Forest Service
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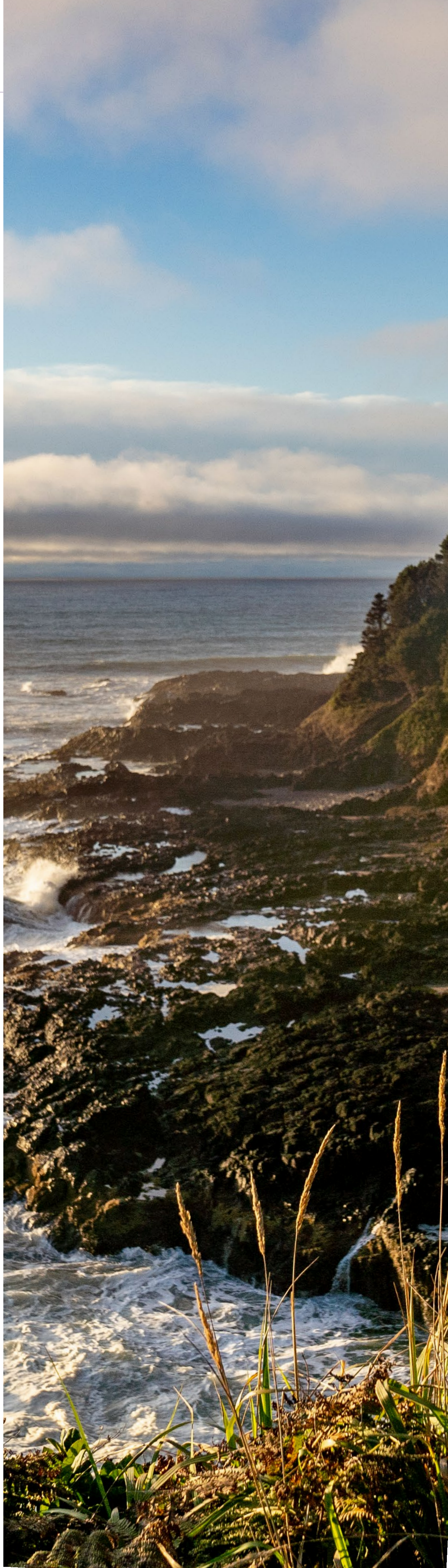
Climate Change Vulnerability and Adaptation in Coastal Oregon: Executive Summary

Introduction

The following summary highlights key points from the climate change vulnerability assessment for the federal lands of coastal Oregon (Halofsky et al. 2024). The vulnerability assessment was developed by the Oregon Coast Adaptation Partnership (OCAP)—a science-management partnership consisting of the U.S. Department of Agriculture, Forest Service (Siuslaw National Forest, Oregon Dunes National Recreation Area, Cascade Head Experimental Forest, Pacific Northwest Region, Pacific Northwest Research Station) and Northwest Climate Hub; U.S. Department of the Interior, Bureau of Land Management (Northwest Oregon District and Coos Bay District); and the University of Washington School of Environmental and Forest Sciences. The vulnerability assessment presents projected changes to climate and assesses the effects on natural resources from the Pacific coast of Oregon to the western margins of the Willamette Valley. OCAP resource managers then developed adaptation options in response to the vulnerabilities of each resource, including both high-level strategies and on-the-ground tactics.

Historical and Future Climate

- The region has a mild, maritime climate with a Mediterranean precipitation pattern. More than 70 percent of annual precipitation occurs between November and March. Significant dry spells can occur during summer. Fog and low cloud cover are a major feature of coastal climate.
- Although the OCAP assessment area is relatively low in elevation, the Oregon Coast Range still creates a strong climate gradient between the coast and inland valleys, with enhanced precipitation on windward (west) slopes. Temperature difference is greatest in summer when the coast is much cooler than inland areas. Winter temperatures are generally above freezing, but subfreezing temperatures occur, especially inland and at higher elevations (fig. 1).
- The mean annual temperature within the OCAP assessment area has increased by 1.2 to 1.5 °C (2.2 to 2.7 °F) since 1895.
- Climate models project either no change or a negligible increase in annual precipitation, which already exhibits high interannual variability. Projections also show a shift toward slightly more winter precipitation (8 to 10 percent), little change in spring and fall, and less precipitation during summer (–28 percent).
- Atmospheric-oceanic conditions characterized by phenomena such as the El Niño Southern Oscillation and Pacific Decadal Oscillation will persist, leading to climate variability at annual and decadal scales.
- Compared to observed historical temperatures, mean annual temperatures are projected to increase by about 4.0 °C (7.2 °F) by the end of the 21st century (2070 through 2099) under a high greenhouse gas emissions scenario (Representative Concentration Pathway [RCP] 8.5[1]) (fig. 2).



[1] Different Representative Concentration Pathway (RCP) scenarios are used in climate modeling to project the trajectory of greenhouse gas emissions and their combined effect with other factors that influence the amount of heat that enters and leaves the Earth's atmosphere. RCP 4.5 represents a future with significant reduction in global greenhouse gas emissions and climate stabilization by 2100. RCP 8.5 represents a future with no climate change mitigation, high population growth, and continued increase in greenhouse gas emissions through 2100.

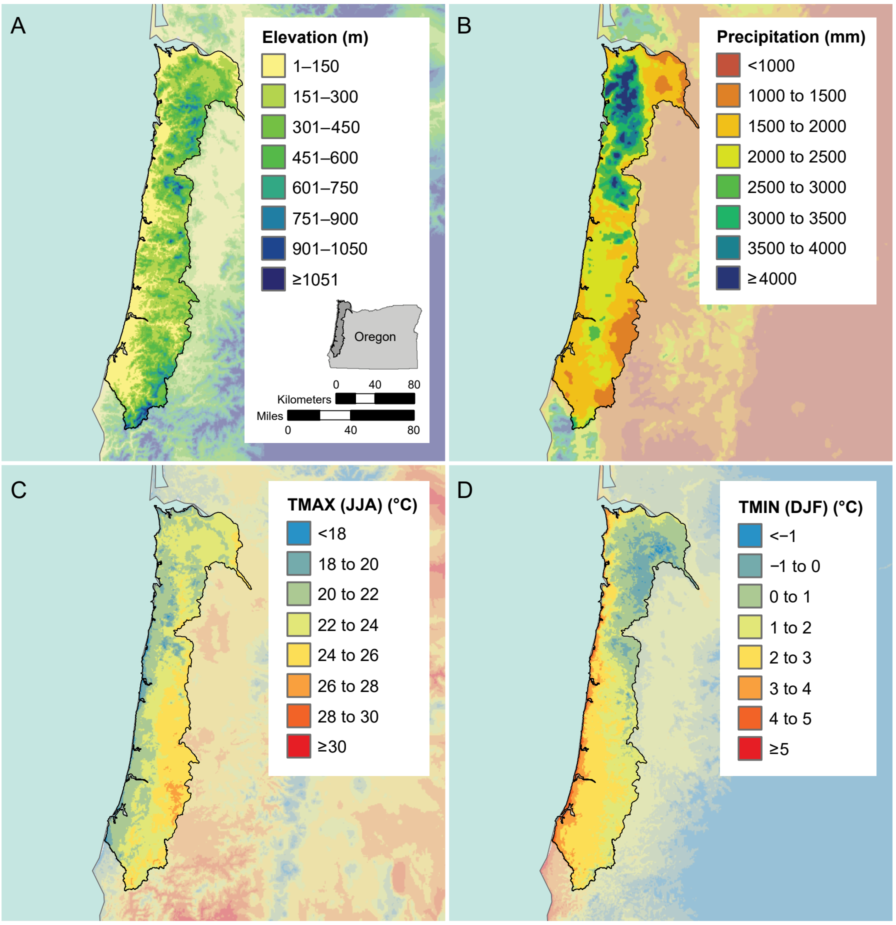


Figure 1—Oregon Coast Adaptation Partnership (OCAP) assessment area elevation and climate from 1970 through 1999. Parameter-elevation Regression on Independent Slopes Model (PRISM) data were used to plot (A) elevation; (B) mean annual precipitation; (C) mean daily maximum temperature (TMAX) for June, July, and August (JJA); and mean daily minimum temperature (TMIN) for December, January, and February (DJF). The OCAP assessment area boundary is overlaid. PRISM uses point data, a digital elevation model, and other spatial datasets to generate gridded estimates of climatic parameters at multiple timescales.

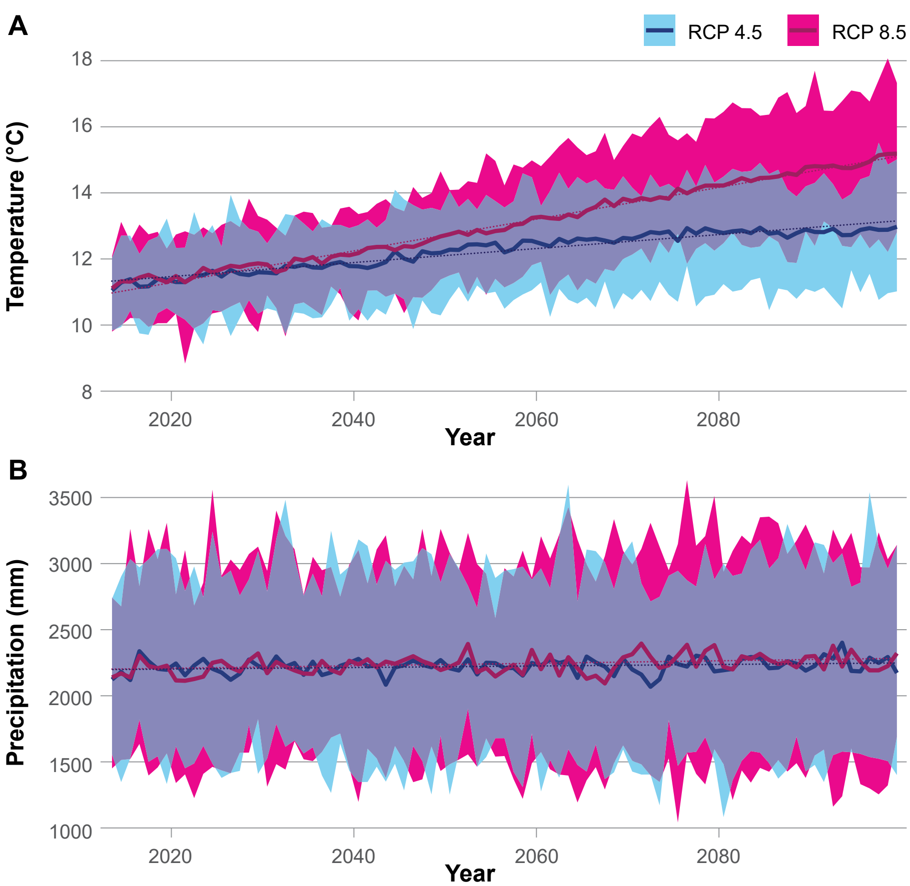


Figure 2—A comparison of annual (A) temperature and (B) precipitation projections under Representation Concentration Pathway (RCP) 4.5 and RCP 8.5 climate change scenarios for the Oregon Coast Adaption Partnership assessment area through the end of the 21st century. The model averages projected warmer temperatures regardless of scenario through at least mid-century, whereas there was no discernible trend for precipitation.

Water Resources and Hydrology

- If timing and intensity of rainfall in the Oregon Coast Range change as expected, low streamflows in summer will be lower, and peak flows in winter will be higher (fig. 3).
- Tidal zones are areas of high vulnerability given their exposure to sea-level rise, upstream hydrologic effects, and higher storm intensity. Higher tidal storm surges are likely (fig. 4).
- Stream drying during low flows and sedimentation during peak flows and floods degrade water quality, affecting human water supplies and aquatic habitat. Increased stream temperatures also affect water quality. Late-summer municipal water supplies and low-elevation wastewater treatment facilities are also highly vulnerable.
- Major public roadways and roads and trails managed by OCAP partners are vulnerable to climate change effects. Flooding at stream crossings and low-lying areas is a major risk, especially for roads with outdated design standards. Risk-reduction actions (including closure) may be necessary in some cases.

Adaptation Options

- Improve the functionality of existing waterbodies through restoration and repair, and upgrade associated infrastructure to accommodate increasing stressors.
- Restore hydrologic connectivity and channel structure in low-elevation depositional floodplains to increase resilience to flooding. Reintroduce or support existing populations of American beaver (*Castor canadensis*), or construct beaver dam analogs and add large woody debris to streams.
- Increase the resilience of transportation systems by upsizing culverts and other road crossings to accommodate higher flows. Evaluate roads for rerouting or decommissioning based on human safety concerns or budgets.
- Take advantage of restoration management activities before and after disturbance events to perform additional work aimed at increasing resilience.

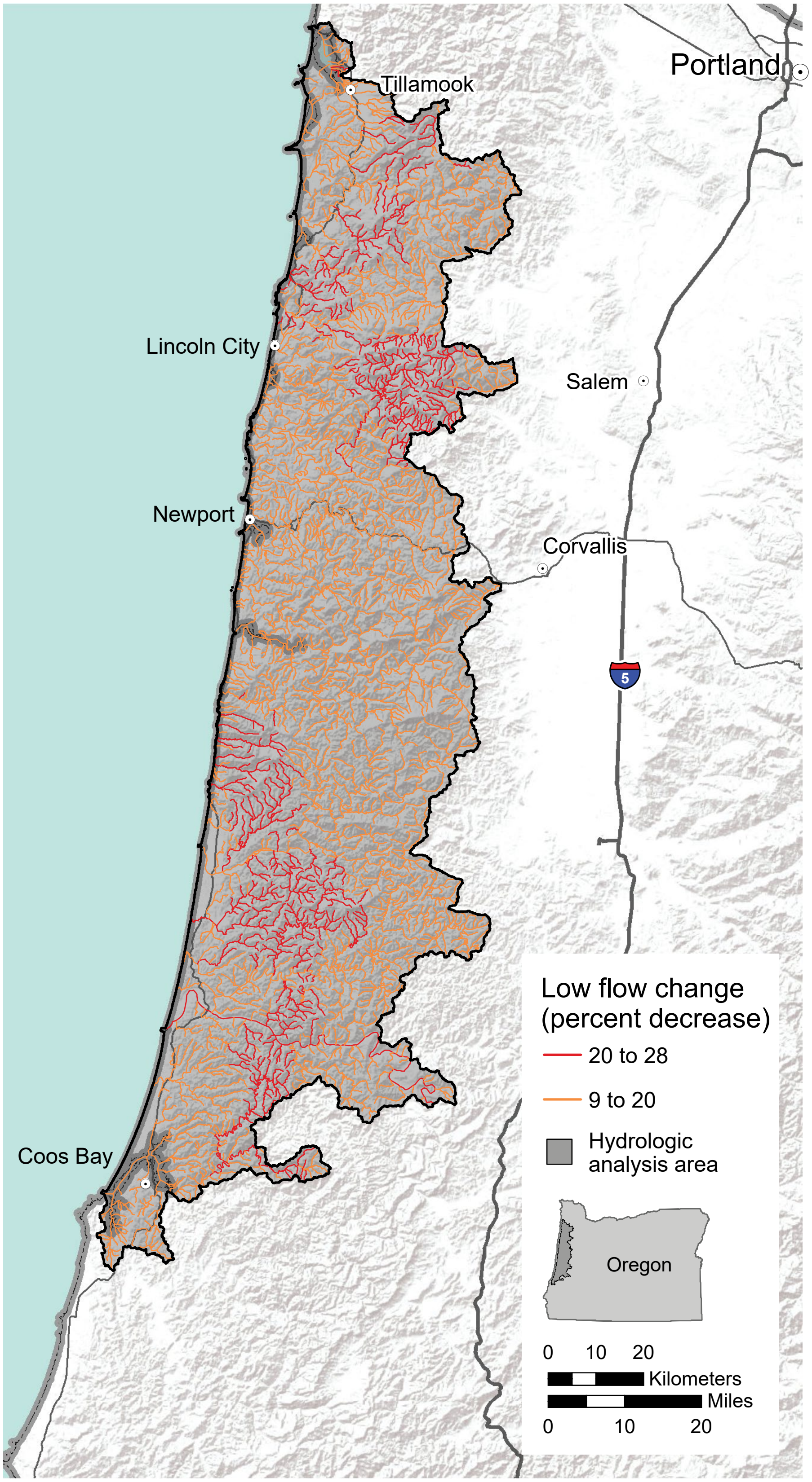


Figure 3—Projected percentage decrease in low flows between a historical period (1970 through 1999) and the 2080s (2070 through 2099) under the A1B greenhouse gas emission scenario. Projections are based on Variable Infiltration Capacity model projections of surface water input changes filtered by the geologically based unit hydrograph. See Halofsky et al. (2024) for modeling details.

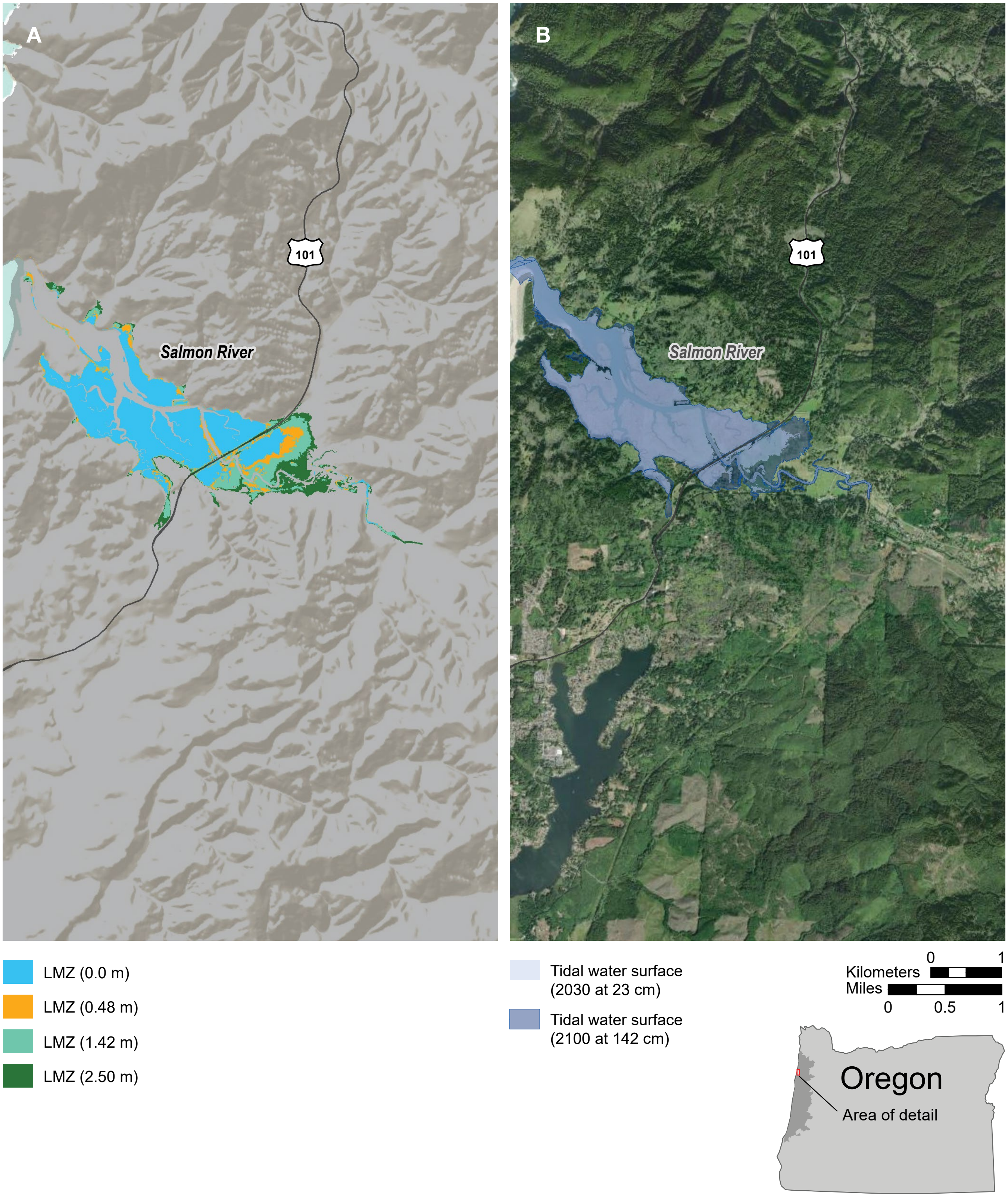


Figure 4—Potential areas of landward migration zones (LMZs) for vegetation under different tidal inundation scenarios for the Salmon River in the Oregon Coast Adaptation Partnership assessment area. (A) Landward migration zones shown are areas that could become future tidal wetlands under sea-level rises of 0, 0.48, 1.42, and 2.5 m. (B) Projected tidal water surface for a 50-percent annual chance of a coastal flood event in 2030, given a 23-cm rise in sea level, and in 2100, given a 142-cm rise in sea level. See Halofsky et al. (2024) for modeling details.

Aquatic Ecosystems and Watersheds

- Rapid shifts in temperature and precipitation regimes may alter the timing of environmental conditions, potentially disconnecting alignment among seasonal freshwater habitats to which native fish species are adapted (table 1). Transition times in estuaries and marine areas may also change.
- The vulnerability of a fish species will likely depend on how much or how little their life history traits expose them to climate change effects.

Adaptation Options

- Improve and expand habitat, while increasing connectivity to improve fish movement across the aquatic landscape.
- Ensure streams and floodplain characteristics are intact to allow upstream movement to habitat refugia.
- Increase connectivity in estuaries to expand habitat needed for species transitioning to different life stages.
- Specific tactics include reducing sources of sedimentation, removing barriers to fish passage, reintroducing or supporting current American beaver populations, removing tide gates, and maintaining access to coastal lakes.

Vegetation Management

- The OCAP assessment area will most likely remain a largely forested landscape, but higher temperatures, soil moisture deficits, and wildfire will affect species composition and structure of vegetation (table 2, fig. 5). Effects are expected to differ geographically, and a considerable amount of uncertainty about ecological implications still exists.
- Stressors, including nonnative species, may drive vegetation shifts by competitively excluding native species or altering disturbance regimes.
- Insects and disease may decrease productivity as summer drought stress increases with higher temperature and less coastal fog.
- Wildfire has recently been rare, but historical fires demonstrate the potential for extremely large events that could bring about shifts in forest type. Short-interval reburns could promote transitions to nonforest vegetation or protracted periods of early-seral development.

Adaptation Options

- Maintain good forest vigor and manage for resilience to disturbances at multiple spatial scales.
- Manage for high diversity—species, structural, and genetic—to increase adaptive capacity.
- Control nonnative invasive species to reduce risks to native species.
- Reduce fire risk, while considering fire-severity regime, ignition sources, and resources and values at risk. A better understanding of wind events (especially east wind) will facilitate improved fire management.

Table 1—Projected change in the percentage of streams with mean temperatures lower than 17 °C (62.5 °F) in August for focal fish species habitats and estimated climate vulnerability for each species

Species	Historical (1993–2011)	2040s (2030–2059)	2080s (2070–2099)	Climate vulnerability
	PERCENT			
Steelhead (*Oncorhynchus mykiss*)	60	36	21	Moderate (winter run)
Coastal cutthroat trout (*O. clarkii clarkii*)	86	67	43	Moderate
Pacific lamprey (*Entosphenus tridentatus*)	62	32	14	High
Western brook lamprey (*Lampetra richardsoni*)	85	64	34	High
Green sturgeon (*Acipenser medirostris*)	2.3	0	0	Moderate
Eulachon (*Thaleichthys pacificus*)	0	0	0	High
Coho salmon (*O. kisutch*)	82	59	34	High to very high
Chinook salmon (*O. tshawytscha*)	72	44	23	Very high (spring run), high (fall run)
Chum salmon (*O. keta*)	59	24	13	Moderate

Note: Assessment ratings are from the National Oceanic and Atmospheric Administration and the State of Oregon. More details in Halofsky et al. (2024).

Table 2—Summary of key vulnerabilities by forests type in the Oregon Coast Adaptation Partnership assessment area

Forest type	Key vulnerabilities
Moist forests	Douglas-fir (*Pseudotsuga menziesii*) will likely continue to dominate and may replace Sitka spruce (*Picea sitchensis*) in coastal areas and noble fir (*Abies procera*) at higher elevations. Western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*) may be restricted to cool locations with high soil moisture. Increased fire frequency may favor hardwoods at lower elevations. Invasives such as common gorse (*Ulex europaeus*) and Scotch broom (*Cytisus scoparius*) are pyrogenic and could facilitate fire spread where they are abundant.
Dry forests	Douglas-fir along with grand fir (*Abies grandis*) will continue to dominate, as both are tolerant of warm, dry conditions. Increased disturbance will favor hardwoods such as Oregon white oak (*Quercus garryana*), bigleaf maple (*Acer macrophyllum*), and tanoak (*Lithocarpus densiflorus*). Composition could resemble Klamath Mountains mixed-evergreen forests to the south, with Pacific madrone (*Arbutus menziesii*) and giant chinquapin (*Chrysolepsis chrysophylla*) becoming more common. Warmer, wetter winters may increase risk from pathogens and potentially allow sudden oak death to move northward.
Special habitats	Meadow loss is likely to continue from snowpack loss and tree encroachment, and where they persist, may shift to drier plant communities. Altered soils and seed banks may limit the role of high-severity fire in maintaining meadows. Fire may also increase exposure to invasions of nonnative plant species. Altered hydrology and increased disturbance are likely to influence the structure of riparian areas and wetlands. High-elevation wetlands are particularly vulnerable. Sea-level rise is a major threat to tidal estuaries and marshes. Historical marsh conversion could limit the ability of some species to migrate landward. Already highly modified by invasives, dune systems are likely to be particularly vulnerable to climate change. European beachgrass (*Ammophila arenaria*), an invasive plant species, may decline with increasing temperatures leading to uncertainty about how other dune species will respond.

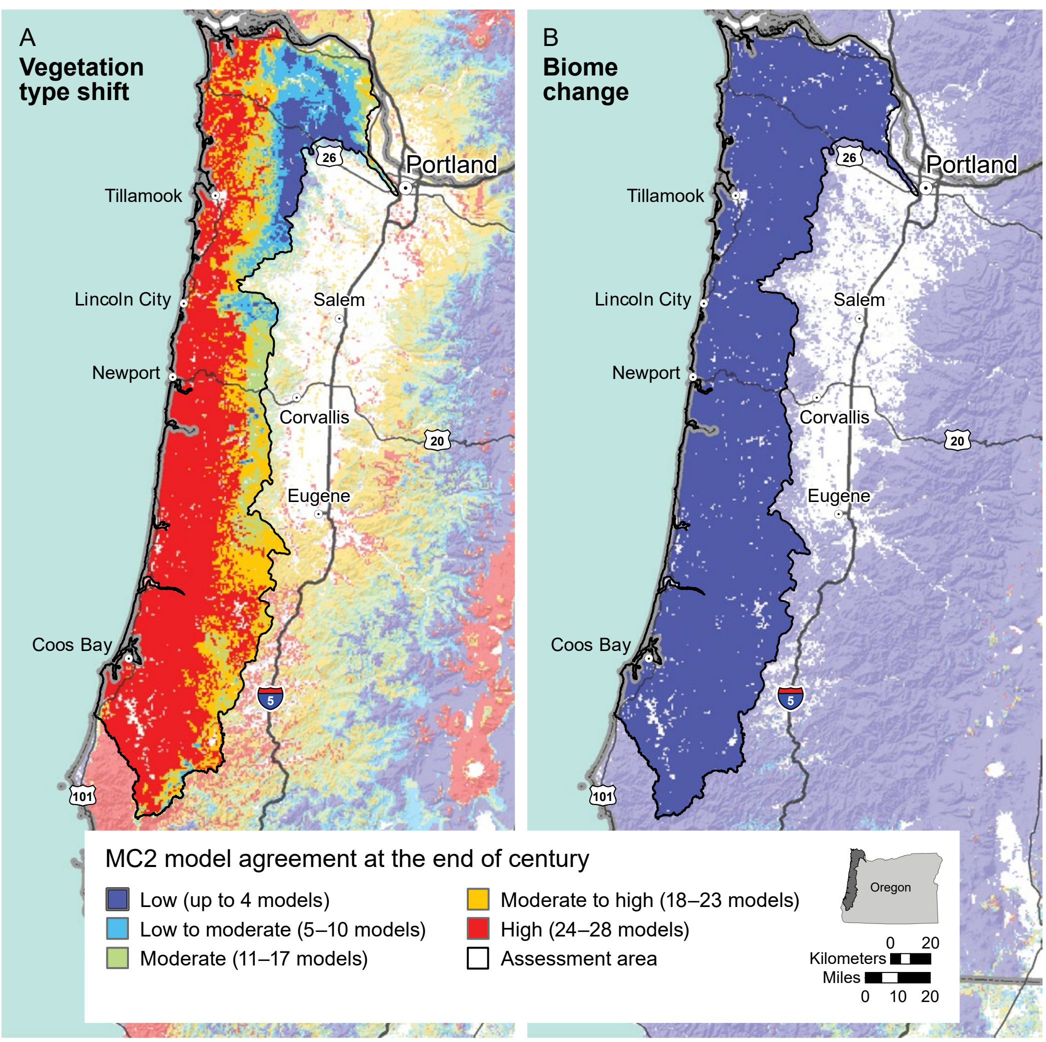


Figure 5—MC2 model agreement (among 28 climate scenarios) at the end of century (2080 [2070 through 2099]) for (A) simulated shift in vegetation type and (B) simulated change in biome (e.g., forest to woodland or shrubland to grassland).

Wildlife Habitat Management

- Ecosystem responses to climate change will affect animal species through altered food availability, competition, predator-prey dynamics, and availability of key habitat features (table 3).
- Despite the flexibility and adaptive capacity of many species, widespread shifts in animal ranges and extirpation of some species may result from climate change and other stressors.

Adaptation Options

- A broad strategy encompassing all proposed actions is to develop a region-wide plan to ensure a mosaic of landscape conditions that include refugia, areas managed for diverse and resilient forests and grasslands supported under current climatic conditions, and transition areas where plants and wildlife can adapt to new ecological conditions.
- Increase habitat connectivity to help ensure a mosaic of conditions at multiple spatial scales, including forested corridors, structures for safe crossing of major highways, and management activities for individual species.
- Consider translocation of species (including assisted migration) where appropriate.

Table 3—Summary of climate change effects on focal wildlife habitat types

Focal habitat	Effects
Mixed conifer forest	Mixed conifer forest is likely to persist but with potential for significant shifts in dominant tree species leading to vegetation types more comparable to northern California coastal forests. Older, structurally complex stands may be more resilient to a warmer climate but are also exposed to higher disturbance risk. Example fauna: Humboldt's flying squirrel (*Glaucomys oregonensis*), northern spotted owl (*Strix occidentalis caurina*), red tree vole (*Arborimus longicaudus*), marbled murrelet (*Brachyramphus marmoratus*).
Coastal Sitka spruce forest	Warming may expand suitability for coastal Sitka spruce forest but may also increase suitability for hardwoods. Decreased fog would stress the drought-intolerant Sitka spruce (*Picea sitchensis*). Example fauna: Humboldt marten (*Martes caurina humboldtensis*), red tree vole, marbled murrelet, many amphibian species.
Oak savanna woodlands	Oak savanna woodlands may potentially increase along the margins of the Willamette Valley but could be hampered by lack of connectivity between oak areas. This ecosystem is sensitive to sudden oak death, severe summer drought, and fire-caused mortality of oak. Example fauna: western gray squirrel (*Sciurus griseus*), acorn woodpecker (*Melanerpes formicivorus*), mountain quail (*Oreortyx pictus*).
Montane forests and meadows	Risks to montane forests and meadows include more winter flooding, reduced snowpack duration, and drought stress in summer. Noble fir (*Abies procera*) may be limited to small pockets of habitat with cooler temperatures and high soil moisture. Example fauna: Humboldt's flying squirrel, Roosevelt elk (*Cervus canadensis roosevelti*), gray-crowned rosy finch (*Leucosticte tephrocotis*), many amphibian species.
Coastal meadows and grasslands	Sea-level rise, loss of fog, and tree encroachment threaten coastal meadows that are already highly modified by human activity. Example fauna: rufous hummingbird (*Selasphorus rufus*), Oregon silverspot butterfly (*Speyeria zerene hippolyta*), greenish-blue butterfly (*Plebejus saepiolus littoralis*), several reptile species.
Aquatic and wetland ecosystems	Increased frequency, duration, and intensity of drought will alter the timing and volume of runoff (particularly in unregulated basins), decrease groundwater recharge, increase evapotranspiration, and increase water temperatures in aquatic and wetland ecosystems. Example fauna: American beaver (*Castor canadensis*), mountain beaver (*Aplodontia rufa*), bald eagle (*Haliaeetus leucocephalus*), many amphibian species.
Marine and estuarine	Sea-level rise, stronger storm events in winter, and warmer and drier conditions in summer will influence the spatial extent of marine and estuarine habitats as well as interactions with coastal terrestrial habitats. Example fauna: black oystercatcher (*Haematopus bachmani*), western snowy plover (*Charadrius nivosus nivosus*), hairy-necked tiger beetle (*Cicindela hirticollis*).
Dune shrub forest	Sea-level rise and warmer and drier conditions in summer will influence the spatial extent and vigor of dune shrub forest. Private land and forest plantations also limit eastward migration. Example fauna: Humboldt marten, white-footed vole (*Arborimus albipes*), several reptile and amphibian species.

Recreation

- The OCAP assessment area has multiple geographic zones (coastal dunes, headlands, beaches, marine zone, estuaries and coastal lagoons, and upland areas) where warm-weather recreational activities (hiking, camping, nature viewing, etc.) occur (fig. 6). Expansion of the recreation season because of favorable conditions in spring and fall could potentially create stress for facilities and management systems.
- More wildfire in both the assessment area and other locations in Oregon and the Pacific Northwest in general will result in closures of recreational sites, fire restrictions, and altered use patterns (e.g., recreationists coming from inland areas where fire and smoke are prevalent).
- Sea-level rise, higher high-tide lines, shifts in precipitation, and storm surges will put coastal infrastructure and access roads at risk and potentially make some areas unusable.

Adaptation Options

- Incorporate climate change vulnerability in sustainable recreation planning by anticipating shifts in supply and demand for recreation types and by building infrastructure that is resilient to climate change.
- Increase management flexibility and capacity to meet shifting recreational demands.
- Increase resilience to wildfire through infrastructure modifications and assertive communication with recreationists during fire events.
- Improve communication and outreach with the public and local communities about risks and availability of recreational sites.

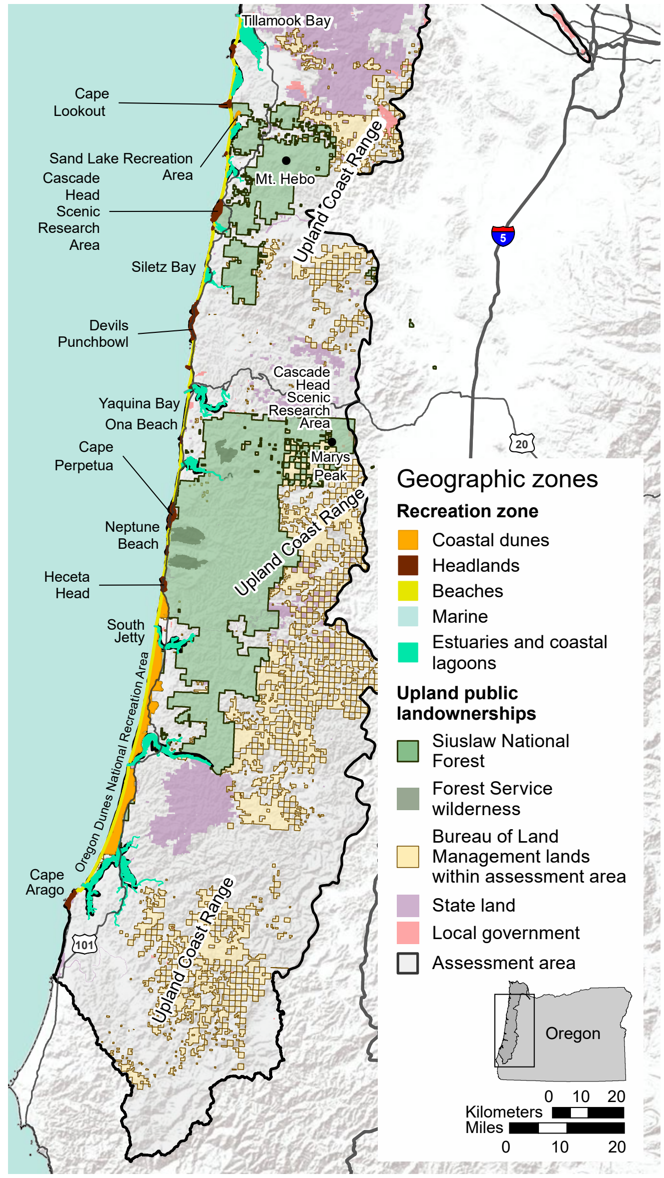


Figure 6—Geographic zones in the Oregon Coast Adaptation Partnership assessment area. The uplands zone includes any land not in the other five zones on the map.

Ecosystem Services

- Climate change effects on ecological processes and plant and animal communities may affect culturally important natural resources, places, and traditions, including how people and landscapes are connected.
- American Indians may be particularly vulnerable to climate shifts because of cultural connections with ecosystems and specific plant and animal species.
- Forests in the OCAP assessment area are expected to remain productive in supplying timber and nontimber forest products (table 4). Reductions from drought and wildfire may occur for some species in some locations, whereas others may benefit from change. Socioeconomic conditions may have greater effects than climate on industries and communities that participate in the timber economy.
- Current forest conditions in the assessment area are conducive to high carbon uptake. If frequency and extent of disturbances increase by the late 21st century, carbon storage may level off or decline.
- Warming could affect insect pollinator physiology and behavior, creating potential phenological mismatches in timing of flower and pollinator emergence.

Adaptation Options

- Manage for ecosystem function and resilience as an overarching strategy focused on sustainability.
- Protect areas that provide key ecosystem services and values.
- Prepare for acute stresses (e.g., extreme events) and chronic stresses (e.g., development, sedimentation in water) through planning, cross-jurisdictional coordination, and communication.
- Prioritize management and restoration of pollinator habitat on federal land and near federal facilities.
- Ensure equitable access and a sustainable supply of nontimber forest products for resource users while maintaining ecological function.

Table 4—Summary of metrics describing selected ecosystem services in Siuslaw National Forest (SIU) and Bureau of Land Management, Northwest Oregon (NWOR) and Coos Bay (CB) District

UNIT	Ecosystem service	Timber volume[a]	Nontimber forest products[b]					Carbon stock[c]	Recreation[d]	Water supply[e]
			Christmas trees	Mushrooms	Nontimber wood/firewood	Decorative and craft plants	Transplants			
	Area (× 1000 ha)	*Million board feet sold*	*Permits*	*Pounds*	*Million board feet sold*	*Limbs, boughs, foliage, cones, etc. in pounds*	*Number*	*Metric tonnes per hectare*	*Visits × 1,000*	*Millions of cubic meters*
SIU	255	36	257	44,664	4.3	2,972,240	1,673	405	1,495	4138.4
NWOR	289	109	29	127,996	0.25	573,589	3,220	487	1,526	Unavailable
CB	130	38	170	126,551	0.19	68,768	0	469	775	Unavailable

[a] Timber volume is the 2013 through 2018 annual average reported by the Forest Service, Pacific Northwest Region and Bureau of Land Management, Northwest Oregon District natural resources staff.

[b] Nontimber forest products metrics are 2013 through 2018 annual averages reported by the Forest Service, Pacific Northwest Region and Bureau of Land Management, Northwest Oregon District natural resources staff.

[c] Carbon stocks are 2013 estimates reported by the Siuslaw National Forest (USDA FS 2015) and Bureau of Land Management units (BLM 2016).

[d] Recreation is for 2016 visits reported by the Siuslaw National Forest National Visitor Use Monitoring program and Bureau of Land Management, Northwest Oregon District recreation staff. Bureau of Land Management, Northwest Oregon District recreation is only for resource areas within the Oregon Coast Adaptation Partnership assessment area.

[e] Water supply is mean annual renewable water supply estimates for 1981–2010 (Brown et al. 2016).

Source: Tent graphic designed by Brgfx, http://www.freepick.com; water-drop graphic from http://www.vexels.com.

For Further Reading

Halofsky, J.E.; Peterson, D.L.; Gravenmier, R.A., eds. 2024. Climate change vulnerability and adaptation in in coastal Oregon. Gen. Tech. Rep. PNW-GTR-1024. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 380 p. https://doi.org/10.2737/PNW-GTR-1024.

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Photo credits: Cover—Cape Perpetua, Oregon, USDA Forest Service photo. Pages 1 and 9—Siuslaw National Forest, USDA Forest Service photos by Cecilio Ricardo. Page 3—Nestucca River, USDI Bureau of Land Management photo.

Abstract

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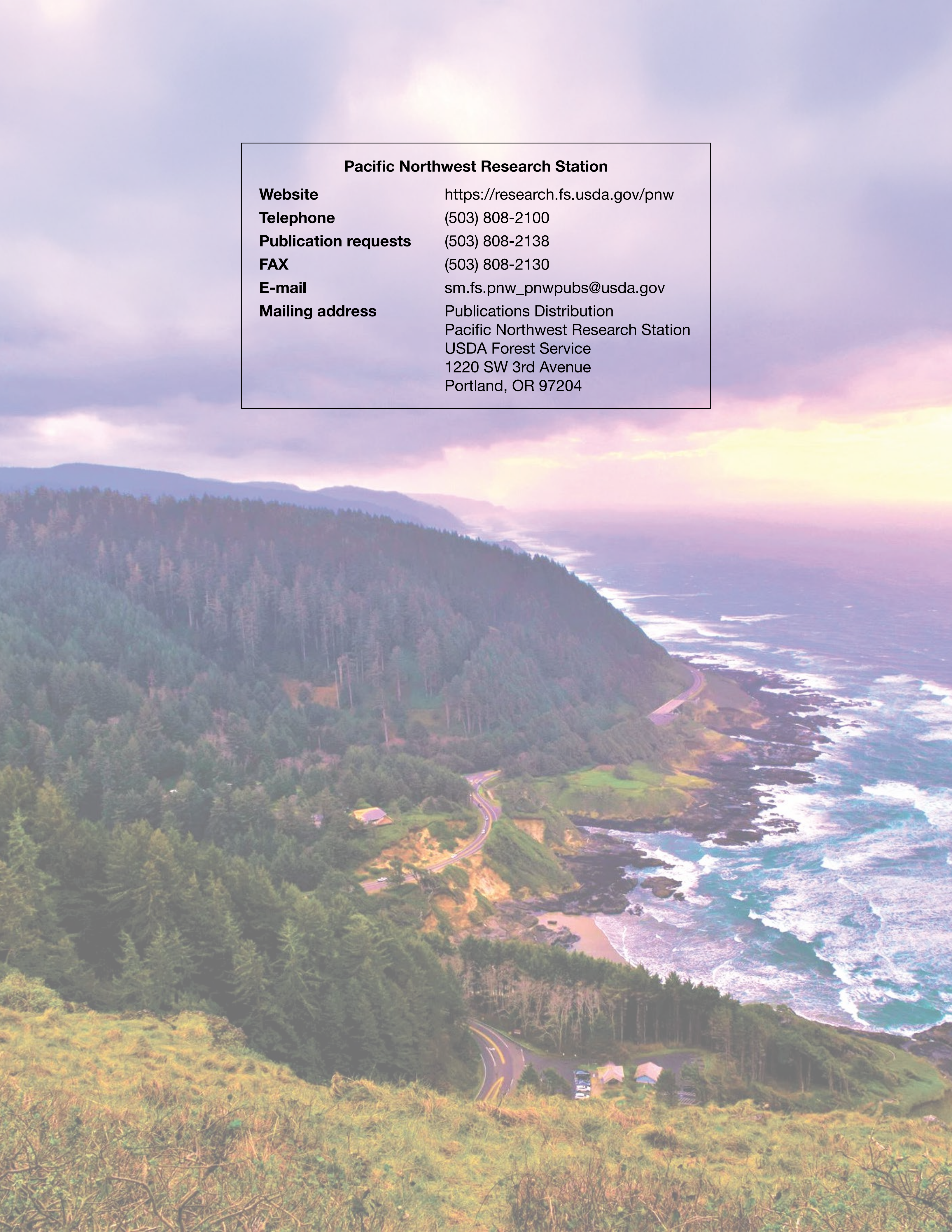
This is the executive summary for the report, *Climate Change Vulnerability and Adaptation in Coastal Oregon*, by Halofsky et al. (2024, PNW-GTR-1024). The vulnerability assessment was developed by a science-management partnership consisting of the U.S. Department of Agriculture, Forest Service (Siuslaw National Forest, Oregon Dunes National Recreation Area, Cascade Head Experimental Forest, Pacific Northwest Region, Pacific Northwest Research Station) and Northwest Climate Hub; U.S. Department of the Interior, Bureau of Land Management (Northwest Oregon District and Coos Bay District); and the University of Washington School of Environmental and Forest Sciences. The partnership assessed the vulnerability of natural resources to climate change and developed adaptation options that minimize negative impacts and facilitate ecosystem transition to a warmer climate.

KEYWORDS:
Adaptation
Aquatic ecosystems
Climate change
Climate-smart management
Ecosystem services
Fisheries
Hydrology
Infrastructure
Recreation
Science-management partnership
Terrestrial ecosystems
Vegetation
Wildfire
Wildlife



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