability data, Oregon Department of Forestry, 2018
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

Source: DOGAMI, 2020

Historic Resources

Of the 3,121 historic resources in Region 1, only three are located in an area of high wildfire hazard, all of them in Curry County. Eight are located in an area of moderate wildfire hazard: three in the coastal portion of Douglas County, four in Coos County, and one in Tillamook County.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, none of the counties is Region 1 is particularly vulnerable to wildfire. Scores range from very low to moderate vulnerability. While the scores based on Communities at Risk and from the 2020 vulnerability assessment only match for Coos and the coastal portion of Douglas County, in both assessments scores range from very low to moderate vulnerability. Overall, vulnerability to wildfire in Region 1 is low.

Most Vulnerable Jurisdictions

None of the counties in Region 1 are most vulnerable to wildfire hazards.

Risk

Table 2-173. Risk of Wildfire Hazards in Region 1

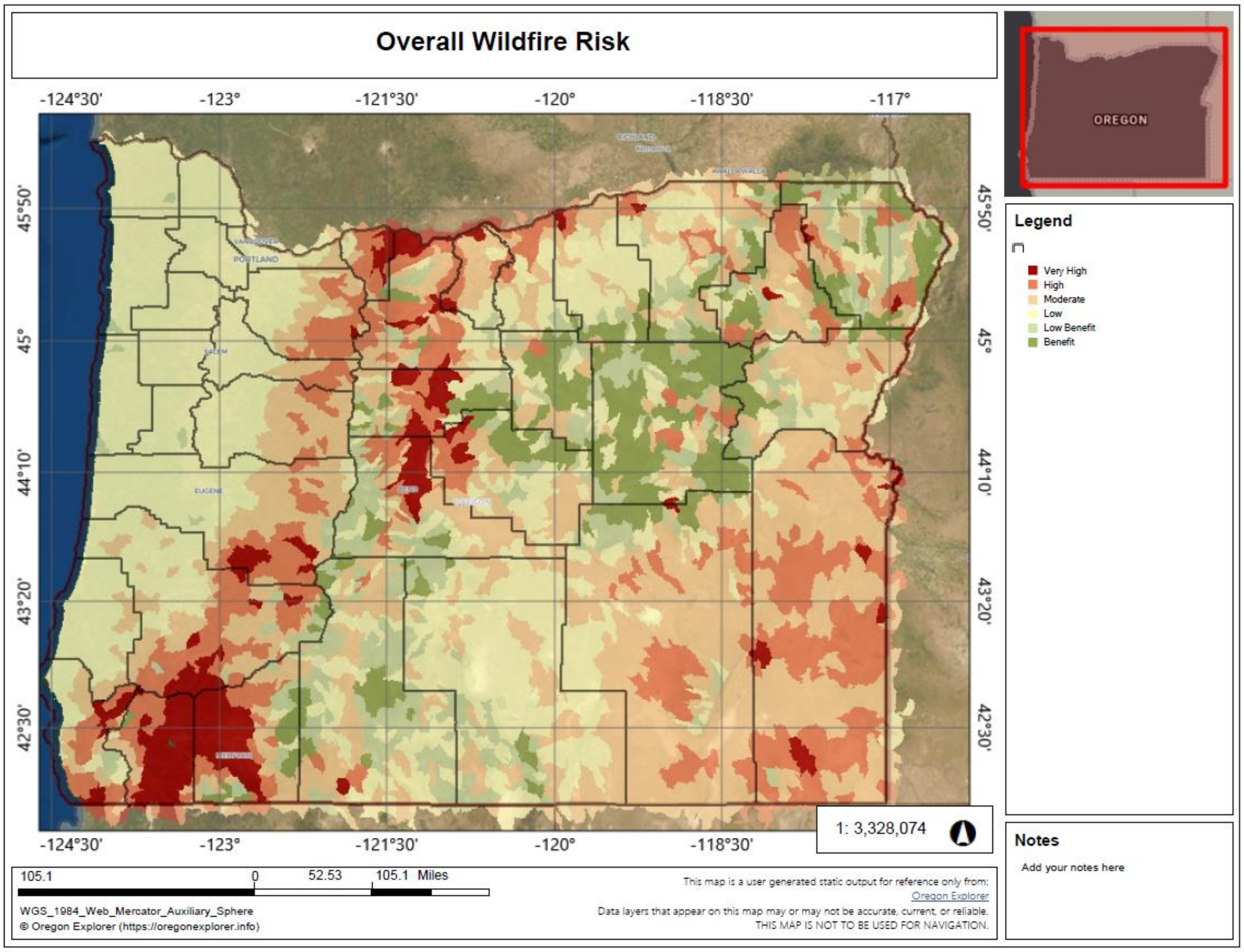
	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Risk	L	H	L	H	H	L	L

Source: DOGAMI, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the wildfire probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, the risk from wildfire is high in Coos County and the coastal portions of Douglas and Lane Counties.

This outcome is inconsistent with that which would be expected from combining ODF's probability and vulnerability ratings: Coos County has a high risk rating. With low probability and low vulnerability Coos County would be expected to have low risk. Similarly, for the coastal portion of Lane County, a high risk rating is inconsistent with its moderate and low probability and vulnerability ratings. Among all these measures, the coastal portion of Douglas County consistently rates higher, and therefore is the county at greatest risk of wildfire in Region 1.

Figure 2-142. Overall Wildfire Risk



Source: Oregon Explorer, 2020

Windstorms

Characteristics

High winds can be expected throughout Region 1, due to their coastal location. Destructive windstorms are less frequent, and their pattern is fairly well known. They form over the North Pacific during the cool months (October through March), move along the coast, and swing inland in a northeasterly direction. Wind speeds vary with the storms. Gusts exceeding 100 miles per hour have been recorded at several coastal locations (**Table 2-174**) but lessen as storms move inland. These storms, such as the Columbus Day Storm of October, 1962, can be very destructive. Less destructive storms can topple trees and power lines and cause building damage. Flooding can be an additional problem. A large percentage of Oregon's annual precipitation comes from these events (Taylor & Hatton (1999); FEMA-1405-DR-OR, 2002YEAR, Reducing Windstorm Damage to Property and Electrical Utilities).

Tornadoes

Most people do not associate tornadoes with the State of Oregon, and certainly not in coastal areas. Nevertheless, tornadoes have occurred in Region 1. They are characteristically brief and small, but also damaging. The first recorded tornado on the Oregon Coast occurred in 1897 (**Table 2-175**). Two more occurred in 2016 in Tillamook County; one caused about $1M in damage.

Historic Windstorm Events

Table 2-174. Historic Windstorms in Region 1

Date	Location	Description	Remarks
Jan. 1880	western Oregon	very high winds, 65-80 mph near Portland	flying debris; fallen trees
Jan. 1921	Oregon coast / Lower Columbia	winds 113 mph at mouth of Columbia; gusts at Astoria, 130 mph	widespread damage
Apr. 1931	western Oregon	unofficial reports of wind speeds up to 78 mph	widespread damage
Nov. 1951	most of Oregon	winds 40–60 mph with 75–80 mph gusts	widespread damage, especially to transmission lines
Dec. 1951	most of Oregon	winds, 60–100 mph, strongest along coast	many damaged buildings; telephone/power lines down
Dec. 1955	western Oregon	wind gusts at North Bend 90 mph	significant damage to buildings and farms
Jan. 1956	western Oregon	heavy rains, high winds, mud slides	estimated damage: $95,000 (1956 dollars)
Nov. 1958	most of Oregon	wind gusts to 75 mph at Astoria; gusts to 131 mph at Hebo	damage to buildings and utility lines
Nov. 1962	statewide	wind speeds of 131 mph on the Oregon coast (Columbus Day Windstorm Event)	Oregon's most destructive storm: 23 fatalities; damage at $170 million
Mar. 1963	Coast and NW Oregon	100 mph gusts (unofficial)	widespread damage
Oct. 1967	western and N. Oregon	winds on Oregon Coast 100–115 mph	significant damage to buildings, agriculture, and timber

Date	Location	Description	Remarks
Mar. 1971	most of Oregon	notable damage in Newport	falling trees took out power lines; building damage
Jan. 1986	N and central Oregon coast	75 mph winds	damaged trees, buildings, power lines
Jan. 1987	Oregon coast	wind gusts to 96 mph at Cape Blanco	significant erosion (highways and beaches); several injuries
Dec. 1987	Oregon coast / NW Oregon	winds on coast 60 mph	saturated ground enabled winds to uproot trees
Mar. 1988	N. and central coast	wind gusts 55–75 mph	one fatality near Ecola State Park; uprooted trees
Jan. 1990	statewide	100 mph winds in Netarts and Oceanside	one fatality; damaged buildings; falling trees (FEMA-853-DR-Oregon)
Feb. 1990	Oregon coast	wind gusts of 53 mph at Netarts	damage to docks, piers, boats
Jan. 1991	most of Oregon	winds of 63 mph at Netarts; 57 at Seaside	75-foot trawler sank NW of Astoria
Nov. 1991	Oregon coast	slow-moving storm; 25-foot waves off shore	buildings, boats, damaged; transmission lines down
Jan. 1992	southwest Oregon	wind gusts of 110 mph at Brookings	widespread damage
Jan. 1993	Oregon coast / N. Oregon	Tillamook wind gusts at 98 mph	widespread damage, esp. Nehalem Valley
Dec. 1995	statewide	wind gusts over 100 mph; Sea Lion Caves: 119 mph; followed path of Columbus Day Storm (Dec. 1962)	four fatalities; many injuries; widespread damage (FEMA-1107-DR-Oregon)
Nov. 1997	western Oregon	winds of 89 mph at Florence; 80 mph at Netarts and Newport	severe beach erosion; trees toppled
Feb. 2002	SW Oregon	75–100 mph on the SW coast (Douglas, Coos, and Curry Counties)	widespread loss of electricity and damage to public utility infrastructure (FEMA-1405-DR-Oregon)
Apr. 2004	Lane County		$5,000 in property damage (figure includes damages outside of Lane County)
Dec. 2004	Lane County		$6,250 in property damage (figure includes damages outside of Lane County)
Dec. 2004	Lincoln County		$6,250 in property damage (figure includes damages outside of Lincoln County)
Dec. 2004	Tillamook County		$6,250 in property damage (figure includes damages outside of Tillamook County)
Dec. 2004	Clatsop County		$6,250 in property damage (figure includes damages outside of Clatsop County)
Jan. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	two storm events with high winds of 86 mph and 103 mph	$244,444 and $144,444 in estimated property damage among all four coastal counties; the storm also impacted 5 other counties outside Region 1; total damages equal $300,000 and $200,000, respectively
Feb. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	wind storm event with winds measured at 77 mph	$150,000 and $91,600 in estimated property damage among all four coastal counties; the storm also impacted nine other counties outside of Region 1; total damages equal $300,000 and $275,000

Date	Location	Description	Remarks
Mar. 2006	Clatsop, Tillamook, Lincoln, Lane Counties	two wind storm events with winds measured at 60 mph and 75 mph	$75,000 and $211,000 in estimated property damage among all four coastal counties; the storms also impacted 10 other counties outside of Region 1; total damages equal $75,000 and $475,000
Nov. 2006	Coos, Curry, Douglas Counties	storm with winds measured at 70 mph.	total of $10,000 in damages
Dec. 2006	Coos, Curry, Douglas Counties	storm with winds measured at 90 mph	total of $225,000 in estimated damages for Coos, Curry, and Douglas Counties; the storm also impacted Josephine County, leading to a total storm damage of $300,000
Dec. 2006	Clatsop, Tillamook Counties	storm with high winds	total of $10,000 in damages
Nov. 2007	Clatsop, Tillamook Counties	storm with high winds	total of $10,000 in damages
Dec. 2007	Clatsop, Tillamook Counties	series of powerful Pacific storms	resulted in Presidential Disaster Declaration; $180 million in damage in the state, power outages for several days, and five deaths attributed to the storm
Dec. 2008	Clatsop, Lane, Tillamook, Lincoln Counties	intense wind and rain events	resulted in nearly $8 million in estimated property and crop damages for Clatsop, Lane, Tillamook, and Lincoln Counties
Dec. 2015	Regions 1-4	FEMA-4258-DR: severe winter storms, straight-line winds, flooding, landslides, and mudslides	
Oct. 2016	Manzanita, Oceanside in Tillamook County	tornadoes	EF2 in Manzanita with estimated damages of $1M; EFU in Oceanside with no damage
Apr. 2019	Curry, Douglas, Linn, Wheeler, Grant, and Umatilla	FEMA-4452-DR: Severe storms, straight-line winds, flooding, landslides, and mudslides	
Jul. 2018	Portland, Multnomah County	tornado	EF0; damage to trees and homes
Apr. 2019	Curry, Douglas, Linn, Wheeler, Grant, and Umatilla	FEMA-4452-DR: Severe storms, straight-line winds, flooding, landslides, and mudslides	Apr. 2019
Feb. 2020	Region 7: Umatilla, Union, Wallowa Counties	FEMA-4519-DR: Severe storms, tornadoes, straight-line winds and flooding	

Sources: Taylor and Hatton (1999); Hazards and Vulnerability Research Institute (2007); Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org; https://www.fema.gov/disaster/

Table 2-175. Tornadoes Recorded in Region 1

Date	Location	Remarks
June 1897	Bay City, Oregon	observed, but no damage recorded
Oct. 1934	Clatskanie, Oregon	observed; no damage
Apr. 1960	Coquille, Oregon	accompanied by heavy rain; no damage
Nov. 1965	Rainier, Oregon	crossed Columbia River; two buildings damaged
Oct. 1966	Seaside, Oregon	windows broken, telephone lines down, outdoor signs destroyed
Oct, 1967	Near Astoria, Oregon airport	began over ocean and moved inland. Several homes and commercial buildings damaged
Dec, 1973	Newport, Oregon	some roof damage
Dec. 1975	Tillamook, Oregon	90 mph wind speed; damage to several buildings
Aug. 1978	Scappoose, Oregon	manufactured home destroyed; other damage
Mar. 1983	Brookings, Oregon	minor damage
Nov. 1984	Waldport, Oregon	damage to automobiles and roofs
Feb. 1994	Near Warrenton, Oregon	damage in local park
Nov. 2002	Curry County, Oregon	$500,000.00 in property damage
Nov. 2009	Lincoln County, Oregon	$35,000 in property damage, damage to homes and automobiles
Oct. 2016	Manzanita, Tillamook County, Oregon	EF2; peak winds of 125-130 mph. Began as waterspout over the ocean and move onshore with estimated damages of $1M
Oct. 2016	Oceanside, Tillamook County, Oregon	EFU; no damage

Sources: National Weather Service, Portland; Taylor and Hatton (1999); National Climatic Data Center (2013) Storm Events Database, http://www.ncdc.noaa.gov/stormevents/; Hazards and Vulnerability Research Institute (2007); the Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org ; National Climatic Data Center (2013); U.S. Tornado Climatology, http://www.ncdc.noaa.gov/oa/climate/severeweather/tornadoes.html; ; https://www.ncdc.noaa.gov/stormevents/; https;//www.weather.gov/pqr/07-01-2019

Probability

Table 2-176. Local Assessment of Vulnerability to Windstorms in Region 1

	Clatsop	Coos	Curry	Douglas*	Lane*	Lincoln	Tillamook
Vulnerability	H	H	H	H	—	H	H

*Coastal portions of Douglas and Lane Counties

Source: Most recent local hazard vulnerability analyses (**Table 2-4**)

Table 2-177. State Assessment of Windstorm Probability in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	H	H	H	H	H

Source: PUC and OCCRI

High winds occur yearly in Region 1. Two tornadoes touched down in Tillamook County in 2016, one that caused about $1M in damage. The 100-year event is considered to be a storm with 1-

minute average winds of 90 miles per hour. A 50-year event has average winds of 80 mph, and a 25-year event has winds of 75 miles per hour.

Climate Change

There is insufficient research on changes in the likelihood of windstorms in the Pacific Northwest as a result of climate change. While climate change has the potential to alter surface winds through changes in the large-scale free atmospheric circulation and storm systems, there is as yet no consensus on whether or not extratropical storms and associated extreme winds will intensify or become more frequent along the Pacific Northwest coast under a warmer climate.

Vulnerability

Table 2-178. Assessment of Vulnerability to Windstorms in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	H	M	H	H	H

Source: PUC and OCCRI

Many buildings, utilities, and transportation systems within Region 1 are vulnerable to wind damage. This is especially true in open areas, such as along the Oregon Coast, natural grasslands, or farmland. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes.

Oregon's history of wind damage underscores the need for a comprehensive wind-hazard mitigation program. The necessity of such an action is partly supported in an after-action report focusing on western Oregon's high-wind event of February 7, 2002 (Hazard Mitigation Survey Team Report, FEMA-1405-DR-OR). Other historic events (e.g., 1962 Columbus Day Storm) provide additional insights.

Structures most vulnerable to high winds in Region 1 include insufficiently anchored manufactured homes and older buildings in need of roof repair. Section 307 of the Oregon Building Code identifies high-wind areas along the Oregon Coast and sets anchoring standards for manufactured homes located in those areas. It is essential that coastal counties ensure that the standards are enforced. The Oregon Department of Administrative Service's inventory of state-owned and operated buildings includes an assessment of roof conditions as well as the overall condition of the structure.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power and/or utility lines, effectively bringing local economic activity and other essential activities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed by uprooted ancient trees growing next to a house. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Tree-lined coastal roads and highways present a special problem. This is because much of the traveling public enjoys the beauty of forested corridors and most certainly would be concerned with any sort of tree removal program. In short, any safety program involving tree removal must be convincing, minimal, and involve a variety of stakeholders.

Wind-driven waves are common along the Oregon coast and are responsible for road and highway wash-outs and the erosion of beaches and headlands. These problems are addressed in the **Flood** section of this regional analysis. Unlike Oregon's Willamette Valley (Region 3), there are no water-borne ferry systems in Region 1 whose operations would be affected by high winds. Bridges spanning bays or the lower Columbia River would be closed during high-wind periods.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

The value of state-owned and leased buildings and critical facilities in Region 1 is approximately $535,054,000 representing the total potential for loss of state assets due to coastal hazards. The value of locally owned critical facilities is $1,294,655,000. Because windstorms could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to windstorms. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. According to Department of Administrative Services records, only one minor loss of just over $700 to a state facility was recorded in Region 1 since the beginning of 2015. It was caused by a windstorm.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard. The counties with the greatest social vulnerability statewide are Marion, Morrow, Umatilla, Wasco, Jefferson, Klamath, and Malheur.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

All the coastal counties are most vulnerable to windstorm damage. Coos County's high social vulnerability compounds the effects of windstorms on its population and requires more resources for preparation, mitigation, and response.

Risk

Table 2-179. Risk from Windstorms in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Risk	M	H	M	M	M	M	M

Source: PUC, OCCRI, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. In Region 1 the probability of windstorms occurring is high. All counties are highly vulnerable to damage from windstorms, but heavy damages are rare. Coos County's social vulnerability is higher than that of Region 1's other counties, and this will intensify the impacts from windstorms the County experiences. Considering the Region's high overall probability high vulnerability, along with Coos County's high social vulnerability, the risk from windstorms is considered high throughout Region 1. Coos County carries the greatest risk.

Winter Storms

Characteristics

Severe winter weather in Region 1 is characterized by extreme cold, snow, ice, and sleet. Snow and ice are less common in the coastal regions, but often bring flooding after snow melts. Flooding is where the problem begins. See the **Flood** section in this regional analysis for more about flooding along the Oregon Coast.

Historic Winter Storm Events

Table 2-180. Historic Winter Storms in Region 1

Date	Location	Description
Jan. 1998	Clatsop County	trees and large tree limbs were knocked down causing widespread power outages; citizens urged to stay home; 3 known fatalities
Jan. 2002	statewide	strong winter storm with high winds at coast and heavy snows to the inland areas of Northwest Oregon; Florence had 46 mph sustained winds and 36 mph gusts to 63 mph, Newport Jetty 39 mph with gusts to 53 mph, and Garibaldi 42 mph; 32 inches of snow at Timberline Lodge on Mount Hood and 30 inches at Santiam Pass
Jan. 2004	statewide	frigid arctic air mass, heavy snow, sleet and freezing rain; weight from the snow and ice buildup resulted in widespread downed trees and power lines, leaving 46,000 customers without power, and collapsed roofs; Oregon Governor Kulongoski estimated cost of damages to public property at $16 million
Dec. 2008	northern Oregon coast	third unusually cold storm system that season with heavy snow in northwest Oregon; heavy snowfall across northwest Oregon; 11–24 inches of snow in the north Oregon Coast Range
Feb. 6–10, 2014	Lincoln, Tillamook and Clatsop Counties	a strong winter storm system affected the Pacific Northwest during the February 6–10, 2014 time period bringing a mixture of arctic air, strong east winds, significant snowfall and freezing rain to several counties in northwest Oregon; a much warmer and moisture-laden storm moved across northwest Oregon after the snow and ice storm (Feb. 11–14), which produced heavy rainfall and significant rises on area rivers from rain and snowmelt runoff; during the 5-day period Feb. 6–10, 2 to10 inches fell in the coastal region of northwest Oregon; freezing rain accumulations generally were 0.25 to 0.75 inches; the snowfall combined with the freezing rain had a tremendous impact on the region
Feb. 11–14, 2014	Lincoln, Tillamook and Clatsop Counties	DR-4169 Linn, Lane, Benton and Lincoln Counties declared. Another weather system moved across northwest Oregon during the February 11–14 time frame; this storm was distinctly different from the storm that produced the snow and ice the week prior and brought abundant moisture and warm air from the sub-tropics into the region; as this storm moved across the area, 2 to 7 inches of rain fell across many counties in western Oregon; the heavy rainfall combined with warm temperatures led to snowmelt and rainfall runoff that produced rapid rises on several rivers, which included flooding on three rivers in northwest Oregon
Dec. 6-23, 2015	Statewide storm events	DR-4258 Clatsop, Columbia, Multnomah, Clackamas, Washington, Tillamook, Yamhill, Polk, Lincoln, Linn, Lane, Douglas, Coos, and Curry Counties declared. Several pacific storm systems moved across the region over the Dec 12-13 weekend. Each storm system brought several inches of snow to the mountain areas. Moist onshore winds produced a steady stream of showers over the foothills of the Cascades with snow levels between 1,000 and 2,000 feet. This resulted in heavy snow for the Northern Oregon Cascades and Coast Range.

Date	Location	Description
Feb. 22-26, 2019	Coos, Curry, Douglas, (Oregon Coast Range)	DR-4432 Jefferson, Lane, Douglas, Coos and Curry Counties declared. Persistent troughing off the coast of the Pacific Northwest focused a stream of mid-level moisture over the Inland Northwest resulting in a long duration snow event as the plume drifted north and south several times between the 22nd and 27th of February.

Source: National Weather Service; https://www.fema.gov/disaster; https://www.ncdc.noaa.gov/stormevents

Probability

Table 2-181. Probability Assessment of Winter Storms in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Probability	H	H	—	H	L	—	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

On the basis of historical data, severe winter storms could occur about every 4 years in Region 1. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time.

Climate Change

There is no current research available about changes in the incidence of winter storms in Oregon due to changing climate conditions. However, the warming climate will result in less frequent extreme cold events and high-snowfall years.

Vulnerability

Table 2-182. Local Assessment of Vulnerability to Winter Storms in Region 1

	Clatsop	Coos	Curry	Douglas*	Lane*	Lincoln	Tillamook
Vulnerability	—	L	—	L	—	M	H

*Coastal portions of Douglas and Lane Counties

Source: Most recent local hazard vulnerability analyses (**Table 2-4**)

Table 2-183. State Assessment of Vulnerability to Winter Storms in Region 1

	Clatsop	Coos	Curry	Douglas	Lane	Lincoln	Tillamook
Vulnerability	H	H	—	M	L	—	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

Severe winter weather in Region 1 is characterized by extreme cold, snow, ice, and sleet. These conditions bring widespread power outages and road closures due to downed trees from the heavy ice. These events close roads and isolate communities. Due to the logistics of the coastal regions many of the communities may become isolated due to winter storms. Countywide road closures can cause considerable travel delays. Communities in Region 1 that may be impacted by severe winter storms include Astoria, Cannon Beach, Rockaway Beach, Oceanside, Lincoln City, Depot Bay and Newport.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1–5). Social vulnerability scores do not vary by hazard. The counties with the greatest social vulnerability statewide are Marion, Morrow, Umatilla, Wasco, Jefferson, Klamath, and Malheur.

According to the CDC Social Vulnerability Index, Coos County and Coastal Douglas County are the most socially vulnerable in the region; however, the social vulnerability score for Coastal Douglas County is not distinct from that of Douglas County as a whole. For information on social vulnerability in Douglas County, see Region 4. Coos County's vulnerability is driven by the share of households without access to a vehicle, unemployment rates, and the percentage of residents with a disability. Social vulnerability is low in Curry County; however, the county is in the 90th percentile for the share of residents aged 65 and older and also for the share of residents with a disability.

Coos County is not one of the counties in Region 1 considered most vulnerable to loss of life or property damage from winter storms. Therefore, its high social vulnerability is not anticipated to have a significant impact on its overall vulnerability to winter storms.

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

The value of state-owned and leased buildings and critical facilities in Region 1 is approximately $535,054,000 representing the total potential for loss of state assets due to coastal hazards. The value of locally owned critical facilities is $1,294,655,000. Because winter storms could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to winter storms. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. According to Department of Administrative Services records, only one minor loss of just over $700 to a state facility was recorded in Region 1 since the beginning of 2015. It was not caused by a winter storm.

Risk

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life.

Clatsop, Tillamook, and Lincoln Counties are considered at greater risk from winter storms than the other counties in Region 1.